Linguistik Aktuell Linguistics Today

Optimality-Theoretic Studies in Spanish Phonology

Edited by
Fernando Martínez-Gil
Sonia Colina

John Benjamins Publishing Company

Optimality-Theoretic Studies in Spanish Phonology

Linguistik Aktuell/Linguistics Today

Linguistik Aktuell/Linguistics Today (LA) provides a platform for original monograph studies into synchronic and diachronic linguistics. Studies in LA confront empirical and theoretical problems as these are currently discussed in syntax, semantics, morphology, phonology, and systematic pragmatics with the aim to establish robust empirical generalizations within a universalistic perspective.

Volume 99

Optimality-Theoretic Studies in Spanish Phonology
Edited by Fernando Martínez-Gil and Sonia Colina

Optimality-Theoretic Studies in Spanish Phonology

Edited by

Fernando Martínez-Gil
The Ohio State University

Sonia Colina
University of Arizona

John Benjamins Publishing Company
Amsterdam / Philadelphia

The paper used in this publication meets the minimum requirements of American National Standard for Information Sciences – Permanence of Paper for Printed Library Materials, ANSI Z39.48-1984.

Library of Congress Cataloging-in-Publication Data

Optimality-theoretic studies in Spanish phonology / edited by Fernando Martínez-Gil and Sonia Colina.
p. cm. (Linguistik Aktuell/Linguistics Today, ISSN 0166–0829 ; v. 99)
Includes bibliographical references and indexes.
1. Spanish philology. I. Martínez-Gil, Fernando. II. Colina, Sonia.

PC4071.O68 2006
461--dc22 2006052032
ISBN 978 90 272 3363 9 (Hb; alk. paper)

John Benjamins Publishing Co. · P.O. Box 36224 · 1020 ME Amsterdam · The Netherlands
John Benjamins North America · P.O. Box 27519 · Philadelphia PA 19118-0519 · USA

To Suzie, Colin, and Paul

To Eric, Mariana and Adrian

Table of contents

Introduction

Fernando Martínez-Gil and Sonia Colina

Optimality Theory (OT) is undoubtedly the most influential phonological theory of the last decade. Its central tenet is that phonological patterns in human language arise in the resolution of conflicts among competing constraints. OT has been applied extensively to problems in a number of areas within the study of sound structure, including synchronic phonological analysis, the phonology–phonetics interface, the phonology–morphology interface, phonological and analogical change in historical linguistics, language variation, dialectology, and language acquisition. Different types of book-length OT publications have appeared recently, such as thematic guides, textbooks, collections of articles on specific aspects of the phonology, and so on. To our knowledge, however, there exists no comprehensive collection of OT research that focuses exclusively on the phonology of one particular language. This volume does precisely this for Spanish, a language in possession of a rich literature of phonological research of its own. Given the availability of a substantial amount of dialectal data, Spanish is also a very interesting testing ground for optimality-theoretic claims with regard to language variation.

This book is structured around six major areas of phonological research. In addition to traditional areas of phonological analysis, such as segmental and prosodic structure, it addresses closely related subareas, such as grammar interface (phonetics and morphology), intonation, dialectal variation, historical phonology, and phonological acquisition. Although the book focuses on Optimality-theoretic contributions to Spanish phonology, especially in view of the dominant role of OT in current phonological theory, it also offers a comprehensive sample of issues that have raised a great deal of interest and theoretical debate in Spanish phonology within the generative framework in recent years, such as consonantal lenition, glide fortition, *s*-aspiration, *n*-velarization, nasal place assimilation and neutralization, the depalatalization of coda nasals and laterals, the status of word-final vowels, including -*e*, the role of phonology in inflectional and derivational phonology, the problem of exceptional hiatuses, the metrical principles that govern Spanish primary stress, the status of "glides", and the nature of phonological phrasing.

The contributions contained in this volume also address many topics currently under debate in OT in general, such as opacity, the analysis of analogy in language variation and change, chain shifts, level stratification in OT, output-to-output correspondence, local constraint conjunction, Dispersion Theory, modeling variation in OT, the role of perceptual, cognitive, systemic and external influences on linguistic structure, constraint demotion and promotion in language acquisition, the Gradual Learning Algorithm in language variation and language acquisition, and the status of gestural and non-gestural constraints in the phonetics–phonology interface.

The contributions in this volume show that new and valuable insights can be gained by submitting the Spanish data to Optimality Theory. Thus, by taking inventory of the results of applying OT to various areas of Spanish phonology, this volume makes an essential contribution to two related but distinct fields, namely, Spanish linguistics and phonological theory.

Some chapters of this book will be suitable as core reading for advanced undergraduate and introductory graduate-level phonology courses, in particular those that offer comprehensive reviews of a specific area of study, such as syllabification (Colina) or language change (Holt), or those that, in addition to more technical content, include overviews of specific topics, as for instance, vowel harmony systems (Martínez-Gil), lenition in Romance (Baker), or the diachronic evolution of the vowel system of Latin (Martínez-Gil). The book will be most relevant for courses in general linguistics and graduate seminars in Spanish linguistics, especially because of its treatment of essential topics in Spanish phonology (e.g., *s*-aspiration, nasal place assimilation and neutralization, the depalatalization of coda nasals and laterals, the status of word-final vowels, including -*e*, exceptional hiatuses). It will also be useful as a reference book for researchers in linguistics and related fields with interest and/or specialization in phonology, phonological theory and acquisition, and linguistics. Furthermore, given the current multidisciplinary interest in Spanish, this volume may also be included in the reading lists of courses in related areas of cognitive science, first and second language acquisition, education, bilingualism, and speech and hearing science.

The following is a description of the volume's sections and chapters contained therein (length of editorial comment is obviously no reflection on chapter's level of quality or interest):

Section 1

The articles in this section include contributions on phonetics and phonology to capture the current significance of studies on the interaction of these two disciplines, and to illustrate the role played by OT in the recent increase of interest in this area. While Bradley's contribution deals directly with the interaction between phonetics and phonology at the level of the theory, arguing that phonetic (i.e., gestural) constraints can be incorporated in the phonology, Pilar Prieto's article discusses the interaction of syntactic and prosodic constraints in intonational phrases, thus adding one more interactional domain to the picture — the syntactic domain.

It is no coincidence that studies on the phonetics–phonology interface have multiplied under OT. The mechanism of constraint interaction makes the theory well equipped to address interface issues, be it the phonetics–phonology, phonetics–syntax or morphology–phonology interface. This book calls attention to success of OT in accounting for the interface phenomena by structuring two of its six sections around interface topics (Section 1 on the phonetics–phonology interface and Section 4 on the phonology–morphology interface).

Travis Bradley's "Spanish complex onsets and the phonetics–phonology interface" analyzes cross-dialectal phonetic variation in Spanish complex onsets in light of recent work on the phonetics–phonology interface. Two basic patterns of obstruent-rhotic cluster realization, vowel intrusion and coarticulation-induced rhotic assibilation, receive a phonetically-motivated explanation in terms of the temporal coordination of consonantal gestures, within the framework of Articulatory Phonology. Drawing upon recent developments in gestural Optimality Theory, Bradley proposes an account in which the interaction among gestural alignment constraints generates the range of attested patterns. On the basis of stress restrictions, non-concatenative morphology, the universal non-contrastiveness of intersegmental gestural coordination, and sonority conditions on complex onsets, vowel intrusion and rhotic assibilation are shown to be invisible to phonological processes that operate over segments and syllables. In contrast to theories that relegate gestural timing to a low-level phonetic implementation component, this study argues for a unified model in which gestural and non-gestural constraints are present in the same level of the phonology. Once a *representational* distinction is made between segments and gestures in the phonological representation, a *derivational* mapping between phonology and phonetics becomes unnecessary to account for the invisibility of gestural percepts.

Pilar Prieto's article "Phonological phrasing in Spanish" investigates the role of syntactic and prosodic markedness constraints on the construction of *phonological phrases* (φ- or p-phrases) in Peninsular Spanish. She shows that the construction of prosodic structure in this language cannot rely solely on syntactic information but has to refer to prosodic markedness constraints that regulate the size and balance of phrase constituents. The proposal is cast in a constraint-based OT approach, where the notion of edge alignment from Selkirk (1984) and constituent wrapping from Truckenbrodt (1995, 1999) are considered to be ranked and violable constraints. Specifically, phonological phrasing in Spanish is determined by the interaction of right-alignment of syntactic and phonological phrases (Align-XP,R) with a maximal requirement on the length of p-phrases (Max-Bin) and a minimality constraint on the prosodic parsing of utterances (Min-Bin). Prieto shows that other Romance languages (and English and Egyptian Arabic) have also provided critical evidence in favor of the importance of prosodic restrictions on phrasing prediction.

Section 2

The contributions in this section focus primarily on the interplay between markedness and faithfulness at the segmental level. "Hiatus resolution and incomplete identity" and "Upstepping vowel height" predominantly involve vowels and vowel features, whereas "Depalatalization in Spanish revisited" and "The phonology of implosive nasals in five Spanish dialects" focus on consonantal features. Although the topic of the chapter is segmental phonology, most chapters also have a clear connection with syllable structure as the segmental phenomena involved are determined by position in the syllable. This is particularly true of "The phonology of implosive nasals in five Spanish dialects", since the featural modifications experimented by the nasal consonants are a consequence of trying to avoid place features and coda consonants, and of "Depalatalization in Spanish revisited", as depalatalization is accounted for through the prohibition on palatal nasals in the coda. "Hiatus resolution and incomplete identity" is also connected to syllable structure as the output forms result from trying to avoid codas, long, identical vocoids, and onsetless syllables.

In "Hiatus resolution and incomplete identity", Eric Baković argues that potential vowel hiatus between words in Chicano Spanish is always resolved using one of several strategies, the choice among these strategies being influenced by several factors. One of these is the avoidance of adjacent segment identity, but complete identity appears not to be required: differences with respect to the feature [±high] are ignored in a specific set of cases. Baković proposes that the avoidance of adjacent similar segments is due to the simultaneous satisfaction of a constraint No-Long, which penalizes completely identical adjacent segments only, and other independently motivated constraints in the grammar.

Maria-Rosa Lloret and Joan Mascaró's study "Depalatalization in Spanish revisited" argues against recent claims that the non-occurrence of palatal nasals and laterals in syllable-final position in Spanish (e.g., *desdén – desdeñar*, *clavel – clavellina*) is a lexical remnant that should be treated in terms of allomorphy, and present evidence for maintaining depalatalization as an actual phenomenon by appealing also to the phonology of borrowings and to other cases of place centralization. They provide a parallel OT account of these facts in which overapplication of depalatalization in onset position in plural and diminutive forms (e.g., *desdenes*, *claveles*, *clavelito*) is analyzed as an output–output effect, in line with work by Baković (1998, 2001) with respect to the plural cases. In their view, output–output effects extend to diminutives because the correspondence relation is restricted by the strongest version of 'base' proposed in Kager (1999a,b).

The main goal of Fernando Martínez-Gil's article "Upstepping vowel height: a constraint-based account of metaphony in Proto-Spanish and Lena Asturian" is to argue for a unified analysis of stepwise vowel raising phenomena known as *metaphony* within the OT framework. It is shown that previous serial accounts based on autosegmental spreading rules operating on vowel height features are unable to capture adequately the unitary nature of the metaphonic shifts. It is suggested that stepwise raising in both Proto-Spanish and Lena Asturian emerges primarily in the interaction of two constraints, unranked with respect to each other: a markedness constraint which demands that the stressed vowel agree in vowel-height features with a following high vocoid within a word's dominant foot, and a local conjunction of identity constraints on contrastive vowel height features, which enforces stepwise raising by effectively restricting unfaithfulness between input and output to at most one feature. Both the agreement and the constraint conjunction constraint dominate the individual faithfulness constraints requiring input–output identity of vowel height features. Finally, it is shown that this analysis can be easily extended to handle the somewhat different metaphonic shifts in Nalón Valley Asturian, closely related to the Lena variety, by appealing to a different ranking of the same constraints proposed for the Lena variety, a result predicted by factorial typology.

In "The phonology of nasal consonants in five Spanish dialects" Carlos Eduardo Piñeros examines the processes of nasal place assimilation, neutralization, velarization and absorption in coda nasals in five dialects of Spanish in terms of three independent markedness constraints: Agree(Place), Place Hierarchy, and Align-C(Nasal). Despite being concerned with different aspects of the structure of output forms, these constraints conspire to undermine the place features of nasal consonants in the syllable coda. Data from five different Spanish dialects support the view that coronal is the unmarked place for consonants, and that the tendency of syllable-final nasals to become velar is not a consequence of assigning them an unmarked place articulator but of assimilating them to the preceding vowel. From this standpoint, velarization is only an intermediate step in a larger-scale process, whereby the nasal consonant is incorporated into the structure of the nuclear segment for the sake of segment-to-syllable alignment.

As indicated, the articles in this section constitute a good illustration of the interaction of universal markedness and faithfulness constraints that accounts for phonological systems in an OT framework. A limited set of independently justified constraints serves to account for processes that appear significantly different on the surface. Thus, in rather simplified terms, gliding, coalescence and vowel deletion in Chicano Spanish result from the interplay of syllabic markedness constraints (No Long, Onset, No coda, One-to-one) and faithfulness constraints targeting vowel features and vowels (Ident (hi), Ident (ba), Ident (low), Max-V, Uniformity). In Martínez-Gil's contribution, the markedness constraint requiring agreement in height features between vowels (Agree V-Height) and its ranking with respect to faithfulness constraints on preservation of vocalic features (Ident (hi), Ident (low) and Ident (ATR) are responsible for vowel harmony facts. The processes of nasal place assimilation, neutralization, velarization and absorption of nasal consonants analyzed by Piñeros result from three independent markedness constraints: Agree(Place), Place hierarchy, Align-C(Nasal) and their interaction with the faithfulness constraints that ban deletion of place features, segments, and feature nodes (major, nasal, stricture): Max(Place), MaxOns (place), Max Obs, Uniformity, Max(feature), Max(seg). In "Depalatalization in Spanish revisited" once again the markedness constraints Agree(Place) and Place hierarchy (*Labial, *Coronal, *Palatal), in conjunction with the Identity faithfulness constraints Ident(place), IdentOns(Place), ID-BA(PL), IdentObs(place), IdentSonorant(Place) are responsible for the depalatalization of nasals and overapplication to derived forms (e.g. from singular to plural).

Section 3

Although, given the nature of constraint interaction, syllable structure and stress appear in most, if not all, sections of this book, the chapters in Section 3 have a clear focus on syllable structure and stress. Colina's article is of a more general, comprehensive nature, offering an optimality-theoretic account of Spanish syllable structure with two goals in mind: (a) to highlight the advantages of an optimality theoretic approach to syllabification in order to show that OT has brought about significant improvement to our understanding of Spanish syllable structure; (b) to offer an overview of Spanish syllable structure under a non-derivational analysis.

The other two contributions in this section deal with concrete issues of syllabification and stress: Cabré and Prieto study the syllabification of vowel sequences, more specifically, exceptional hiatuses, while Roca offers an account of the narrowing of the three-syllable window brought about by vowel sequences. Cabré and Prieto examine the results of an empirical study on native-speaker syllabification intuitions and show that a correspondence-based OT analysis can capture the prosodic and analogical forces found to govern the process together with the interspeaker variation in the data. Roca's study formulates an optimality theoretic account of the non-verbal stress system of Spanish in order to show that the reduction of the three-syllable window is principally driven by Onset and the nature of the stress bearers (i.e. [−consonantal] segments). Although the data presented in Colina's and Roca's chapters are fairly well-known in the literature (the challenge being accounting for them), Cabré and Prieto's article presents new experimental data on exceptional hiatuses.

Sonia Colina's article "Optimality-theoretic advances in our understanding of Spanish syllabic structure" integrates all areas covered by traditional analyses of syllabification (e.g., syllable types, phonotactic restrictions, syllabification algorithms, domain of syllabification, and repair strategies), while it reviews some of the superior aspects of OT that have brought about significant improvement in our understanding of Spanish syllabic structure: the replacement of language-specific rules with universal constraints; the resolution of rule conspiracies; and the elimination of stipulatory statements (quality of epenthetic vowels) and adhoc conditions on rule application. The descriptive facts are explained through the general mechanism of the interaction of universal markedness and faithfulness constraints. Cross-dialectal and intra-speaker variation are obtained through variation in the ranking of the constraints. By resorting to universal constraints and language-specific ranking, variation is shown to result from the implementation of various ways of obtaining the same goal (e.g., elimination of coda consonants: complete deletion, voice neutralization, stricture neutralization, vocalization, etc.). Processes that were presented as separate in a derivational model (i.e., Spanish diphthongization, resyllabification and onset strengthening) are shown to respond to the same motivation (to avoid onsetless syllables). The article aims to be an updated optimality-theoretic alternative to general accounts of syllabification such as Harris (1989) and Hualde (1991). Not surprisingly, some constraints proposed in articles relating to segmental phonology and syllabic structure (Section 2: Piñeros, Lloret and Mascaró), are also present in Colina's general account of syllable structure:

e.g., Have Place, Place Hierarchy, Agree, Ident (place). Roca's and Cabré and Prieto's contributions also rely on already familiar constraints. In addition to metrical and syllabic constraints (Trochee, Onset), Cabré and Prieto resort to prosodic prominence constraints (prominent units: stressed, word-initial position, short stem), and paradigmatic/correspondence constraints (to account for analogical effects). Besides Trochee & Onset, Roca relies on metrical alignment constraints that align metrical constituents (foot boundary or the foot head) with the morphological constituent 'stem', and on the association of constraints to lexical class for marked, exceptional stress patterns and the words affected by them.

In "Exceptional hiatuses in Spanish", the data examined by Teresa Cabré and Pilar Prieto provide a close examination of how Spanish speakers syllabify sequences of vocoids of rising sonority within the lexicon (e.g., *piano* 'piano', *persiana* 'blind' or *historia* 'history'). A survey of 246 words was administered to 15 Peninsular Spanish speakers to examine in a quantitative way the strength of prosodic and morphological conditions on the appearance of the so-called exceptional hiatuses. The data reveal that the word initiality effect is not as strong as stated in the literature and that there are large differences between speakers: within the same dialect, half of the informants have the word-initiality effect in words such as *piano* 'piano' or *diálogo* 'dialogue', while the rest have practically generalized the presence of a diphthong in this position. Interestingly, morpheme boundary effects are found in conservative speakers and their conditions differ depending on the paradigm: (a) in nominal forms, gliding is blocked when there is an intervening morpheme boundary and when the glide is a high back vowel (*virt*[u.ˈo]*so* 'virtuous' vs. *od*[ˈjo]*so* 'hateful', *act*[u.ˈa]*l* 'present' vs. *cord*[ˈja]*l* 'cordial'); (b) in verbal paradigms, gliding is blocked when there is an intervening morpheme boundary and when the high vowel can be stressed in some form of the paradigm (*conf*[i.ˈa]*r* 'to trust', *confío* 'I trust' vs. *camb*[ˈja]*r* 'to change', *cambio* 'I change'). In general, the situation indicates that language change is in progress and that, for some speakers, the presence of lexical items that are pronounced with a hiatus is gradually disappearing.

In "The Spanish stress window" Iggy Roca offers an OT analysis of the word stress patterns of Spanish non-verbs, paying close attention to the interaction with the parse of abutting vowels and to the partly diverging behavior of traditional words (native or assimilated) and foreign forms in common use. Central to Roca's analysis are several right-alignment constraints relating some metrical material (foot boundaries and the foot head) to the morphological constituent 'stem'. The syllabification of abutting vowels is principally driven by Onset. Crucial aspects of the analysis concern the identity of stress bearers, in particular whether they project from rime vowels or from syllable heads, and the status of "glides", indeed their very existence.

Section 4

The papers in this section deal with the interface phonology–morphology. It is important to note that, despite somewhat different goals, three of the four chapters overlap significantly with regard to their empirical base. Bermúdez-Otero, Bonet and Saltarelli's contributions all address what is perhaps the most controversial area of Spanish morphophonology: morphological classes (including word markers and gender), e-epenthesis and plural formation. As all three authors recognize, these issues are intricately connected, so that it is not feasible to attempt an account of one without addressing the others. Such complex interaction is probably the reason why a definitive solution seems to have eluded phonologists until now. Yet, at the same time, it is also this interdependence that makes its resolution crucial to Spanish phonological analysis. All three authors formalize their proposals within an optimality-theoretic framework, using slightly different proposals within OT: Stratal OT, Classic OT, and Optimal Paradigms. Bonet and Bermúdez-Otero deal extensively with word-classes and their morphological structure (base and desinence) and pluralization; Saltarelli focuses on pluralization and paradigms. Despite different emphases, all three analyses make it clear that pluralization in Spanish cannot be fully explained without referring to the word classes of Spanish (including their morphological structure) and to the status of final [e] (and vice versa). This fact of course provides solid evidence of the morphophonological nature of pluralization and non-initial epenthesis in Spanish. In addition to their contribution to our understanding of Spanish morphophonology, these articles constitute an excellent resource for graduate courses covering the topics of word-classes, final [e] and pluralization in Spanish, given, of course, their shared empirical and analytical coverage.

In "Morphological structure and phonological domains in Spanish denominal derivation" Ricardo Bermúdez-Otero argues that Spanish denominal derivation evidences a morpho-phonological process of stem-final vowel deletion, contra most of the literature that assumes a morphotactic restriction: e.g. *man-**o*** 'hand', *man-az-a* 'hand.AUG', **man-**o**-az-a*. Stratal Optimality Theory requires vowel deletion, for otherwise the interaction between diphthongization and depalatalization gives rise to a stratification paradox. This paper adduces independent morphological evidence to confirm the existence of stem-final vowel deletion in Spanish, as predicted by Stratal Optimality Theory. The data reveal a previously unrecognized contrast between pseudoplural nouns and nouns with athematic stems ending in /s/, and cast light on the relative roles of suffixes and infixes in diminutive formation.

Eulàlia Bonet's article "Gender allomorphy and epenthesis in Spanish" argues, contrary to most previous approaches, that modern-day Spanish does not have final epenthesis or plural epenthesis, based on several types of empirical evidence. As a consequence, former epenthetic vowels have been reinterpreted as "gender" allomorphs or class markers. Only initial and internal epenthesis are possible in the synchronic grammar of Spanish. It is also shown that, contrary to some views, *-o* is not the default class marker. Under this new light, class markers are reanalyzed within Optimality Theory. It is claimed that all allomorphs are present in the input and that the constraint ranking, together with lexical specifications, determine which class marker surfaces and what contexts favor vowel epenthesis. Invariable plural formation follows naturally under this approach.

Mario Saltarelli's "A paradigm account of Spanish number" develops a paradigm account of number in Spanish in a constraint interaction framework inspired by the theory of Optimal Paradigms, working under the assumptions that an adequate grammar provides a formal characterization of the sound-meaning relation between the morpho-phonological alternants of a lexical constant, such as in the Number paradigm, e.g. Spanish <*casa,casas*> 'house', Italian <*panino,panini*> 'sandwich', or Latin <*puella/puellae*> 'lass' and that inflectional languages exhibit intricately complex systems of paradigms meeting legibility requirements at phonological interface through organizational principles such as category hierarchy and markedness. The analysis of Spanish Number proposed crucially relies on the parallel evaluation of the realization of both values of the paradigm of a single lexical constant, rather than on the evaluation of a single form of the alternation. Saltarelli argues that the paradigm approach to Spanish Number provides a more uniform account while shedding light on "exceptional" cases. His analysis has implications for the general constraint based theory of morpho-phonology.

Caroline Wiltshire's chapter, "Prefix boundaries in Spanish varieties: a non-derivational OT account", shifts the locus of the phonology–morphology interface to the left edge of the word, dealing with word and prefix boundaries and their interaction with segmental restrictions on coda and word-final segments. She focuses on the special phonology of prefixes, often used to provide arguments for rule ordering or special devices in Optimality Theory. Three cases of special behavior in varieties of Spanish are examined: aspiration of /s/ to [h] in Caribean; velarization of /n/ to [ŋ] in Granadan; and the non-fortition of /j/ to [ʒ] in Argentinean. In all three, prefix-final output segments match word-final outputs in those dialects. Therefore, prefixed words are analyzed as containing an internal word boundary, as $[pre[fix]_{PW}]_{PW}$. A constraint (family) is proposed which prefers weaker forms of consonants at prosodic boundaries, WEAK|WD. "Weak" consonants may undergo debuccalization or resist fortition. The account provides for syllabification and segmental alternations at prefix and word edges in non-derivational OT.

Section 5

The contributions in Section 5 deal with language variation and change. Optimality Theory has been applied to language change from very early on in its development; recent refinements in the theory have encountered significant explanatory success both in the synchronic and diachronic arenas (Dispersion Theory, Stochastic OT, etc). Accordingly, this section is designed to demonstrate that OT can explain language change and variation in a way that previous theories of phonology could not. Section 5 also shows that OT is well-equipped to incorporate functional, systemic constraints that account for preservation of contrast within the phonological system (Dispersion Theory, Baker's paper) as well as a good amount of phonetic detail necessary to understand the full significance of systemic changes, such as, for instance, lenition in the history of Romance. Three papers (Holt, Baker, and Gutiérrez-Rexach) focus on historical change while also recognizing the role of synchronic variation in language change. Baker and Gutiérrez-Rexach provide OT analyses of lenition and the syllabification margins (onsets and codas) in the history of Romance and Holt offers an overview of analyses of change in Spanish and Hispano-Romance. All three, and Holt in particular, discuss the issue of how to formalize change within OT. The fourth paper in this section (Díaz-Campos and Colina) has a more synchronic focus, dealing with sociolinguistic variation and change within the context of first language acquisition. It addresses the issue of modeling the non-categorical phenomenon of deletion of intervocalic approximants in an optimality-theoretic framework.

"Optimality Theory and Language Change in Spanish" by Eric Holt is a comprehensive overview of Optimality-Theoretic approaches to language change in Spanish, reviewing a number of works that invoke not only the interaction of faithfulness and markedness constraints, but also the role of perceptual, cognitive, systemic and external influences on linguistic structure and change at the level of segment and segmental inventory, syllable- and prosodic structure, and intersecting points of morphology, and mentions formal considerations that impact these. The chapter also includes an appendix that attempts to list all works published to date that treat language change and variation in Spanish and Hispano-Romance from an OT perspective.

Gary Baker's "Duration, voice, and dispersion in stop contrasts from Latin to Spanish" takes a new look at the evolution of stops from Latin to Spanish. In a series of sound changes that have often been described as a chain shift, geminates reduced to singletons, voiceless stops voiced, and voiced stops approximantized. These changes, generally attributed to lenition, are analyzed in Optimality Theory as variant constraint ranking over time, couching the analysis in the terms of Flemming's Dispersion Theory, a functionalist approach that takes whole systems of contrast into account rather than focusing on piecemeal change. The changes in question are thus viewed not only as the predictable effects of lenition in word-medial, intervocalic position (where they took place) but as part of a suite of changes that weakened stops in the same way while maintaining extant contrasts in the process. In addition to voicing distinctions, the phonetic cue of closure duration is shown to play a role, based on the findings of numerous researchers that duration functions crosslinguistically as a major means of marking voiceless/voiced stop contrasts. Moreover, it is shown that modifications to Dispersion Theory recognizing a more direct role for faithfulness allow the analyst to motivate constraint reranking over time as an effect of language acquisition and reanalysis of underlying forms. Reference to traditionally unspecified phonetic detail (e.g. stop closure duration) is argued to provide both a richer model and a fuller understanding of the nature and mechanisms of contrast underlying the changes in question. Moreover, since lenition — an often vaguely defined concept — is shown to operate in highly similar ways across these changes, the current approach provides for a more coherent, unified analysis than those heretofore presented.

In "The interaction between faithfulness constraints and sociolinguistic variation", Manuel Díaz-Campos and Sonia Colina examine the constraints governing the acquisition of sociolinguistic variables. More specifically, they investigate the acquisition of the school variety of Venezuelan Spanish characterized, according to previous research, by increased levels of retention of [ð̞] in lower socioeconomic-class children. The paper offers a quantitative analysis that provides empirical evidence for faithfulness effects in high activation domains, as well as a formal account of the data framed within OT. Positional faithfulness constraints are shown to interact with extra-linguistic variables such as socioeconomic class, and age, indicating the acquisition of stylistic variation. The results of the empirical investigation reveal a pattern of deletion of intervocalic [ð̞] in younger lower socioeconomic background children that is consistent with the informal variety spoken in the immediate community. This favorable tendency toward deletion is overruled when intervocalic [ð̞] is located in high activation domains, such as stressed syllable and word-initial position. In contrast, the older, lower-socioeconomic background children have fewer instances of deletion. The results suggest that the grammar of older, lower-socioeconomic class children contains two rankings, one favoring deletion and another one (acquired later) favoring retention. These rankings are activated as a consequence of external constraints such as *socioeconomic class*, *age*, and *style*. Probabilistic weights attached to each one of the rankings account for the general likelihood of selection of each ranking.

In "Sonority scales and syllable structure", Javier Gutiérrez-Rexach develops an analysis of syllable-structure changes from Latin to Proto-Romance and Spanish within the framework of recent developments in the formal treatment of OT. Some aspects of the transition in syllable structure from Classical Latin to Vulgar Latin are argued to guide margin-structure transformations. After characterizing the syllable structure (the set of possible margins: onsets and codas) of Classical Latin and Vulgar Latin / Proto-Romance / Spanish, it is claimed that structural transitions from Latin to Vulgar Latin show a general tendency to create more harmonic or sonorous structures (margins). This sonority-based treatment maximizes the impact of sonority scales on syllabification, going beyond standard generative treatments combining derivational rules and sonority constraints such as the Sonority Sequencing generalization.

All four papers in Section 5 are essential reading for graduate courses dealing with the nature of language change and variation and how a linguistic theory can account for it, incorporating the role of perception, cognition, systemic and external (social) influences on linguistic structure and change. In addition, Baker's contribution will be very useful as an introduction to the basic postulates of Dispersion Theory. It also contains a good overview of the historical facts surrounding lenition in Romance. Holt's paper contains an overview of the issues and major work in OT and historical Spanish phonology that will be extremely useful in the classroom.

Section 6

The contributions in this section focus on the acquisition of first language phonology in normally developing children, as well as in children with phonological delay (Barlow). The data are from original and published research, including the CHILDES database, and study the acquisition of syllable types developmentally (over a period of two to three years) (Morales-Front), of consonant clusters (Barlow), and of stress, both lexical and phrasal (Lleó and Arias).

All three papers frame the analysis of the data within an OT model and argue for the superiority of OT over previous models in accounting for acquisition: (a) Lleó and Arias explicitly compare OT to a Principles and Parameters approach and argue that the OT approach is much simpler and avoids making unjustified assumptions about the alleged universality of some parameters (e.g., directionality, foot form, etc); (b) Morales shows that OT, in combination with the Gradual Learning Algorithm, can explain the gradual nature of acquisition in a way not possible for previous models of phonology in which acquisition was understood as the sudden setting of parameters or learning of rules; (c) similarly, Jessica Barlow shows that the rankings of independently motivated optimality-theoretic constraints naturally allow for the asymmetries found in cluster reduction strategies (within and across children's grammars) to occur. The articles in this section also constitute a clear illustration of the fruitful interaction between phonological theory and acquisition studies recently facilitated by OT. All three contributions show that theoretical phonology can throw significant light on acquisition data and vice versa, that theories of phonology can be improved by incorporating acquisition data.

It is also worth noting that Section 6, dealing with syllable structure and stress from an acquisition perspective, constitutes a perfect companion to Section 3, also on syllabification and stress, in the adult phonological system.

As mentioned above, Jessica Barlow's "Constraint conflict in the acquisition of clusters in Spanish" characterizes the cluster production patterns of four Spanish-speaking children. Each child demonstrates a different pattern of production. The data support previous claims that there is a general preference for "sonority-based onset selection" cross-linguistically; this is explained via an appeal to independently motivated syllable structure markedness constraints. Divergence from the sonority pattern also occurs within and across the children's systems, which also has been observed in previous research. The asymmetries between cluster types are accounted for by appealing to independently motivated segmental markedness and faithfulness constraints. Taken together, the constraint interactions make testable predictions for different typologies of developing and fully-developed grammars.

In "Acquisition of syllable structure in Spanish", Alfonso Morales-Front examines the emergence and gradual acquisition of syllable types in Spanish. Using data from five children of the CHILDES project, it was found that the different syllable types emerge in a consistent pattern in four stages (1) V, CV, (2) VC, CVC, (3) CGV, CGVC, and (4) CCV. It was also found that this process of acquisition is gradual and that the frequency of syllable structures in the ambient language influences the order of acquisition. For instance, the presence of onsetless syllables in the first stage, opposed to a period of CV-only syllables, can be justified by taking into account the frequency of these types of syllables in the adult model. The formal analysis of the data is presented in two sections. One discusses the Constraint Demotion Algorithm according to which acquisition can be captured through constraint demotion. The fact that the Constraint Demotion Algorithm cannot account for the progression from emergence to acquisition, as well as the fact that there is variation during the same stage, in general and in the same individual, producing different outputs, is a weakness of the Constraint Demotion Algorithm and motivates proposing a new alternative analysis using the Gradual Algorithm Constraint. This model results in a better account not only of the gradual process of learning, but also the individual variation of the same individual at a given stage.

"Foot, word, and phrase constraints in first language acquisition of Spanish stress" by Lleó and Arias provides an analysis of stress acquisition in Spanish, within the framework of Optimality Theory, focusing on the earliest utterances by two monolingual Spanish children. The Spanish stress algorithm exhibits right-headedness both at word and phrase level. Leaving aside some peripheral cases that call for moraic trochees, it was assumed that the main core of the Spanish system is based on the syllabic trochee as the basic prosodic pattern. The children's first twenty one-word utterances made up of trochaic patterns were phonetically analyzed for the values of amplitude, pitch, and duration. The same analysis was carried out for word combinations comprising two trochaic-shaped words, as well as for some multisyllabic words present in our corpus. All vowels were analyzed with *Pitchworks*. The results show that Spanish children master the constraint hierarchy responsible for word and phrasal stress assignment from very early on; however, they may produce prominence in a non-standard fashion, because their command of the acoustic parameters responsible for an adult-like phonetic implementation is not yet under control. Moreover, they tend to overgeneralize the trochaic pattern to some iambic-shaped words. It is suggested that all these phenomena are to be construed in terms of constraint re-ranking.

Acknowledgements

Our gratitude to everyone that has contributed to make this volume possible, especially the following scholars (listed alphabetically), who provided careful and detailed reviews of the articles submitted for publication: Julie Auger, Paul Boersma, Giovana Bonilha, María Carreira, Megan Crowhurst, Stuart Davis, Paola Escudero, Ian Flemming, Sonia Frota, Randall Gess, Jorge Guitart, Mike Hammond, José Ignacio Hualde, David Ingram, Anthony M. Lewis, Diane Ohala, Orhan Orgun, Lori Repetti, Sam Rosenthall, and Max Wheeler.

We would also like to thank the contributors to this volume for their patience and dedication, as well as for their comments and reviews of the articles in the book.

References

Baković, E.J. 1998. "Spanish codas and overapplication." In *Romance Linguistics: Theoretical Perspectives (Selected Papers from the 27th Linguistic Symposium on Romance Languages, 1997)*, A. Schwegler, B. Tranel and M. Uribe-Etxebarria (eds), 13–23. Amsterdam/Philadelphia: John Benjamins.

———. 2001. *"Nasal place neutralization in Spanish." In U Penn Working Papers in Linguistics 7.1: Proceedings of the 24th Annual Penn Linguistics Colloquium, M. Minnick Fox, A. Williams and E. Kaiser (eds), 1–13. Philadelphia, PA: PWPL. (Available online at: http://roa.rutgers.edu, No. 386.)*

Harris, J. W. 1989. "Our present understanding of Spanish syllable structure." In *American Spanish Pronunciation*, P. C. Bjarkman and R. M. Hammond (eds), 151–169. Washington, DC: Georgetown University Press.

Hualde, José I. 1991. "On Spanish syllabification." In *Current Studies in Spanish Linguistics*, Héctor Campos and Fernando Martínez-Gil (eds), 475–493. Washington, DC: Georgetown University Press.

Kager, R. 1999a. "Surface opacity of metrical structure in Optimality Theory." In *The Derivational Residue in Phonological Optimality Theory*, B. Hermans and M. v. Oostendorp (eds), 207–245. Amsterdam/Philadelphia: John Benjamins.

———. 1999b. *Optimality Theory*. Cambridge: Cambridge University Press.

Selkirk, E. 1984. *Phonology and Syntax. The Relation between Sound and Structure*. Cambridge, Massachusetts: MIT Press.

Truckenbrodt, H. 1995. *Phonological phrases: Their Relation to Syntax, Focus, and Prominence*. MIT, Cambridge, Massachusetts. Ph.D. Diss.

Truckenbrodt, H. 1999. "On the relation between syntactic phrases and phonological phrases", *Linguistic Inquiry* 30: 219–255.

Spanish complex onsets and the phonetics–phonology interface*

Travis G. Bradley
University of California, Davis

This study analyzes cross-dialectal phonetic variation in Spanish complex onsets in light of recent work on the phonetics–phonology interface. Two basic patterns of obstruent-rhotic cluster realization, vowel intrusion and coarticulation-induced rhotic assibilation, receive a phonetically-motivated explanation in terms of the temporal coordination of consonantal gestures, within the framework of Articulatory Phonology (Browman and Goldstein 1989, 1990, 1991, et seq.). Drawing upon recent developments in gestural Optimality Theory (Davidson 2003, Gafos 2002, Hall 2003), I propose an account in which the interaction among gestural alignment constraints generates the range of attested patterns. On the basis of stress restrictions, non-concatenative morphology, the universal non-contrastiveness of intersegmental gestural coordination, and sonority conditions on complex onsets, I show that vowel intrusion and rhotic assibilation are invisible to phonological processes that operate over segments and syllables. In contrast to theories which relegate gestural timing to a low-level phonetic implementation component, this study argues for a unified model in which gestural and non-gestural constraints are present in the same level of the phonology (Hall 2003). Once a *representational* distinction is made between segments and gestures in the phonological representation, a *derivational* mapping between phonology and phonetics becomes unnecessary to account for the invisibility of gestural percepts.

Keywords: gestural coordination, phonetics–phonology interface, rhotics, vowel intrusion, assibilation

* Ealier versions of this work were presented at the *XXXII Linguistic Symposium on Romance Languages* (University of Toronto, April 2002) and, with Benjamin Schmeiser, at the *6th Hispanic Linguistics Symposium* (University of Iowa, October 2002). For feedback and discussion, I am grateful to Gary Baker, Eric Bakovic, Jill Beckman, Barbara Bullock, Adamantios Gafos, Nancy Hall, David Heap, Haike Jacobs, Joan Mascaró, John McCarthy, Jean-Pierre Montreuil, Carlos Eduardo Piñeros, Donna Rogers, Benjamin Schmeiser, Bart van der Veer, and Caroline Wiltshire. Thanks also to two anonymous reviewers for their constructive comments. I alone am responsible for any remaining shortcomings in the present work. This research was partially supported by funding from the Division of Humanities, Arts, and Cultural Studies (College of Letters and Science, UC Davis) and by a Faculty Research Grant, "Phonetic Variation in The Cross-dialectal Realizations of Spanish Tap and Trill" (Academic Senate, UC Davis).

0. Introduction

In Articulatory Phonology (Browman and Goldstein 1989, 1990, 1991, et seq.), the grammar is assumed to operate on articulatory gestures, which are dynamically defined along both spatial and temporal dimensions and produce a constriction in the vocal tract. Many alternations that have previously been explained in discrete, phonological terms can be analyzed in terms of gestural overlap and/or reduction in casual speech. However, the status of gestural representations in the synchronic grammar remains controversial. Should gestures be phonological primitives as well as units of articulation, or is Articulatory Phonology better viewed as a model of phonetic implementation? If gestures are primitives, should they supplant segments or coexist with them? Should the temporal coordination of gestures be specified in underlying representation, or should it be determined by the grammar?

Phonetic variation in Spanish complex onsets — in particular, /Cɾ/ — provides a fertile empirical terrain in which to explore these theoretical issues. Rhotics are known for the considerable phonetic variety they exhibit across languages, dialects, and speech styles. Nonetheless, a common trend among contemporary generative studies of Spanish has been to gloss over what are deemed to be irrelevant, low-level details of phonetic implementation. Such a move is taken, for instance, by Harris (1983: 62), who reduces the "astonishing variety of *r*-quality phones … to just two … which will be understood to jointly exhaust the rich phonetic variety […] I will say little more about phonetic detail…" However, an investigation of phonetic detail is important to uncovering systematic aspects in the patterning of rhotics, which ultimately bears on the status of gestural representations and constraints in the grammar. Recent studies on Spanish rhotics have begun to redress the lack of attention given to phonetic detail (e.g., Blecua 2001, Bradley 1999, 2001a, 2004, Bradley and Schmeiser 2003, Colantoni 2001, Colantoni and Steele 2005, Hammond 1999, 2000, Hualde 2004, Lewis 2004, Schmeiser 2004, Willis 2005, and Willis and Pedrosa 1999). The present work contributes to this line of research by investigating the role of gestural coordination in Spanish complex onsets.

There are two basic patterns of /Cɾ/ cluster realization across Spanish dialects. Vowel intrusion involves the appearance of a vowel-like fragment between the two consonants. Coarticulation entails the absence of such fragments, with concomitant assibilation of the rhotic and gradient laryngeal and/or place accommodation of the cluster. Drawing upon recent developments in gestural Optimality Theory (Davidson 2003, Gafos 2002, Hall 2003), I propose an account of these patterns in terms of differences in the temporal coordination of gestures, which are controlled by gestural alignment constraints. On the basis of stress restrictions, non-concatenative morphology, the universal non-contrastiveness of intersegmental gestural coordination, and sonority conditions on complex onsets, I show that vowel intrusion and rhotic assibilation are invisible to phonological processes that operate over segments and syllables. Invisibility suggests that gestural coordination is a low-level phenomena of phonetic implementation, which can often produce mismatches with the phonological representation. However, I show that a *derivational* relationship between phonology and phonetic implementation is unnecessary once a *representational* distinction is made between segments and gestures (Hall 2003). In a unified model, gestural alignment constraints determine intersegmental gestural timing, while non-gestural constraints make reference to segments, syllables, and other aspects of prosodic structure. The universal non-contrastiveness of gestural coordination suggests that UG contains no faithfulness constraints on input timing.

This paper is organized as follows. Section 1 documents patterns of phonetic variation in the realization of complex onsets in Spanish. Section 2 develops an account of vowel intrusion in terms of competing gestural coordination constraints, and Section 3 extends the analysis to coarticulation. Section 4 discusses implications for the phonetics–phonology interface. Section 5 compares the proposed analysis with previous ones, and Section 6 summarizes and concludes.

1. Phonetic patterns of Spanish complex onsets

In Spanish, complex onsets consist of an obstruent /p, t̪, k, b, d̪, ɡ, f/ followed by a liquid /l/ or /ɾ/, except for /d̪l/ and, depending on the dialect, /t̪l/ (Harris 1983: 13–14, 20–22, 31–35, Harris and Kaisse 1999: 125, Hualde 1991: 481–483, 1999: 171–172). It has long been noted in the Spanish phonetic literature that the apicoalveolar tap /ɾ/ is usually accompanied by a vocalic element appearing between the rhotic and a preceding or following consonant (Gili Gaya 1921, Lenz 1892, Malmberg 1965, Navarro Tomás 1918, Quilis 1970). Researchers have given a variety of descriptive labels to the vowel fragment, including *svarabhakti, transitional, parasitic, epenthetic,* etc. Adopting terminology from Hall's (2003) cross-linguistic study, I henceforth refer to this phenomenon as *vowel intrusion* and to the fragments themselves as *intrusive vowels.* The reason for this terminological choice is to distinguish vowel intrusion from true epenthesis of a phonological vowel, a distinction that will be motivated in Section 4. The examples in (1) illustrate vowel intrusion in complex onsets.

(1)	*<u>pr</u>onto*	[pᵊɾ]	'soon'
	<u>fr</u>esco	[fᵊɾ]	'fresh'
	<u>tr</u>es	[t̪ᵊɾ]	'three'
	<u>gr</u>acias	[ɡᵊɾ]	'thanks'

Although represented here in narrow phonetic transcription as a superscript schwa [ᵊ], the intrusive vowel typically has formant structure similar, but not identical, to that of the nuclear vowel appearing on the opposite side of the tap constriction (Quilis 1993: 337–342).

One of the striking characteristics of intrusive vowels in Spanish is their variable duration, as was pointed out early on in phonetic studies based on kymographic inscriptions. For example, Gili Gaya (1921) made the following observation based on measurements of /Cɾ/ tokens from words pronounced by speakers of Peninsular Spanish:

> The duration of the intervening vocalic element is highly variable even in the same word repeated several times by the same individual. This variability prob-

> ably stems from rate of speech and from the fact that speakers are unaware of the existence of this vowel fragment, even though in most cases it attains a duration greater than that of the *r* (Gili Gaya 1921: 278–279).

In a later study of Spanish /ɾ/, Malmberg (1965: 10, 35) observed that the duration of the intrusive vowel often approximates that of an unstressed vowel. In fact, the intrusive vowel has occasionally given rise to a lexicalized anaptyctic vowel which copies the nucleus that is tautosyllabic with the complex onset, as shown by the diachronic examples in (2) (Gili Gaya 1921: 280, Quilis 1988: 300).

(2)	*peréces*	< *preces*	'prayers'
	tarabilla	< *trabilla*	'stirrup'
	corónica	< *crónica*	'chronicle'
	chácara	< *chacra*	'farm'
	gurúpa	< *grupa*	'hindquarters'
	tíguere	< *tigre*	'tiger'

Quilis (1970) reports similar variability in the duration of the intrusive vowel appearing in /Cɾ/ clusters, which ranges from 8 ms to 56 ms. The mean duration for intrusive vowels is 29 ms versus 20 ms for the tap constriction. In an acoustic study of Castilian Spanish, Blecua (2001) finds that the mean duration of the intrusive vowel in /Cɾ/ is significantly longer than that of the tap constriction itself (27.9 ms versus 20.5 ms). The standard deviation is larger for the mean duration of the intrusive vowel than for that of the tap constriction (9 versus 5.4), which indicates greater variability in the former. Both of these results agree with the findings of Gili Gaya (1921) and Quilis (1970). In a more recent experimental study, Colantoni and Steele (2005) report variable duration of intrusive vowels in Buenos Aires Spanish, ranging from 20 ms to 47 ms. Therefore, vowel intrusion in clusters containing /ɾ/ is not limited to Peninsular Spanish varieties. The phenomenon seems to be quite pervasive across dialects and is also found with /ɾ/ and other sonorants in other languages (see the discussion in Section 2).[1]

In contrast to /Cɾ/, onset clusters containing an obstruent followed by a lateral typically do not exhibit vowel intrusion in Spanish. Previous phonetic studies provide ample evidence and description of the intrusive vowel in /Cɾ/, but /Cl/ clusters are remarkably absent from such discussions. Some researchers have proposed that the

1. There are reports, often conflicting, of other aspects of phonetic detail in the realization of Spanish /Cɾ/ onset clusters. The measurements of Gili Gaya (1921) suggest that the intrusive vowel is longer when the /CɾV/ demisyllable is word-initial or stressed and when the initial consonant of the cluster is dorsal. Blecua (2001) finds longer intrusive vowels after voiced consonants and after dorsals. Based on data from Madrid Spanish, Schmeiser (2004) corroborates Blecua's findings, but fails to find any significant effects for word position or stress. For Buenos Aires Spanish, Colantoni and Steele (2005) document significantly longer intrusive vowels after voiced consonants, after dorsals, and in stressed demisyllables. However, they report that word-medial clusters show longer vowels than word-initial ones. Given the variable nature of the phenomenon, discrepancies among reported findings are not unexpected and can be plausibly attributed to differences among speakers and/or dialects. To attempt a comprehensive analysis of all of these patterns is beyond the goals of this paper, but see Colantoni and Steele (2005) for an in-depth discussion of the phonetic factors involved in obstruent-liquid cluster realization.

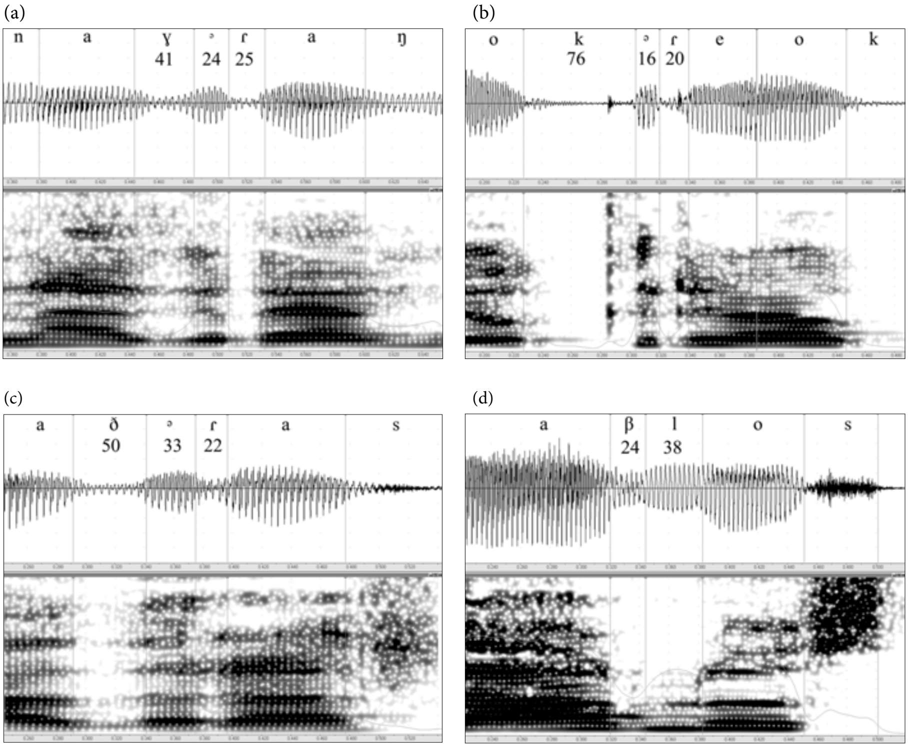


Figure 1. Vowel intrusion in *una gran cantidad* 'a great quantity' (a), *yo creo que* 'I believe that' (b), and *cuadras* 'stables' (c) versus no vowel intrusion in *establos* 'cow sheds' (d)

intrusive vowel is part of the definition of Spanish /ɾ/, which underscores its failure to appear with /l/. For instance, Gili Gaya (1921: 279) states that the rhotic "is a vocalic sound interrupted by an alveolar contact that is voiced and more or less tense." Furthermore, there is an asymmetry in the number of historical examples showing the development of anaptyctic vowels in Spanish onset clusters. The majority of examples cited by Malmberg (1965) and Quilis (1988) involve /Cɾ/, as shown in (2). In contrast, the only given example containing /Cl/ is *Ingalaterra* < *Inglaterra* 'England'. With respect to Buenos Aires Spanish, Colantoni and Steele (2005) demonstrate that intrusive vowels are almost categorically absent in /Cl/ clusters, occurring at a rate of less than 2% in their sample.

The waveforms and spectrograms in Figure 1 provide a visual illustration of obstruent-liquid cluster realizations, with durational measurements indicated in milliseconds. The acoustic examples presented in this paper are based on data from a single female speaker from La Paz, Bolivia, and are thus intended to provide a representative description of the phenomena under discussion.[2] In (a-c), [ɾ] is phonetically separated

2. The Bolivian data come from a larger corpus of Spanish fieldwork material consisting of recorded interviews and readings of literary texts of varying lengths, constructed through consultation with from the preceding obstruent by an intrusive vowel of variable duration, in which some trace of formant structure is recoverable from the nuclear vowel opposite the tap constriction.[3] On the other hand, the [βl] cluster in (d) is realized as a contiguous sequence with no intervening vowel fragment.

The discussion of vowel intrusion thus far suggests that /Cɾ/ clusters are realized along an intersegmental duration continuum as a function of the relative phonetic separation between the consonants of the cluster. At the other end of this continuum are cases of what I shall refer to as *coarticulation,* exemplified in (3). These examples come from Alonso's (1925) descriptive study of Peninsular Spanish varieties spoken near Álava, Navarra, Rioja, and Aragón.

(3)	*apretar*	[pɹ̥]	'to squeeze'
	hombre	[bɹ]	'man'
	otro	[tɹ̥]	'other'
	vendrá	[dɹ]	's/he will come'
	padre	[ðɹ]	'father'
	escribir	[kɹ̥]	'to write'
	magras	[ɣɹ]	'lean (FEM PL)'

As suggested by these narrow transcriptions, coarticulation entails some frication, or assibilation, of the rhotic and the loss of both the intervening intrusive vowel and the extra-short constriction period of apicoalveolar /ɾ/. Rhotics are subject to partial devoicing when coarticulated with a preceding voiceless consonant (e.g., [pɹ̥] versus [pᵊɾ]). In addition, dental /t̪/ and /d̪/ accommodate the constriction location of the rhotic, yielding an alveolar quasi-affricate realization (e.g., [tɹ̥] versus [t̪ᵊɾ]).[4] The articulatory descriptions provided by Alonso (1925) and Malmberg (1965) are particularly revealing on all of these points:

native speaker informants from over 25 different regions throughout the Spanish-speaking world. Informants were initially recorded on reel-to-reel tape, and the recordings were later digitized and stored on CD-ROM in MPEG format at 22,050 Hz and 16-bit. The fieldwork corpus was made available by John Dalbor at the Pennsylvania State University and subsequently digitized under the supervision of Eric Bakovic at the University of California, San Diego. The tokens presented in this paper were extracted from the corpus recordings, converted to WAV format, and analyzed with version 2.6 of the Summer Institute of Linguistics Speech Analyzer software package.

3. Spanish exhibits a surface alternation in voiced obstruents between stops and continuants. In most dialects, the stops [b, d̪, g] surface after nasal, pause, and in the case of [d̪], after /l/, while the continuants [β, ð, ɣ] appear elsewhere (see Martínez-Gil 2001 and the references cited therein).

4. An anonymous reviewer points out that since coarticulation processes involve some degree of *assimilation* to neighboring segments, the term *coarticulation* is not completely felicitous as a descriptive label for all of the cluster realizations shown in (3). While progressive rhotic devoicing and regressive dental stop retraction do constitute assimilatory effects, the same cannot be said for [bɹ] or [ɣɹ], which show loss of the intrusive vowel but no devoicing or place accommodation. As I argue in Section 3, however, all of these realizations receive a unified explanation in terms of greater overlap of articulatory gestures. Therefore, I continue to employ the term *coarticulation* as a unifying label in order to emphasize the articulatory basis of the phenomenon.

> The *r* combines with the consonants with which it groups, without any epenthetic vocalic element (Alonso 1925: 185).

> The *r* tends to be formed during the articulation of the preceding voiceless stop, invading its release, letting itself in turn be invaded by the voicelessness of the release … I have heard in speakers from diverse regions of the Peninsula the same fusion in moments of physical fatigue, when speaking casually or in a low voice (Alonso 1925: 186, 189).

> This tendency of the consonant *r* to combine with a dental to form a new consonant, which is generally a compromise between the two, is not unknown in other languages (Malmberg 1965: 39).

> Careful speech allows the identity of the sounds to be recovered … Careful speech is sufficient to ensure greater intelligibility by isolating the elements of the consonant group (Alonso 1925: 186–187).

Furthermore, realizations of /Cɾ/ clusters are dependent upon speech style, as per Alonso's observations that casual speech favors coarticulation while careful speech enhances recoverability.

Lipski (1994: 320) points out that in highland Peru, "pronunciation of the groups /t̪ɾ/, /pɾ/, /kɾ/ is partly determined by ethnolinguistic background. Among bilingual speakers, the /ɾ/ in these combinations is a fricative or retroflex approximant, and in the case of /t̪ɾ/ may fuse with the preceding consonant to produce a quasi-affricate." Lipski's description of the Peruvian pattern mirrors that of Alonso (1925) for Peninsular Spanish in that coarticulation may affect /Cɾ/ clusters regardless of the place specification of C_1. However, other Latin American varieties appear to limit coarticulation specifically to homorganic clusters in which C_1 is a coronal stop. Representative data in (4) are based on Argüello's (1978) study of highland Ecuadorian Spanish.[5]

(4)	a.	*tres*	[tɹ̥]	'three'
		cuatro	[tɹ̥]	'four'
	b.	*vendrá*	[n$^{\text{d}}$ɹ]	's/he will come'
		saldrá	[l$^{\text{d}}$ɹ]	's/he will leave'
	c.	*padre*	[ð$^{\text{ə}}$ɾ]	'father'
	d.	*premio*	[p$^{\text{ə}}$ɾ]	'prize'
		cruz	[k$^{\text{ə}}$ɾ]	'cross'

In casual speech, coarticulation affects clusters such as those in (4a,b), where the preceding coronal is realized as noncontinuant. In (4c), however, the voiced coronal surfaces as a continuant after a preceding vowel, and the underlying cluster surfaces intact (cf. example (c) of Figure 1). Coarticulation also fails to affect heterorganic clusters, as in (4d). Furthermore, Lipski (1994) documents a similar pattern for other geographic

5. In accordance with the convention of Hispanic linguistics, Argüello employs [ř] and [ř̥] to represent voiced and voiceless variants, respectively, of the *r asibilada* (assibilated/fricative *r*). For consistency, I continue to employ Alonso's transcription of the coarticulated rhotic as [ɹ] and [ɹ̥] in (4a,b), and I also indicate the lack of coarticulation by transcribing the intrusive vowel [$^{\text{ə}}$] in (4c,d).

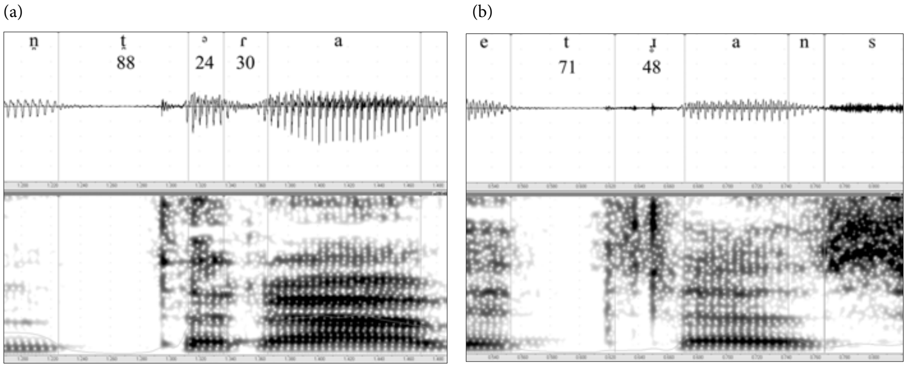


Figure 2. Vowel intrusion in *encontraba* 'found' (a) versus coarticulation in *se transforma* 'changes' (b)

zones, namely Northern interior Argentina (p. 172), highland Bolivia (p. 189), Chile (p. 200), Colombia (pp. 209–210), Central Costa Rica (p. 222), Guatemala (p. 265), Honduras (p. 272), Mexico (p. 279), and Paraguay (p. 308). Available phonetic descriptions suggest that coarticulation between /ɾ/ and a preceding homorganic stop is widespread across these varieties, but similar behavior involving heterorganic C_1 is presumably unattested.

The empirical generalization emerging here suggests an implicational relationship between two types of /Cɾ/ coarticulation in casual speech across Spanish dialects. In Peninsular and Peruvian varieties, coarticulation affects potentially any /Cɾ/ cluster in casual speech, while in other Latin American varieties, it is restricted to clusters in which C_1 is a coronal noncontinuant. For a given dialect, coarticulation of heterorganic clusters entails coarticulation of homorganic ones (with noncontinuant C_1), but the opposite does not hold, as evidenced by the data in (4).

The data in Figure 2 exemplify the variable coarticulation of /t̪ɾ/ clusters, taken from the same highland Bolivian Spanish informant who produced the tokens in Figure 1. In (a), glottal tone and some formant structure are present during the tap constriction following the intrusive vowel. In contrast, vowel intrusion is absent under coarticulation in (b). The rhotic corresponds to a 48 ms period of strident frication, whose turbulence is indicated by the presence of aperiodic energy in the upper spectra. Taken together with (a-c) of Figure 1, these representative data provide some empirical support for the implicational relationship between coarticulation in homorganic and heterorganic clusters. For the Bolivian informant, coarticulation variably affects /t̪ɾ/, whereas other clusters typically exhibit vowel intrusion.

The review of previous phonetic studies yields several generalizations regarding phonetic variation in onset clusters across Spanish dialects:

(5) a. An intrusive vowel of variable duration typically occurs in /CɾV/ but not in /ClV/.
b. The formant structure of the intrusive vowel in /CɾV/ demisyllables is similar, but not identical, to that of the tautosyllabic nuclear vowel.
c. Anaptyctic vowels that arise historically from /CɾV/ copy the quality of the tautosyllabic nuclear vowel.

d. Coarticulation in casual speech of heterorganic /Cɾ/ in a given dialect entails coarticulation of homorganic /Cɾ/ (where C_1 is noncontinuant) but not vice-versa.

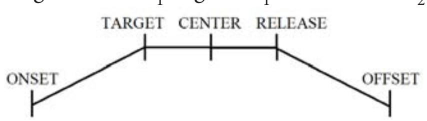
In the following sections, I propose an account of the generalizations in (5) in which the coordination of articulatory gestures is determined by the interaction of Optimality-theoretic alignment constraints.

2. Vowel intrusion and historical copy vowels

Articulatory Phonology provides an explanatory phonetic account of vowel intrusion in terms of the temporal coordination of consonant and vowel gestures. According to Steriade (1990), vowel intrusion results when an overlapping vowel gesture is heard during the open transition between two consonants. Languages vary systematically in the classes of consonants triggering vowel intrusion (Hall 2003). Such variation can be captured in the framework developed by Gafos (2002), which incorporates the gestural representations of Articulatory Phonology within a constraint-based, Optimality-theoretic grammar (Prince and Smolensky 1993, McCarthy and Prince 1993). Gafos proposes that gestural coordination is determined by alignment constraints of the form (6a), which make reference to temporal landmarks during the activation period of a gesture, shown in (6b):

(6) a. ALIGN(G_1, LANDMARK$_1$, G_2, LANDMARK$_2$)
Align landmark$_1$ of gesture$_1$ with landmark$_2$ of gesture$_2$.

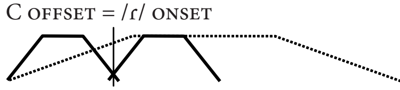
b.



Researchers adopting this framework have posited coordination relations for CV, VC, CC, and VV sequences (Davidson 2003, Gafos 2002, Hall 2003). I propose that an analysis of Spanish onset clusters requires several CC alignment constraints, the first of which is given in (7a). This constraint specifies an OFFSET = ONSET coordination relation in /Cɾ/ sequences, which ensures an open articulatory transition between /ɾ/ and the preceding consonant, as shown in (7b).

(7) a. ALIGN(C, OFFSET, /ɾ/, ONSET)
In /Cɾ/, align the offset of C with the onset of /ɾ/.

b. *Coordination:* C OFFSET = /ɾ/ ONSET

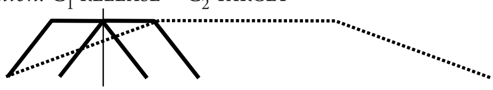


Percept: [C ə ɾ V]

Following Browman and Goldstein (1990) and Steriade (1990), I assume that within a syllable, consonantal articulations are superimposed on the tongue body gesture of the vowel, which is represented by the dotted line in (7b). Open transition allows the initial portion of the full vowel to be perceived between the constriction periods of the initial consonant and /ɾ/. Vowel intrusion is the acoustic result of this articulatory configuration.

The constraint favoring open transition in (7a) competes with other constraints on CC coordination. The alignment constraint in (8a) favors a RELEASE = TARGET relation in which the initial consonant of a /CC/ cluster is unreleased. As illustrated in (8b), close transition between adjacent consonants prevents vowel intrusion in the cluster.

(8) a. ALIGN(C_1, RELEASE, C_2, TARGET)
In /C_1C_2/, align the release of C_1 with the target of C_2.
b. *Coordination:* C_1 RELEASE = C_2 TARGET



Percept: [C ˥ C V]

As Hall (2003: 18) argues, conflicting gestural alignment constraints such as (7a) and (8a) have a functional grounding in terms of perceptibility and effort minimization, respectively. While open transition and vowel intrusion ensure clearer perceptual cues for the adjacent consonants (e.g., consonant release and formant transitions), a greater degree of overlap yields a relatively faster, more efficient overall articulation of the cluster.

The first generalization about Spanish complex onsets given in (5a) is that /Cɾ/ clusters typically have open transition and vowel intrusion, while /Cl/ clusters do not. This pattern actually reflects a broader typology of vowel intrusion behavior involving sonorants. Hall's (2003) cross-linguistic survey shows that vowel intrusion happens more with liquids than with other sonorants, and more with rhotics than laterals, except the alveolar trill. Consider the following implicational hierarchy:

(9) Vowel intrusion triggers (Hall 2003: 28)
obstruents, if ever > other approximants, nasals > [r] > [l] > [ɾ], [ʁ] > gutturals
Among nasals: m > n

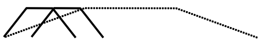
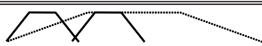
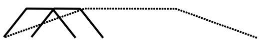
In a given language, if a particular class of consonants in (9) triggers vowel intrusion in clusters, then so do all consonant classes further down the hierarchy (modulo phonotactic restrictions and accidental gaps). One way to capture this typology is to posit a universal ranking of CC coordination constraints favoring open transition, each relativized to a different consonant class. The ranking of overlap-inducing constraints such as (8a) with respect to this hierarchy distinguishes consonants that trigger vowel intrusion from consonants that favor close transition.[6]

Spanish makes the cutoff point between [l] and [ɾ] in (9). Tableau (10) illustrates the difference in gestural alignment between /Cɾ/ and /Cl/ clusters. The ranking of (7a) above (8a) favors candidate (10a) with open transition over candidate (10b) with close transition, thereby ensuring vowel intrusion in [Cᵊɾ V] demisyllables. In turn, (8a)

6. This proposal diverges slightly from that of Hall (2003: 28–30), who posits a hierarchy of *C IN V constraints penalizing the complete overlap of different types of consonant gestures by a tautosyllabic vowel gesture.

outranks the alignment constraint favoring open transition in /Cl/, which accounts for the close transition and the lack of vowel intrusion in [ClV] (10d). In sum, generalization (5a) is explained by the Spanish-specific ranking of (8a) along the universal constraint hierarchy projected from the scale in (9).[7]

(10) Open transition in /Cɾ/ versus close transition in /Cl/

	Align (C, offset, /ɾ/, onset)	Align (C_1, release, C_2, target)	Align (C, offset, /l/, onset)
a. ☞  [C^{ə}ɾV]		*	
b.  [CɹV]	*!		
c.  [C^{ə}lV]		*!	
d. ☞  [ClV]			*

As discussed in Section 1, the duration of the intrusive vowel is highly variable in Spanish /Cɾ/ clusters. Following a proposal by Davidson (2003: 168–174), I suggest that a possible account of such variation might involve specifying a range of landmarks in the initial consonant gesture with which /ɾ/ may be aligned. If the constraint in (7a) is redefined as Align(C, {release ↔ offset}, /ɾ/, onset), then the onset of the /ɾ/ gesture could be aligned with any point between the release and the offset of the preceding consonant, thereby allowing for variability in the duration of the open transition and the intrusive vowel.

This approach to variable intersegmental timing explains the generalizations in (5b,c) regarding the acoustic quality of intrusive vowels and of the historical copy vowels they occasionally give rise to. As shown in (7b), the intrusive vowel stems from the same tongue body gesture as the tautosyllabic nuclear vowel. During the initial portion of the gesture, the tongue body articulator has not yet attained its target for the

7. Although not the central focus of this paper, it is interesting to consider the implications of the analysis for the apicoalveolar trill [r] that appears in many Ibero-Romance varieties. Given the cutoff made between [l] and [ɾ] in the hierarchy in (9), the prediction is that [r] should fail to exhibit vowel intrusion when adjacent to consonants. Blecua (2001, §3.2.1) finds that the overwhelming majority of preconsonantal trills produced by her Castilian Spanish informants do not exhibit any vocalic element between the final closure phase of [r] and the following consonant. Solé (2002a,b) shows that syllable-initial trills in Catalan typically assimilate preceding lingual fricatives across minor prosodic boundaries due to gestural overlap between [r] and the fricative (also see Bradley 2006 on /sr/ clusters in Latin American Spanish). The aerodynamic characteristics of apical trills, together with the gestural coordination predicted in (9), may also explain the failure of [r] to pattern as the second member of complex onsets: "[c]oproduction of trills with tautosyllabic obstruents would affect the narrowly constrained lingual and aerodynamic requirements for tongue-tip trilling" (Solé 2002a: 685).

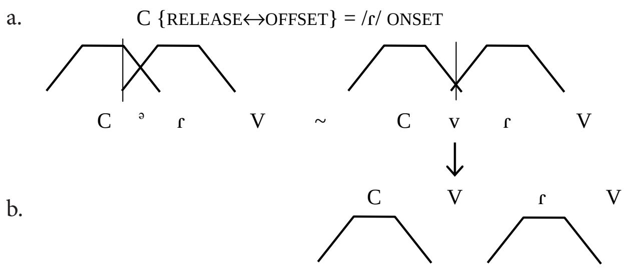


Figure 3. Speaker produces intrusive vowel of variable duration (a), listener reinterprets longer intrusive vowel as lexically-specified (b)

steady-state portion of the vowel. Since the pre-target posture of the tongue body is what colors the open transition between the consonantal gestures, complete identity does not obtain between the intrusive vowel and the nuclear vowel. However, as the temporal gap between the consonantal gestures increases, the vowel quality revealed during the open transition becomes more identifiable (Steriade 1990: 393). Over time, longer intrusive vowels may be phonologically reinterpreted and lexicalized as full nuclear vowels, as illustrated in Figure 3. Overlapping tautosyllabic vowel gestures are omitted here, and [ə] and [v] in (a) are intended to denote shorter and longer intrusive vowels, respectively. Once lexical restructuring has taken place, CC coordination constraints are no longer relevant to the gestures of the original consonant sequence. This is because the consonant gestures are no longer segmentally adjacent due to the presence of the intervening lexically-specified vowel, which has effectively broken up the former cluster.

Crucial to the above diachronic explanation is the notion of *gestural misparsing*, whereby language learners erroneously interpret certain aspects of the acoustic signal to be the result of intentional articulatory gestures on the part of the speaker. Browman and Goldstein (1991: 331–333) observe that changes which arise from misparsing "do not involve adding articulations that were not there to begin with; rather they involve changes in the parameters of gestures that are already present." In Figure 3, the intrusive vowels in (a) and the lexicalized copy vowel in (b) all stem from the same overlapping vowel gesture, and the misparsing that occurs in (b) involves a change in the relative timing of adjacent consonantal gestures.

3. Coarticulation

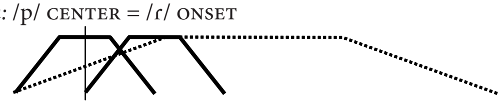
Recall Alonso's (1925: 186–189) observation, discussed in Section 1, that coarticulation of Spanish /Cɾ/ is characteristic of casual speech, while in careful speech the perceptual integrity of the cluster is preserved. Open transition and vowel intrusion in /Cɾ/ enhances the perceptibility of the cluster, as guaranteed by the careful-speech ranking in which ALIGN(C, OFFSET, /ɾ/, ONSET) is dominant (see tableau (10)). In this section, I show how different patterns of coarticulation emerge in casual speech when this constraint is dominated by constraints favoring greater degrees of overlap.

The generalization in (5d) reveals two major patterns of coarticulation among varieties of Spanish: coarticulation of any /Cɾ/ cluster versus coarticulation of /ɾ/ with only a preceding homorganic stop. Again, cross-linguistic evidence suggests the pervasiveness of this pattern, given that some languages forbid vowel intrusion specifically in homorganic clusters while allowing it in heterorganic ones (see Hall 2003: 9–10). An account of this difference requires the additional constraint shown in (11a), the effects of which are illustrated in (11b) for homorganic /t̪ɾ/ and in (11c) for heterorganic /pɾ/. The percept [tɹ̥] in the first cluster denotes close transition and the lack of vowel intrusion (but see below for a more detailed discussion of the assimilatory effects observed in coarticulation).

(11) a. Align(C, center, /ɾ/, onset)
In /Cɾ/, align the center of C with the onset of /ɾ/.
b. *Coordination:* /t̪/ center = /ɾ/ onset

Percept: [t ɹ̥ V]

c. *Coordination:* /p/ center = /ɾ/ onset

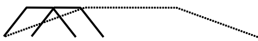
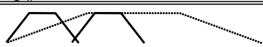
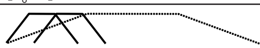


Percept: [p ᵊ ɾ V]

Gafos (2002: 283–287) argues that the coordination relation center = onset can produce different acoustic results depending on the consonant gestures involved. Consider first (11b), where the gestures for /t̪/ and /ɾ/ both involve the tongue tip. At the moment when this active articulator receives instructions to begin the release of the first consonant, it is simultaneously receiving instructions to move in the opposite direction toward the constriction target of the second consonant. In the gestural model, significant overlap between adjacent gestures engaging the same articulator results in a *blending* of gestural characteristics, which "shows itself in spatial changes in one or both of the overlapping gestures" (Browman and Goldstein 1990: 362). Since the temporal distance between the /t̪/ release and the /ɾ/ target in (11b) is not enough to allow the tongue tip to return to a neutral position, gestural blending keeps the articulator in place, producing a close transition. On the other hand, blending does not occur when the adjacent consonant gestures involve different active articulators, as in (11c). In heterorganic clusters, therefore, the center = onset coordination relation will produce an acoustic release between the two consonants.

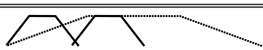
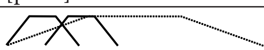
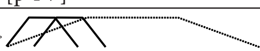
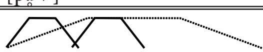
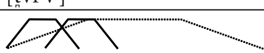
Tableau (12) illustrates the casual speech ranking necessary to account for those dialects in which coarticulation affects only homorganic /Cɾ/. Candidates (12a,b,c) involve different coordination relations for heterorganic /pɾ/, namely offset = onset, center = onset, and release = target, respectively. Candidates (12d,e,f) present the same three relations but for homorganic /t̪ɾ/. High-ranking (11a) optimizes the center = onset coordination for both clusters, and candidates (12b) and (12e) win. As explained above, heterorganic (12b) is realized with open transition and vowel intrusion, but gestural blending ensures close transition in homorganic (12e).

(12) Open transition in heterorganic /pɾ/ versus close transition in homorganic /t̪ɾ/

	Align (C, center, /ɾ/, onset)	Align (C, offset, /ɾ/, onset)	Align (C_1, release, C_2, target)
a.  [pvɾV]	*!		*
b. ☞  [p^{ə}ɾV]		*	*
c.  [pɹ̥V]	*!	*	
d.  [t̪vɾV]	*!		*
e. ☞  [t̪ɹ̥V]		*	*
f.  [t̪ɹ̥V]	*!	*	

To account for dialects in which coarticulation affects both heterorganic and homorganic /Cɾ/ clusters, it is necessary to posit a casual speech ranking in which the constraint favoring close transition, (8a), dominates both (7a) and (11a). As seen in tableau (13), this ranking optimizes close transition in candidates (13c) and (13f).

(13) Close transition in heterorganic and homorganic /Cɾ/

	Align (C_1, release, C_2, target)	Align (C, center, /ɾ/, onset)	Align (C, offset, /ɾ/, onset)
a.  [pvɾV]	*!	*	
b.  [p^{ə}ɾV]	*!		*
c. ☞  [pɹ̥V]		*	*
d.  [t̪vɾV]	*!	*	
e.  [t̪ɹ̥V]	*!		*
f. ☞  [t̪ɹ̥V]		*	*

Coupled with the notion of gestural blending, an analysis based on competing gestural alignment constraints effectively captures the implicational relationship observed in the coarticulation of different types of /Cɾ/ clusters in Spanish. No ranking of the constraints can produce close transition in heterorganic /pɾ/ without also producing it in homorganic /t̪ɾ/. On the other hand, the ranking in tableau (12) is capable of producing close transition in /t̪ɾ/ without also producing it in /pɾ/. Ultimately, this difference is due to the fact that the same gestural coordination relation, CENTER = ONSET, can have different acoustic consequences depending on the articulators involved (Gafos 2002).

The gestural alignment account provides a straightforward explanation of the assimilatory effects observed in coarticulation, documented in Section 1. For instance, Alonso's (1925: 186, 189) observation that rhotics may be partially devoiced after voiceless consonants suggests some degree of overlap between the rhotic constriction and the glottal devoicing gesture associated with the preceding consonant. With respect to /Cɾ/ clusters in which C_1 is a dental stop, the result of coarticulation is often described as an alveolar quasi-affricate. The retraction of the dental stop when overlapped with a following apicoalveolar /ɾ/ plausibly reflects a blended compromise between the lexically-specified constriction locations of the adjacent tongue tip gestures. The gestural account also explains cases of perceived consonantal shortening, as when /d̪ɾ/ clusters are preceded by a nasal or lateral in highland Ecuadorian Spanish (4b). Since there is a decrease in the relative timing between the tap gesture and the secondary gesture responsible for nasality or laterality of the initial sonorant, the duration of the intervening [d] is also decreased, yielding the percept of a reduced [ᵈ].[8]

4. Gestural representations and constraints in the phonology

In this section, I argue that both gestures and segments are present in the phonological representation but are subject to different constraints interacting at the same level in the phonological grammar. I show how the absence of input-output faithfulness constraints on gestural coordination keeps the grammar from overgenerating unattested contrasts based on intersegmental timing.

Many phonologists assume a division between phonological and phonetic components in the grammar (see Liberman and Pierrehumbert 1984, Keating 1990, Cohn 1990). Underlying forms are devoid of non-contrastive properties such as syllabification or temporal relations between articulatory gestures. The phonological component derives a syllabified surface representation that is categorical, qualitative, and timeless, and phonetic implementation then supplies gradient, quantitative aspects of non-contrastive detail to yield a fully-specified phonetic representation. Evidence that gestural

8. It remains unclear why in a dialect such as highland Ecuadorian Spanish, coarticulation affects the [ᵈɹ] clusters in (4b) but not [ðᵊɾ] in (4c). In the gestural account proposed here, a CENTER = ONSET coordination relation would predict close transition and no vowel intrusion in both cases. I suggest that the difference is most likely related to the stop-continuant alternation in which the voiced coronal obstruent participates.

coordination belongs in phonetic implementation comes from the observation that the acoustic consequences of different timing relations are in many ways invisible to the phonology. For instance, the duration of the intrusive vowel in a /Cɾ V/ demisyllable often approximates that of an unstressed vowel, which may give the appearance of two vowels, i.e., [CvɾV]. However, there is good reason to believe that vowel intrusion does not create a new syllable, unlike true phonological epenthesis of a nuclear vowel (Hall 2003).

Two arguments from Spanish support the phonological invisibility of vowel intrusion. First, intrusive vowels are never counted in stress computation. In Spanish, main stress is confined without exception to a three-syllable window at the right edge of the morphological word (Harris 1995: 869). If vowel intrusion in the /Cɾ/ clusters of proparoxytones such as *kilómetro* [ki.ˈlo.me.t̪oɾo] 'kilometer' and *demócrata* [de.ˈmo.kaɾa.t̪a] 'democrat' were to create a new syllable, then stress would fall outside the three-syllable window: *[ki.ˈlo.me.t̪o.ɾo], *[de.ˈmo.ka.ɾa.t̪a]. Although theoretically possible, stress shift is unattested as a means of repairing the prosodic ill-formedness of examples such as these. Second, in the Spanish language game Jerigonza, often used by younger speakers as a secret speech code, intrusive vowels again pattern as invisible. In one version of the game, an epenthetic CV syllable is inserted to the right of every syllable boundary in a word. The consonant is from the set /p, t̪, k, ʧ/, and the vowel is a copy of the preceding syllable nucleus (Piñeros 1999). If the intrusive vowel in *libro* [ˈli.βoɾo] 'book' were syllabic, then CV-insertion should also target this nucleus. The fact that Jerigonza word formation yields *li.pi.bro.po* instead of **li.pi.bo.po.ro.po* shows that speakers treat the [βoɾ] sequence as a complex onset and ignore the intrusive vowel.

The stress and Jerigonza facts demonstrate that vowel intrusion is not a synchronic process of vowel epenthesis, even when the intrusive vowel is as long as a full unstressed vowel. Rather, intrusive vowels attain phonological status only in the diachronic dimension as a result of gestural misparsing (see the discussion surrounding Figure 3). This account predicts that diachronic reanalysis of intrusive vowels cannot yield forms such as the ungrammatical *[ki.ˈlo.me.t̪o.ɾo] and *[de.ˈmo.ka.ɾa.t̪a], which, to the best of my knowledge, is correct.

Perhaps the best evidence for the invisibility of intrusive vowels is that gradient differences in intersegmental timing are universally non-contrastive. Hall's (2003) cross-linguistic survey shows that in each language, vowel intrusion either always happens or never happens in a given environment (modulo variability due to fast/casual speech). This places the intrusive vowel on a par with consonant release, which plays an important role in the perceptual licensing of contour segments although it is never phonologically contrastive per se (Steriade 1993). Moreover, Spanish speakers are typically unaware of the existence of intrusive vowels in clusters containing /ɾ/. It seems unlikely that any language would have minimal pairs based solely on minute differences in the phonetic timing of adjacent consonant gestures.[9]

9. While minute differences in intersegmental timing never form the sole basis of a phonological contrast, timing can impact the ability of listeners to successfully recover other contrasts. For ex-

Phonological invisibility is also found in the case of rhotic assibilation. As discussed in Section 1, Spanish onset clusters are limited to two consonants, where the first is an obstruent and the second is a liquid. Assuming that the assibilated rhotic is an obstruent since it is clearly fricative, coarticulation of /Cɾ/ clusters yields an apparent violation of the sonority conditions that determine complex onset phonotactics in Spanish. In the same way that intrusive vowels are invisible in stress computation and non-concatenative morphology, the assibilated rhotic is invisible to sonority sequencing, which otherwise disallows onset clusters consisting of two obstruents.

How is the phonological invisibility of vowel intrusion and rhotic assibilation to be accounted for? In the model of Zsiga (2000), the phonology acts upon abstract features and segments, which are then mapped to gestures that are coordinated by language-specific alignment constraints in phonetic implementation. Intrusive vowels and assibilated rhotics arise in the phonetics, where stress and sonority constraints are no longer operative and where segments cease to be relevant after features are mapped to gestures. On this view, vowel intrusion and rhotic assibilation constitute a *phonetics–phonology mismatch* in the sense of Blevins (1995: 232–234). More recently, however, Hall (2003) argues against the necessity of a derivational mapping between segments and features in the phonology and gestures in the phonetics. She argues instead for a unified representational model in which gestures are associated to segments, which in turn group together into higher prosodic constituents such as syllables, feet, prosodic words, and so on. If the constraints responsible for stress computation, Jerigonza word formation, and syllabification refer only to higher segmental and prosodic structure, then it follows that they will be insensitive to any percepts arising from specific gestural coordination relationships.

Consider Figure 4, in which gestures, segments, and syllables exist simultaneously in the same phonological representation. As we have seen in Section 2, gestural coordination constraints interact to produce open transition and vowel intrusion in (a) versus close transition and no vowel intrusion in (b). At the same time, phonological constraints evaluate segmental and prosodic structure. The fact that /t̪ɾ/ is a permissible onset cluster in Spanish is accounted for by a language-specific ranking of universal sonority and syllabification constraints (see Colina 1995, 1997, this volume). Recall that /d̪l/ onsets are not allowed in any Spanish variety and that dialects differ in the syllabification of /t̪l/. Martínez-Gil (2001: 209) suggests that cooccurrence restrictions on dental-lateral clusters can be explained as an effect of the Obligatory Contour Principle (OCP; McCarthy 1986, Odden 1986), whereby adjacent coronal noncon-

ample, the non-affrication of the /t/-/ʃ/ sequence in the English minimal pairs *white shoes* versus *why choose* and *might shop* versus *my chop* is dependent on intergestural timing. The very fact that intrusive vowels are credited with enhancing the perceptual cues of adjacent consonants in open transition deems them as playing at least some role in phonological contrasts. To these cases we can add the apparent deletion of English word-final /t/ when heavily overlapped and perceptually hidden by a following word-initial consonant, e.g., [mʌsbi] *must be* and [pɚfekmemɹi] *perfect memory* (Browman and Goldstein 1990: 361). Also, the failure of trills to contrast with taps in the second position of complex onsets in Ibero-Romance has a plausible basis in aerodynamic factors and gestural coordination, as suggested in Fn. 7.

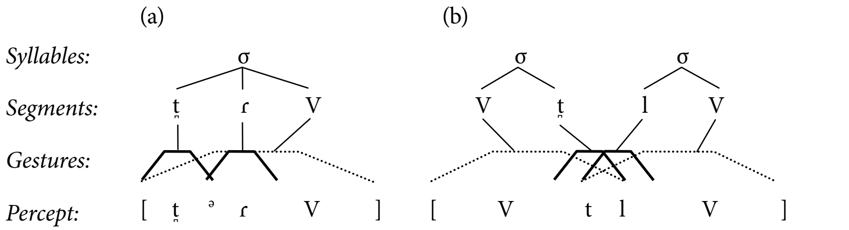


Figure 4. Open transition in tautosyllabic /t̪ɾ/ (a) versus close transition in heterosyllabic /t̪l/ (b)

tinuant segments are prohibited in the syllable onset. Dialect-specific rankings of the relevant OCP constraints with respect to NoCoda determine whether a dialect prefers heterosyllabic /t̪l/, as shown in (b).[10]

Crucially, the intrusive vowel in (a) of Figure 4 is not part of the segmental representation, which accounts for its invisibility to phonological processes that make reference to syllables. As we have seen, intrusive vowels are the acoustic consequence of non-overlapping consonant gestures and are not part of the formal representation of segments. In short, the mismatch between phonological vowel epenthesis and phonetic vowel intrusion requires not a *derivational* difference between phonological and phonetic components but rather a *representational* difference between segments and gestures in the phonological representation. The same argument holds with respect to rhotic assibilation and sonority sequencing. Under a different ranking of gestural alignment constraints, coarticulation of the /t̪ɾ/ cluster in (a) would yield the percept of an assibilated rhotic, i.e., [tɹ̥]. However, the resulting sequence would still syllabify as a complex onset because sonority and syllabification constraints operate over the segmental string [t̪ɾV] and are not sensitive to percepts that arise from gestural coordination.

Finally, consider the observation that intersegmental gestural timing never forms the sole basis of a phonological contrast. If UG had an input-output faithfulness constraint such as Ident(timing), then some language might rank it above gestural alignment constraints. This would allow input coordination relations between adjacent consonants to surface faithfully, thereby overpredicting a contrast based on gestural coordination, such as the presence versus absence of consonant release. The possibility of contrast overgeneration fails to capture the fact that Spanish speakers treat phonetic forms such as [o.t̪oɾo], [o.t̪ᵊɾo], and [o.tɹ̥o] as phonologically equivalent realizations of the same word *otro* 'other'. What this suggests is that UG contains no faithfulness to underlying gestural alignment and that phonetic timing relations must result from interacting markedness constraints alone (Hall 2003; also see Kirchner 1997). Underlying gestures may be temporally coordinated in various ways or perhaps not at all, but the absence of faithfulness to input timing ensures that timing will never be contrastive

10. The gestural account predicts blending of the dental /t̪/ in close transition with the following alveolar lateral, independently of the cluster's heterosyllabic status. Further articulatory investigation is needed to verify this prediction empirically.

per se.[11] Rather, surface coordination will always be determined by the interaction of gestural alignment constraints, as shown in Sections 2 and 3.

It is important to emphasize that the proposal to include both segments and gestures within the same phonological representation does not entail the existence of two separate evaluation mechanisms in an Optimality-theoretic grammar. In the unified model, "[c]onstraints referring to gestural and non-gestural phenomena are present in the same level of the grammar" (Hall 2003: 12). Tableaux (10), (12), and (13) show only the interaction among conflicting gestural alignment constraints, but this is not meant to imply that such constraints evaluate output candidates independently of the non-gestural constraints that determine stress or syllabic configurations. For a given input, the optimal surface form, such as those exemplified in Figure 4, is accounted for by the interaction of constraints in a single, unified tableau. In many cases, it is likely that gestural and non-gestural constraints will not conflict with each other, simply because they evaluate different aspects of the phonological representation. More intriguing is the possibility that gestural alignment constraints may make reference to higher-level aspects of representation, such as prosodic domains or underlying morphological structure. Models that assume a derivational relationship between phonology and phonetic implementation predict that morphology cannot influence gestural coordination. However, such interaction is predicted by a unified model in which gestural alignment constraints have access to underlying morphological structure (see Bradley 2005 and Cho 2001 for further discussion of the influence of prosodic and morphological structure on gestural coordination).

5. Comparison with previous accounts

Steriade (1990) is the first to demonstrate the utility of gestural representations in accounting for vowel intrusion phenomena in Winnebago, Late Latin, and Sardinian. The first application of Articulatory Phonology to Spanish rhotics is found in Bradley (1999; see also 2001a). Specifically, I proposed an account of open and close transition in highland Ecuadorian Spanish clusters containing /ɾ/, as well as an explanation for the assibilation of syllable-initial trills in terms of gestural reduction. In that work, I assumed a division between phonology and phonetic implementation in the grammar, with gestural timing determined in the latter component, as in Zsiga's (2000) model. However, the mechanisms governing the coordination of gestures were never made explicit. Given the study's relatively limited dialectal focus, no attempt was made to connect the gestural coordination patterns of Spanish clusters to vowel intrusion phenomena in other languages. The present work formalizes the competition among

11. In phonological frameworks that take a systemic view of contrast, it is insufficient to ban Ident(timing), either because no underlying representation is assumed (Flemming 1995) or because generalized systemic faithfulness exists as an independent constraint in the grammar (Padgett 2003a,b,c). See the discussion in Bradley (2005), in which I argue that imperceptible contrasts based on gestural timing must be universally ruled out by inviolable perceptual distinctiveness constraints.

gestural coordination relations in terms of Optimality-theoretic alignment constraints and connects the variation observed in Spanish with other languages, following Hall's (2003) work.

On the basis of derived-environment effects in Korean palatalization, Cho (1998a,b) proposes an Optimality-theoretic analysis in which a markedness constraint favoring gestural overlap competes with a constraint requiring faithfulness to input Phase Windows, which define permissible ranges of overlap between adjacent gestures (see Byrd 1996). In Bradley (2002), I propose a similar approach to derived-environment effects in Norwegian /ɾC/ clusters. The approach is further extended to dialectal variation in Spanish /Cɾ/ clusters by Bradley and Schmeiser (2003) and to coda rhotics in highland Ecuadorian Spanish by Bradley (2004). The assumption underlying all of these works is that input morphemes already have their gestural timing relations fully and reliably specified in terms of Phase Windows so that faithfulness, Ident(timing), can depend on them. On this view, a predictable non-contrastive property of phonetic detail — intersegmental timing — is incorporated directly into the phonological representation. As McCarthy (personal communication; 2003, Fn. 7) points out, however, the assumption that inputs are fully-specified for intersegmental timing runs counter to the Richness of The Base hypothesis of Optimality Theory, which forbids placing restrictions directly on input representations (Prince and Smolensky 1993). Moreover, the use of Ident(timing) faces the problem of overgenerating contrast, as discussed in Section 4 above. The analysis developed in the present study avoids these complications because optimal gestural coordination relations are determined by interacting markedness constraints. The problem of having to specify intersegmental timing in underlying forms becomes irrelevant under this approach.

Finally, Blecua (2001) argues against a gestural account of vowel intrusion in Spanish /CɾV/ and /VɾC/ sequences, as outlined in Bradley (1999, 2001a). She maintains that if the intrusive vowel were merely the portion of the nuclear vowel that appears between the tap constriction and the adjacent consonant, then we would expect the formant structure of both vocalic sounds to be identical.

> However, the results obtained in our study indicate that the structures are not identical; although the vowel has an important influence on the formant structure of the vocalic element, the triangle formed by this element in a formant chart is included within that of the vowel […] In this sense, it is difficult to accept that the vocalic element is the part of the vowel that has been separated by the tap constriction (Blecua 2001: §4.1.1).

Rather, Blecua proposes that the intrusive vowels appearing on either side of the /ɾ/ constriction are an inherent part of the rhotic itself. Since the formant structure of these vocalic elements serves no distinctive function, it simply adopts characteristics that are similar to the tautosyllabic vowel. Although not explicitly discussed by Blecua, a similar representation of the tap as a tripartite contour segment has been independently proposed by Inouye (1995) and further elaborated in Bradley (2001a,b).

While the representation of /ɾ/ as a sequence of approach, closure, and release phases works for Spanish, such an account fails to explain the fact that in other languages, intrusive vowels can be triggered by consonants other than /ɾ/ (Hall 2003). An analysis in terms of interacting gestural coordination constraints effectively situates Spanish vowel intrusion within a broader cross-linguistic typology. Specifically, a universal ranking of alignment constraints favoring open transition captures the implicational relations among vowel intrusion triggers and also explains why /ɾ/ is the only such trigger in Spanish (see tableau (10)). As discussed in Section 2, a gestural account of vowel intrusion also explains the lack of complete identity between intrusive vowels and their tautosyllabic nuclei. During the open transition between the adjacent consonantal gestures, the tongue body has not yet attained its target for the steady-state portion of the nuclear vowel. As we have seen in Figure 3, full identity is achieved diachronically in some cases when longer intrusive vowels become lexicalized as nuclear vowels.

6. Conclusion

In this paper, I have shown that Articulatory Phonology, in conjunction with Optimality Theory, makes possible an explanatory account of the phonetic patterning of complex onsets in Spanish. Furthermore, I have shown that there is no danger in assuming phonetically rich gestural representations along with segments and syllables in the phonology. The fact that vowel intrusion and rhotic assibilation derive from gestural coordination accounts for the invisibility of these phenomena to processes that refer to segmental and prosodic structure. In Optimality Theory, the absence of faithfulness to input timing ensures that no language grammar can generate contrasts based solely on differences in gestural coordination — even if such differences happen to be present in the input. Finally, since the gestural alignment constraints necessary to account for Spanish vowel intrusion are universal and violable, different rankings of these constraints can account for vowel intrusion patterns observed in other languages.

References

Argüello, F. 1978. The Žeísta Dialect of Spanish Spoken in Ecuador: A phonetic and phonological study. PhD dissertation, The Pennsylvania State University.

Alonso, A. 1925. El grupo tr en España y América. *Homenaje a Menéndez Pidal* II: 167–191. (Madrid).

Blecua, B. 2001. Las vibrantes en español: Manifestaciones acústicas y procesos fonéticos. PhD dissertation, Universitat Autònoma de Barcelona.

Blevins, J. 1995. The syllable in phonological theory. In *Handbook of Phonological Theory,* J. Goldsmith (ed.), 206–244. Cambridge MA: Blackwell.

Bradley, T.G. 1999. Assibilation in Ecuadorian Spanish: A phonology–phonetics account. In *Formal Perspectives on Romance Linguistics,* J.-M. Authier, B.E. Bullock, and L.A. Reed (eds), 57–71. Amsterdam: John Benjamins.

Bradley, T.G. 2001a. The Phonetics and Phonology of Rhotic Duration Contrast and Neutralization. PhD dissertation, The Pennsylvania State University.

Bradley, T.G. 2001b. A typology of rhotic duration contrast and neutralization. In *Proceedings of NELS 31,* M.J. Kim and U. Strauss (eds), 79–97. Amherst MA: Graduate Linguistics Student Association.

Bradley, T.G. 2002. Gestural timing and derived environment effects in Norwegian clusters. In *WCCFL 21 Proceedings,* L. Mikkelsen and C. Potts (eds), 101–114. Somerville MA: Cascadilla.

Bradley, T.G. 2004. Gestural timing and rhotic variation in Spanish codas. In *Laboratory Approaches to Spanish Phonology,* T. Face (ed.), 197–224. Berlin: Mouton de Gruyter.

Bradley, T.G. 2005. Systemic markedness and phonetic detail in phonology. In *Experimental and Theoretical Approaches to Romance Linguistics,* R. Gess and E. Rubin (eds), 41–61. Amsterdam: John Benjamins.

Bradley, T.G. 2006. Phonetic realizations of /sr/ clusters in Latin American Spanish. In *Selected Proceedings of the 2nd Conference on Laboratory Approaches to Spanish Phonetics and Phonology* [Proceedings Project]. M. Díaz-Campos (ed.), 1–13. Somerville MA: Cascadilla.

Bradley, T.G. and Schmeiser, B.S. 2003. On the phonetic reality of /ɾ/ in Spanish complex onsets. In *Selected Proceedings of the 6th Hispanic Linguistics Symposium,* P.M. Kempchinsky and C.-E. Piñeros (eds), 1–20. Somerville MA: Cascadilla.

Browman, C. and Goldstein, L. 1989. Articulatory gestures as phonological units. *Phonology* 6: 201–252.

Browman, C. and Goldstein, L. 1990. Tiers in articulatory phonology, with some implications for casual speech. In *Papers in Laboratory Phonology I: Between the Grammar and Physics of Speech,* J. Kingston and M.E. Beckman (eds), 341–376. Cambridge: CUP.

Browman, C. and Goldstein, L. 1991. Gestural structures: Distinctiveness, phonological processes, and historical change. In *Modularity and the Motor Theory of Speech Perception,* I.G. Mattingly and M. Studdert-Kennedy (eds), 313–338. Hillsdale NJ: Lawrence Erlbaum.

Byrd, D. 1996. A phase window framework for articulatory timing. *Phonology* 13: 139–169.

Cho, T. 1998a. Intergestural timing and overlap in Korean palatalization: An optimality-theoretic approach. In *Japanese/Korean Linguistics* 8, D. Silva (ed.), 261–276. Stanford CA: CSLI.

Cho, T. 1998b. The Specification of Intergestural Timing and Overlap: EMA and EPG studies. M.A. thesis, University of California, Los Angeles.

Cho, T. 2001. Effects of morpheme boundaries on intergestural timing: Evidence from Korean. *Phonetica* 58: 129–162.

Cohn, A. 1990. Phonetic and Phonological Rules of Nasalization. PhD dissertation, University of California, Los Angeles.

Colantoni, L. 2001. Mergers, Chain Shifts, and Dissimilatory Processes: Palatals and rhotics in Argentine Spanish. PhD dissertation, University of Minnesota.

Colantoni, L. and Steele, J. 2005. Phonetically-driven epenthesis asymmetries in French and Spanish obstruent-liquid clusters. In *Experimental and Theoretical Approaches to Romance Linguistics,* R. Gess and E. Rubin (eds), 77–96. Amsterdam: John Benjamins.

Colina, S. 1995. A Constraint-Based Analysis of Syllabification in Spanish, Catalan and Galician. PhD dissertation, University of Illinois, Urbana-Champaign.

Colina, S. 1997. Identity constraints and Spanish resyllabification. *Lingua* 103: 1–23.

Colina, S. This Volume. Optimality-theoretic advances in our understanding of Spanish syllabic structure. In *Optimality-Theoretical Studies in Spanish Phonology,* F. Martínez-Gil and S. Colina (eds). Amsterdam: John Benjamins.

Davidson, L. 2003. The Atoms of Phonological Representation: Gestures, coordination, and perceptual features in consonant cluster phonotactics. PhD dissertation, Johns Hopkins University.

Gafos, A. 2002. A grammar of gestural coordination. *Natural Language and Linguistic Theory* 20: 269–337.

Flemming, E. 1995. Auditory Representations in Phonology. PhD dissertation, University of California, Los Angeles.

Gili Gaya, S. 1921. La r simple en la pronunciación española. *Revista de Filología Española* 8: 271–280.

Hall, N. 2003. Gestures and Segments: Vowel intrusion as overlap. PhD dissertation, University of Massachusetts, Amherst.

Hammond, R. 1999. On the non-occurrence of the phone [r̃] in the Spanish sound system. In *Advances in Hispanic Linguistics,* J. Gutiérrez-Rexach and F. Martínez-Gil (eds), 135–151. Somerville MA: Cascadilla.

Hammond, R. 2000. The phonetic realizations of /rr/ in Spanish: A psychoacoustic analysis. In *Hispanic Linguistics at the Turn of the Millennium,* H. Campos, E. Herburger, A. Morales-Front and T.J. Walsh (eds), 80–100. Somerville MA: Cascadilla.

Harris, J. 1983. *Syllable Structure and Stress in Spanish: A Nonlinear Analysis.* Cambridge MA: The MIT Press.

Harris, J. 1995. Projection and edge marking in the computation of stress in Spanish. In *The Handbook of Phonological Theory,* J. Goldsmith (ed.), 867–887. Cambridge MA: Blackwell.

Harris, J. and Kaisse, E. 1999. Palatal vowels, glides and obstruents in Argentinian Spanish. *Phonology* 16: 117–190.

Hualde, J.I. 1991. On Spanish syllabification. In *Current studies in Spanish Linguistics,* H. Campos and F. Martínez-Gil (eds), 475–493. Washington DC: Georgetown University Press.

Hualde, J.I. 1999. La silabificación en español. In *Fonología generativa contemporánea de la lengua española,* R.A. Núñez-Cedeño and A. Morales-Front (eds), 170–188. Washington DC: Georgetown University Press.

Hualde, J.I. 2004. Quasi-phonemic contrasts in Spanish. In *WCCFL 23 Proceedings,* B.S. Schmeiser, V. Chand, A. Kelleher, and A. Rodríguez (eds), 374–398. Somerville MA: Cascadilla.

Inouye, S. 1995. Trills, Taps and Stops in Contrast and Variation. PhD dissertation, University of Los Angeles, California.

Keating, P.A. 1990. Phonetic representations in a generative grammar. *Journal of Phonetics* 18: 321–334.

Kirchner, R. 1997. Contrastiveness and faithfulness. *Phonology* 14: 83–111.

Lenz, R. 1892. Chilenishe Studien. *Phonetische Studien* 5: 272–293.

Lewis, A. 2004. Coarticulatory effects on Spanish trill production. In *Proceedings of the 2003 Texas Linguistics Society Conference* [Proceedings Project], A. Agwuele, W. Warren and S.-H. Park (eds), 116–127. Somerville MA: Cascadilla.

Liberman, M. and Pierrehumbert, J. 1984. Intonational invariance under changes in pitch range and length. In *Language Sound Structure,* M. Aronoff and R.T. Oehrle (eds), 157–233. Cambridge MA: The MIT Press.

Lipski, J. 1994. *Latin American Spanish.* London: Longman Group.

Malmberg, B. 1965. *Estudios de fonética hispánica* [Collectanea Phonetica, I.] Madrid: Consejo Superior de Investigaciones Científicas.

Martínez-Gil, F. 2001. Sonority as a primitive phonological feature: Evidence from Spanish complex onset phonotactics. In *Features and Interfaces in Romance,* J. Herschensohn, E. Mallén, and K. Zagona (eds), 203–222. Amsterdam: John Benjamins.

McCarthy, J. 1986. OCP effects: Gemination and antigemination. *Linguistic Inquiry* 17: 207–263.

McCarthy, J. 2003. Comparative markedness. *Theoretical Linguistics* 29: 1–51.

McCarthy, J., and Prince, A. 1993. Generalized alignment. In *Yearbook of Morphology 1993,* G.E. Booij and J. van Marle (eds), 79–153. Dordrecht: Kluwer.

Navarro Tomás, T. 1918. Diferencias de duración entre las consonantes españolas. *Revista de Filología Española* 5: 367–393.

Odden, D. 1986. On the role of the obligatory contour principle in phonological theory. *Language* 62: 353–383.

Padgett, J. 2003a. Contrast and post-velar fronting in Russian. *Natural Language and Linguistic Theory* 21: 39–87.

Padgett, J. 2003b. The emergence of contrastive palatalization in Russian. In *Optimality Theory and Language Change,* D.E. Holt (ed.), 307–335. Dordrecht: Kluwer.

Padgett, J. 2003c. Systemic contrast and Catalan rhotics. Ms., University of California, Santa Cruz.

Piñeros, C.-E. 1999. Head dependence in Jerigonza, a Spanish language game. In *Advances in Hispanic Linguistics,* J. Gutiérrez-Rexach and F. Martínez-Gil (eds), 265–277. Somerville MA: Cascadilla.

Prince, A. and Smolensky, P. 1993. Optimality Theory: Constraint interaction in generative grammar. Ms., Rutgers University and University of Colorado.

Quilis, A. 1970. El elemento esvarabático en los grupos [pr, br, tr…]. In *Phonétique et linguistique romanes: Mélanges offerts à M. Georges Straka,* 99–104. Lyon-Strasbourg : Société de Linguistique Romane.

Quilis, A. 1988. *Fonética acústica de la lengua española.* Madrid: Editorial Gredos.

Quilis, A. 1993. *Tratado de fonología y fonética españolas.* Madrid: Editorial Gredos.

Schmeiser, B.S. 2004. On the durational variability of svarabhakti vowels in Spanish complex onsets. Paper presented at the *Western Conference on Linguistics,* Los Angeles, November 2004.

Solé, M.J. 2002a. Aerodynamic characteristics of trills and phonological patterning. *Journal of Phonetics* 30: 655–688.

Solé, M.J. 2002b. Assimilatory processes and aerodynamic factors. In *Papers in Laboratory phonology* 7, C. Gussenhoven and N. Warner (eds), 351–386. Berlin: Mouton de Gruyter.

Steriade, D. 1990. Gestures and autosegments: Comments on Browman and Goldstein's paper. In *Papers in Laboratory Phonology I: Between the Grammar and Physics of Speech,* M. Beckman and J. Kingston (eds), 382–397. Cambridge: CUP.

Steriade, D. 1993. Closure, release, and nasal contours. In *Nasals, Nasalization, and the Velum,* M. Huffman and R. Krakow (eds), 401–470. New York NY: Academic Press.

Willis, E. 2005. An acoustic study of the trill in Dominican Spanish. Paper presented at *The XXXVth Linguistic Symposium on Romance Languages,* University of Texas at Austin, February 24–27, 2005.

Willis, E. and Pedrosa, M.B. 1999. An acoustic analysis of the rhotic system of Spanish: Isolated words, read texts and spontaneous speech. Paper presented at the *3rd Hispanic Linguistics Symposium,* Washington, D.C., October 1999.

Zsiga, E. 2000. Phonetic alignment constraints: Consonant overlap and palatalization in English and Russian. *Journal of Phonetics* 28: 69–102.

Phonological phrasing in Spanish*

Pilar Prieto
Institut Català de Recerca i Estudis Avançats and Universitat Autònoma de Barcelona

This article investigates the role of syntactic and prosodic markedness constraints on the construction of *phonological phrases* (φ- or p-phrases) in Peninsular Spanish. The data come from a reading task of a corpus composed of 85 utterances with a wide variety of structures and constituent lengths. Four speakers read each sentence at three different speech rates (normal, slow, and fast). It is shown that the construction of prosodic structure in this language cannot rely solely on syntactic information but has to refer to prosodic markedness constraints which regulate the size and balance of phrase constituents. The proposal will be cast in a constraint-based OT approach (McCarthy & Prince 1993a), where the notion of edge alignment from Selkirk (1984) and constituent wrapping from Truckenbrodt (1995, 1999) are considered to be ranked and violable constraints. Specifically, phonological phrasing in Spanish is determined by the interaction of right-alignment of syntactic and phonological phrases (Align-XP,R) with a maximal requirement on the length of p-phrases (Max-Bin) and a minimality constraint on the prosodic parsing of utterances (Min-Bin). Other Romance languages (and English and recently Egyptian Arabic) have also provided critical evidence in favor of the importance of prosodic restrictions on phrasing prediction (see Ghini 1993a, 1993b for Italian, Prieto 2005 for Catalan, Sandalo & Truckenbrodt 2002 for Brazilian Portuguese, Selkirk 2000, 2005 for English, and Hellmuth forthcoming for Egyptian Arabic; see also Elordieta, Frota, Prieto & Vigário 2003, D'Imperio, Elordieta, Frota, Prieto & Vigário 2005).

Keywords: prosodic phrasing, phonological phrasing, intonational phrasing, Spanish

* A preliminary version of this article was presented at the XIVth Colloquium on Generative Grammar (Porto, April 2004). I am grateful to the audience at this conference, and especially to E. Bonet, G. Elordieta, M. T. Espinal, S. Frota, J.I. Hualde, M.R. Lloret, and an anonymous reviewer for very helpful comments on an earlier version of this paper. Special thanks go to Eva Estebas for conducting the recordings of the database in Madrid and to the 4 speakers who participated in the reading task: Cristina Alfonso, Ma Àngeles Escobar, Carmen Guarddon, and Maribel Medrano. Finally, thanks to the editors, S. Colina and F. Martínez-Gil, for their effort in coordinating this interesting project. This research was funded by grants 2002XT–00032 and 2001SGR 00150 from the Generalitat de Catalunya and BFF2003–06590 and BFF2003–09453-C02-C02 from the Spanish Ministry of Science and Technology.

0. Introduction

Work on syntax-prosody mapping and the prediction of phonological phrases (φ- or p-phrases) has highlighted the role of syntactic boundaries in predicting prosodic structure. Restrictions on alignment to syntactic constituents or heads (Selkirk 1986, 2000, 2005, Nespor & Vogel 1986) and cohesional demands on maximal projections are generally taken to be the active syntactic constraints in prosodic phrase construction. First, the notion of alignment to prosodic and morphological edges has been very influential in phonology and morphology and has been recast in the Generalized Alignment family of well-formedness constraints within Optimality Theory (McCarthy & Prince 1993a:80). Within the syntax/phonology interface work, alignment constraints demand alignment of left or right edges of XPs (maximal projections) with edges of φ or p-phrases (see Selkirk 2000, and Truckenbrodt 1995, 1999, among others):

(1) a. Align-XP,R: Align (XP, R; φ, R)
Align right edge of XP to right edge of φ.
b. Align-XP,L: Align (XP, L; φ, L)
Align left edge of XP to left edge of φ.

Recently, Truckenbrodt's work has convincingly shown that Align-XP can be at times suppressed by another syntax-mapping constraint on maximal projection's unity, Wrap-XP, and that the interaction between the two constraints is able to explain the language-particular differences observed in different Bantu languages (Truckenbrodt 1995, 1999). As stated in (2), Wrap-XP demands that each maximal projection (XP) should be contained in a phonological phrase, with no prosodic phrases breaking it. An XP is thus 'wrapped' when there is a p-phrase (the same or a larger size) that contains the XP. It is not 'wrapped' when the XP is split up across more than one p-phrase.

(2) Wrap-XP (Truckenbrodt 1995, 1999:228)
Each XP is contained in a phonological phrase.

Nowadays, the most widely accepted theory of syntax-phonology interface is based on Selkirk's proposal that p-boundaries make reference to syntactic edges and heads together with Truckenbrodt's cohesional constraint Wrap-XP (which makes reference to the unity of maximal projection constituents). In parallel to that, recent work has argued that prosodic conditions have to be taken into account in the construction of phrasing domains. For example, Mirco Ghini's analysis of phrasing in Italian convincingly argues that Nespor & Vogel's branching conditions can be successfully reanalyzed into prosodic notions of balancing and maximum weight (Ghini 1993a, 1993b).[1]

1. Nespor & Vogel (1986:185) themselves suggested that the branching condition could reflect a minimal length requirement: "It should be noted that the restructured φ is the first constituent of prosodic structure that reflects the idea that length plays a role in the determination of prosodic categories. That is, since nonbranching complements are generally shorter than branching ones, the relative length of nonbranching vs. branching complements appears to be a crucial factor in determining the possibility of restructuring in certain languages. That is, there may be a general tendency to avoid forming particularly short (i.e., nonbranching) phonological phrases."

Recent work on English, Egyptian Arabic, and Romance languages has acknowledged that prosodic constraints are crucial in predicting phonological phrasing (see Prieto 2005 for Catalan, Sandalo & Truckenbrodt 2002 for Brazilian Portuguese, Selkirk 2000 for English, and Hellmuth forthcoming for Egyptian Arabic). These have adopted a version of the binarity size constraint suggested by Ghini. As stated in (3), Max-Bin enforces binarity at the p-phrase level and expresses the fact that the average p-phrases at a normal speech rate are formed by two prosodic words.

(3) Max-Bin (after Sandalo & Truckenbrodt 2002:295)
P-phrases consist of maximally two prosodic words.

The goal of this study is to examine the influence of both syntactic and prosodic factors on prosodic boundary placement in Spanish. A corpus of 85 utterances was designed to provide appropriate data on the effects of syntactic boundary locations and length on phrasing decisions. Four speakers of Peninsular Spanish were asked to read each sentence three times at different speech rates (normal, slow, and fast). The use of three different speech rates was crucial to test the possibility of different groupings of utterances.

The Spanish data will provide critical evidence that length constraints play a major role in phrasing decisions, often suppressing the effects of syntactic constraints. Evidence for the prominent role played by prosodic requirements in Spanish phrasing stems from the tendency to divide utterances into phrases of similar syllabic lengths. For example, the typical grouping (*Comeré pasteles*) (*de chocolate amargo*) 'I will eat cakes of dark chocolate' illustrates how the binarity size constraint overrides a wrapping constituent requirement on the unity of the Object NP. Similarly, the possibility of producing (Subject Verb)(Object) phrasings as in (*Juan leerá*) (*novelas de aventuras*) 'John will read adventure novels' represents a challenge to both syntactic end-alignment and wrapping requirements. On the other hand, Spanish also offers crucial evidence for the role played by Align-XP,R, which comes from the behavior of local versus non-local attachment of PP-adjuncts: the typical pattern of phonological phrasing (*Compró las películas de Woody*)φ (*en Londres*)φ 'He/she bought Woody [Allen] films in London' suggests that the syntactic alignment constraint is stronger than the phonological well-formedness binarity constraint.

The article is organized as follows. Section 1 provides a definition of phonological phrase and the cues that characterize this prosodic unit in Spanish; it also presents the corpus used for this study. Section 2 offers a wide empirical coverage of the Spanish phrasing data together with an OT constraint-based analysis of the default patterns of p-groupings.

1. Methodology

1.1 Cues to phonological phrasing in Spanish

The theory of prosodic phonology (Selkirk 1986, Nespor & Vogel 1986) proposes the existence of a prosodic representation which is independent of (but related to) syntactic structure. Prosodic structure consists of a hierarchy of prosodic constituents represented in (4). The phonological phrase (PPh, p- or φ-phrase, also called Minor Phrase, MiP) is the prosodic unit above the PW.[2] Different cues to prosodic structure have been reported for a variety of languages. Romance languages like Italian and Brazilian Portuguese have phonological diagnostics to test phonological constituency, that is, phonological processes whose domain of application is the phonological phrase. In Florence Italian, Radoppiamento Sintattico, Final Lengthening and Stress Retraction are φ-level phenomena (Nespor & Vogel 1986, 1989; Ghini 1993a, 1993b). In French and Brazilian Portuguese, Stress Retraction also applies within the φ-phrase domain (see Post 1999, 2000; Sandalo & Truckenbrodt 2002, respectively; e.g. Port. *café quente* → *café quente* 'hot coffee').

(4) The prosodic hierarchy

IP	Intonational Phrase (also called Major Phrase)
PPh, φ	Phonological Phrase (also called Minor Phrase)
PW, ω	Prosodic Word
F	Foot
σ	Syllable

Evidence from phonological phrasing in Spanish comes from stress/accent facts and intonation. Spanish speakers place a prominent stress (what we will call p-phrase prominence) or an accent on the last tonic syllable of a p-phrase. In this article, we will assume that a stable and reliable cue for the presence of a phonological phrase is the perception of a prominent stress (together with a level 2 phrase break in the ToBI framework). Optionally, speakers produce a continuation rise at the right boundary of a p-phrase, though it is also possible to perceive a clear phrasing break with no continuation rise. Thus in Spanish the right edges of phonological phrases can be optionally cued by tonal marking. We take the standard view, following Nespor and Vogel (1986) and Selkirk (2005), that phonological phrases can be 'stylistically promoted and optionally realized as intonational phrases'.

Figure 1 illustrates the waveforms and intonation contours of the utterances (*Compraré yogures*)φ (*de la sierra de Gredos*)φ 'I will buy yoghourts from the Gredos Range' (top figure) and (*María bebe*)φ (*agua destilada*)φ 'Mary drinks distilled water' (bottom figure) as produced by two speakers of Peninsular Spanish. The intonation contours display a high boundary tone separating the two phrases: in the first utterance, the H tone is located after the first noun in the object complement; in the second, the continuation rise is placed after the verb, clearly exemplifying a (Subject Verb)(Object) grouping.

2. Earlier work on the prosodic hierarchy also posited the Clitic Group between the Prosodic Word and the Phonological Phrase (Nespor & Vogel 1986), though this prosodic level has fallen out of favor in more recent years.

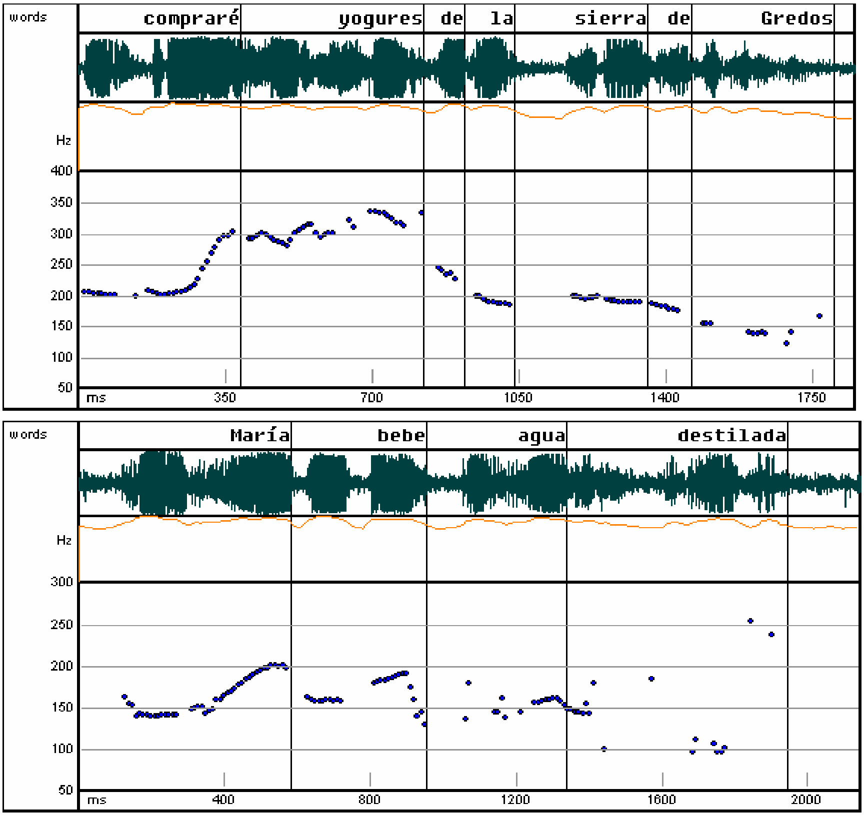


Figure 1. Waveforms and intonation contours of the utterances (*Compraré yogures*)φ (*de la sierra de Gredos*)φ 'I will buy yoghourts from the Gredos' Sierra' (top figure, speaker AE) and (*María bebe*)φ (*agua destilada*)φ 'Mary drinks distilled water' (bottom figure, speaker MM).

1.2 Materials

The main source of data reported in this article is based on a reading task of a corpus containing a set of 85 target utterances (see the complete database in the Appendix). The corpus contained three types of structures (namely, SVO, VP and NP projections) in which constituent length (in terms of the number of prosodic words) and location of syntactic boundaries (including those of PP and AdjP with different level attachments) have been systematically varied. (5) offers several examples from the database: the first triplet varies the length of the subject in SVO structures: (5a) contains a simplex noun, (5b) two prosodic words, and (5c) three prosodic words. The second triplet varies the length of the object in VP structures:

(5) a. El presidente sufre.
'The president is suffering.'
b. El presidente de la Comunidad sufre.
'The president of the Community is suffering.'

c. El presidente de la Comunidad de Madrid sufre.
'The president of the Madrid Community president is suffering.'

a′. Le nombraron profesor.
'They appointed him professor.'
b′. Le nombraron profesor de filología.
'They appointed him professor of philology.'
c′. Le nombraron profesor de filología románica.
'They appointed him professor of Romance philology.'

Recordings were made of four native speakers of Peninsular Spanish (3 from Madrid, CA, CG, AE, and 1 from Burgos, MM) ranging from 35 to 58 years of age. Each utterance was read three times, at normal, fast, and slow rates of speech. The different rates were obtained by giving specific instructions to speakers, namely, by asking them to read each sentence at a normal, fast, and slow rate of speech, in this order. The recorded utterances were prosodically transcribed using the ToBI conventions for tonal and break tiers (Beckman & Hirschberg 1994). After that, we equated major phrases with phrase breaks level 3 and level 4 (intermediate phrases and full intonational phrases) and minor phrases (or phonological phrases) with level 2 phrase breaks (with a disjuncture that is weaker than expected).

Variation in rate of speech was especially crucial in order examine the speech rate effects on phrasing decisions and, specifically, to test possible patterns of p-phrase optionality on our target utterances. Utterances uttered at a slow speech rate quite often produced unnatural pronunciations: typically, every prosodic word was pronounced as a separate intonational phrase. Thus the article will report the typical patterns of phrasing found in normal and fast read speech.[3] Finally, the informants were instructed to read the sentences as new information, without topics or foci.

The results on SVO sentences will be compared to a section dealing with Spanish in recent Romance crosslinguistic study conducted by M. D'Imperio, G. Elordieta, S. Frota, P. Prieto, and M. Vigário (Elordieta, Frota, Prieto & Vigário 2003, Elordieta, Frota & Vigário 2005, D'Imperio, Elordieta, Frota, Prieto & Vigário 2005). This Romance Languages Database (RLD) was designed to allow a direct comparison of intonational phrasing strategies in SVO structures among different Romance languages with regard to the manipulation of constituent length and syntactic complexity.

2. Results: Phonological Phrasing in Spanish

2.1 Minimality effects

The examples in (6) and (7) show that speakers normally phrase verbal heads together with simple objects containing a single noun (V NP)φ and simple noun heads together with simple adjectival or prepositional phrases (N PP)φ. Yet, as we will see in the next section, they tend to produce them in separate p-phrases when complements contain

3. For recent results on phrasing patterns found in Spanish spontaneous speech, see Rao (forthcoming).

two prosodic words. Thus, there is a contrast between (*Compraba mapas*)φ 'I/(s)he used to buy maps' and (*Compraba*)φ (*mapas de Barcelona*)φ or (*Compraba mapas*)φ (*de Barcelona*)φ 'I/(s)he bought maps of Barcelona'.

(6) $[\text{V } [\text{NP}]_{\text{NP}}]_{\text{VP}} \rightarrow (\text{V NP})\varphi$
   a. Le nombraron profesor)φ
      'They appointed him professor.'
   b. (Compraba mapas)φ
      'I/(s)he used to buy maps.'

(7) $[\text{N } [\text{PP}]_{\text{PP}}]_{\text{NP}} \rightarrow (\text{N PP})\varphi$
   a. (Una botella de vino)φ
      'A bottle of wine.'
   b. (Un anillo de plata)φ
      'A silver ring.'

Next consider the examples in (8). Utterances consisting of single prosodic word subjects plus single word verbs regularly group the two prosodic words in a single p-phrase. This is also the case in NP and VP projections.

(8) $[[\text{NP}]_{\text{NP}} [\text{V}]_{\text{VP}}]_{\text{IP/CP}} \rightarrow (\text{NP VP})\varphi$
   a. (La nena quiere)φ
      'The little girl wants some.'
   b. (El presidente sufre)φ
      'The president is suffering.'

The groupings above are easily explained by a constraint on the minimum size of utterances, Min-Bin-ω (IP), as stated in (9). This constraint states that speakers prefer to parse an Intonational Phrase containing two prosodic words into one p-phrase $((\omega\omega)\varphi)_{\text{IP}}$ rather than two p-phrases containing one prosodic word each $((\omega)\varphi\ (\omega)\varphi)_{\text{IP}}$. This constraint can be understood as a minimality requirement on the length of utterances. As we know, minimality requirements have been extensively used within prosodic phonology and morphology to express minimality size effects in terms of moras, syllables or feet (see McCarthy & Prince 1993b, among many others). In the case at hand, the requirement is expressed in terms of the number of prosodic words.

(9) Min-Bin
    P-phrases should consist of minimally two prosodic words.

The following three tableaux derive the minimality effects on IP/CP projections (10a), VP projections (10b), and NP projections (10c). As becomes clear from the example in tableau (10a), it is crucial that the prosodic condition Min-Bin dominates Align-XP,R in the hierarchy (Min-Bin >> Align-XP,R) because no phrase boundary is present after the subject phrase.

(10) a.

$[\ [\text{La nena}]_{\text{NP}}\ [\text{pide}]_{\text{VP}}]_{\text{IP/CP}}$	Min-Bin	Align-XP,R
a. ( )φ ( )φ	*!	
b. ☞ ( )φ		*!

b.

[Compraba [mapas]$_{NP}$]$_{VP}$	Min-Bin	Align-XP,R
a. ( )φ ( )φ	*!	
b. ☞ ( )φ		

c.

[Una botella [de vino]$_{PP}$]$_{NP}$	Min-Bin	Align-XP,R
a. ( )φ ( )φ	*!	
b. ☞ ( )φ		

2.2 Wrapping effects

The examples in (11) and (12) show that when verb or noun phrase heads are followed by syntactic complements (object nouns or prepositional phrases) containing two prosodic words, the speakers produce the utterances in two separate p-phrases. Two patterns of optionality in the assignment of phonological phrases are available to speakers, regardless of rate of speech. Cases of (ωωω)φ were typically produced in fast speech rate.

(11) [V [N PP]$_{NP}$]$_{VP}$ → (V)φ (N PP)φ / (V N)φ (PP)φ
a. (Compraba)φ (mapas de Barcelona)φ
a′. (Compraba mapas)φ (de Barcelona)φ
‘He used to buy maps of Barcelona.’

b. (Comeré)φ (pasteles de chocolate)φ
b′. (Comeré pasteles)φ (de chocolate)φ
‘I will eat chocolate cakes.’

c. (Lo nombraron)φ (profesor de filología)φ
c′. (Lo nombraron profesor)φ (de filología)φ
‘They appointed him professor of philology.’

(12) [N [PP[PP]$_{PP}$]$_{PP}$]$_{NP}$ → (N)φ (PP PP)φ
a. (Un montón)φ (de mapas de Barcelona)φ
a′. (Un montón de mapas)φ (de Barcelona)φ
‘A stack of maps of Barcelona.’

b. (Yogures)φ (de la sierra de Gredos)φ
b′. (Yogures de la sierra)φ (de Gredos)φ
‘Yoghourts from the Gredos Range.’

Table 1. Percentages of (ω)φ(ωω)φ, (ωω)φ(ω)φ, and (ωωω)φ patterns produced in utterances consisting of phrase verbal or nominal heads followed by syntactic complements which contain two prosodic words, for the four speakers.

Speaker	(ω)φ(ωω)φ	(ωω)φ(ω)φ	(ωωω)φ
MN	8%	64%	28%
CA	31%	25%	44%
AE	13%	37%	50%
CG	13%	50%	37%

Table 1 shows the total percentages of (ω)φ(ωω)φ, (ωω)φ(ω)φ, and (ωωω)φpatterns produced in utterances consisting of phrase verbal or nominal heads followed by syntactic complements which contain two prosodic words, for the four speakers. A total of 16 sentences have been analyzed per speaker, for both normal and fast speech rates. The data in Table 1 reveal that while both groupings are possible, namely (ω)φ(ωω)φ and (ωω)φ(ω)φ, 3 out of 4 speakers prefer to place a phrase break within the complex object NP or PP. In our data, a mean of 60% of the cases in normal speech rate were instances of (ωω)φ(ω)φ.

First, the examples produced at normal speech rates show that a binary length requirement Max-Bin such as the one in (13) has an active role in Spanish phrasing. The constraint Max-Bin enforces p-phrases to be maximally binary and thus disallows a phrasing like (ωωω)φ, which was only attested in fast speech reading. The output (ωωω)φ, as in (*Compraba mapas de Barcelona*)φ, typical of fast speech rates, will be dealt with in Sections 2.5 and 2.6.

(13) Max-Bin (after Selkirk 2000, Sandalo & Truckenbrodt 2002)
P-phrases consist of maximally two prosodic words.

If Wrap-XP were a strong constraint we would expect that each maximal projection (XP) should be contained in a phonological phrase, with no prosodic phrases breaking it (see (14)). Crucially, an XP is not 'wrapped' when the XP is split up across more than one p-phrase.

(14) Wrap-XP (Truckenbrodt 1995, 1999:228)
Each XP is contained in a phonological phrase.

Yet, the optionality between (*Compraba*)φ (*mapas de Barcelona*)φ and (*Compraba mapas*)φ (*de Barcelona*)φ (with a tendency to produce the latter phrasing option) indicates that the potential wrapping effect on syntactic constituents is weak in Spanish. Crucially, the phrasing (*Compraba mapas*)φ (*de Barcelona*)φ would constitute a double violation of Wrap-XP, since neither VP nor NP are contained in a φ-phrase, yet this phrasing pattern is found in 60% of the cases. If we take Wrap-XP to be active (see tableau 15a) the only winning candidate would be (*Compraba*)φ (*mapas de Barcelona*)φ. Candidates (b) (ω)φ(ωω)φ and (c) (ωω)φ(ω)φ both satisfy Max-Bin and thus the two options are possible, but candidate (b) wins because it incurs only one violation of Wrap-XP. Finally, Align-XP,R is not violated by any of the candidates because there are no internal maximal projection boundaries that have to be respected. However, if we assume that Wrap-XP is ranked lower in the hierarchy (see tableau 15b) then the right outcome is obtained and both phrasing options, namely (ω)φ(ωω)φ and (ωω)φ(ω)φ, are equally possible.

(15) a.

[Compraba [mapas [de Barcelona] $_{PP}$] $_{NP}$] $_{VP}$	Min-Bin	Wrap-XP
a. ( )φ	*!	
☞ b. ( )φ ( )φ		*
c. ( )φ ( )φ		**!

b.

[Compraba [mapas [de Barcelona]$_{PP}$]$_{NP}$]$_{VP}$	Min-Bin
a. ( )φ	*!
☞ b. ( )φ ( )φ	
☞ c. ( )φ ( )φ	

2.3 Maximality and minimality effects

Next consider the case whereby verbal heads are followed by a complex object containing three prosodic words (in syntactic structures such as [V [N [PP [AP]$_{AP}$]$_{PP}$]$_{NP}$]$_{VP}$). The examples in (16) and (17) illustrate a clear mismatch between syntactic and prosodic constituency: the first object noun is consistently phrased together with the preceding verb due to the fact that the prepositional phrase internal to the object is longer. The resulting prosodic structure, (ωω)φ(ωω)φ, was produced in practically 100% of the cases at both normal and fast speech rates. The prosodic difference between the two realizations (fast vs. normal rates of speech) was typically the presence vs. absence of a continuation rise at the end of the first p-phrase. The addition of a complement, thus, causes a complete 'rebalance' of the distribution of the phonological weight of the sequence in such a way that the resulting p-phrases are more balanced for length. Crucially, a potential phrasing candidate which groups 1+2+1 prosodic words, such as *(*Compraba*)φ (*mapas de la Barcelona*)φ (*antigua*)φ is unattested in our data and was considered to be ungrammatical by our informants.

(16) [V [N [PP [AP]$_{AP}$]$_{PP}$]$_{NP}$]$_{VP}$ → (V N)φ (PP AP)φ
   a. (Compraba mapas)φ (de la Barcelona antigua)φ
      'He used to buy maps of old Barcelona.'
   b. (Comeré pasteles)φ (de chocolate amargo)φ
      'I will eat cakes of dark chocolat.'
   c. (Lo nombraron profesor)φ (de filología románica)φ
      'They appointed him professor of Romance philology.'

(17) [N [PP [PP [AP]$_{AP}$]$_{PP}$]$_{PP}$]$_{NP}$ → (N PP)φ (PP AP)φ
   a. (Una botella de vino)φ (bastante rosado)φ
      'A bottle of fairly rosé wine.'
   b. (Un anillo de plata)φ (bastante bonito)φ
      'A ring made of rather nice silver.'
   c. (Yogures de limón)φ (de la sierra de Gredos)φ
      'Lemon yoghourts from the Gredos Range.'

Note that same phenomenon has been reported for Catalan (Prieto 2005) and for Italian (Ghini 1993a:49, 1993b): (*Ho mangiato*)φ (*dei pasticini ripieni*)φ 'I have eaten filled cakes' vs. (*Ho mangiato dei pasticini*)φ (*ripieni di cioccolata*)φ 'I have eaten cakes filled with chocolate'. These facts reveal that phonological well-formedness constraints (namely, Max-Bin) have a very prominent role in Romance phrasing.

The examples above would go unaccounted for if we only took into account alignment or cohesional constraints. Align-XP, R would predict a p-boundary after the first maximal projection (that is, no breaks within NP of VP), and Wrap-XP would predict it at the right edge of V or N so that the syntactic complement is wrapped, as in (*Compraba*)φ (*mapas de la Barcelona antigua*)φ 'He used to buy maps of old

Barcelona'. Yet the fact is that Catalan, Italian and Spanish speakers place p-boundaries within the verb complement object NP and the noun complement PP when the phonological weight of this complement is substantial. We propose that a combination of the prosodic length constraints Max-Bin and Min-Bin easily derive the correct grouping (*Compraba mapas*)φ (*de la Barcelona antigua*)φ. This can be seen by inspecting the two tableaux in (18) with VP and NP projections: candidates (a) (ωωωω)φ, (b) (ω)φ (ωωω)φ, (c) (ωωω)φ (ω)φ, and (e) (ω)φ(ωω)φ(ω)φ clearly violate one of the two prosodic requirements. [NB: Note that in this case the winning candidate (d) could be obtained through the subordinate effect of Wrap-XP: Wrap-XP is violated twice in (d) (VP and NP are not contained in a p-phrase) and three times in (e) (VP, NP and PP are not wrapped). However, we have seen in Section 2.2 that Wrap-XP had no effect on optional groupings such as (*Compraba mapas*)φ (*de Barcelona)*φ and (*Compraba*)φ (*mapas de Barcelona)*φ:

(18) a.

[Compraba [mapas [de la Barcelona [antigua]$_{AP}$]$_{PP}$]$_{NP}$]$_{VP}$	Max-Bin	Min-Bin
a. ( )φ	*!	
b. ( )φ ( )φ	*!	*
c. ( )φ ( )φ	*!	*
☞ d. ( )φ ( )φ		
e. ( )φ ( )φ ( )φ		*!

b.

[Una botella [de vino [bastante [rosado]$_{AP}$]$_{AP}$]$_{PP}$]$_{NP}$	Max-Bin	Min-Bin
a. ( )φ	*!	*
b. ( )φ ( )φ	*!	*
c. ( )φ ( )φ	*!	*
☞ d. ( )φ ( )φ		
e. ( )φ ( )φ ( )φ		*!

2.4 Alignment effects

Typically, subjects are phrased on their own (S)φ (VO)φ when the verbal projection is relatively short and contains one or two prosodic words (see examples in (19)). Exceptions to this generalization are the following: (a) when the utterance consists of two prosodic words (see minimality effects in Section 2.1); (b) when the verbal projection is long and the V can be grouped with the preceding subject (see Section 2.5).

(19) a. (Javier)φ (visitó Galicia)φ
'Javier visited Galicia.'

b. (Los vecinos catalanes)φ (se enfadan)φ
'The Catalan neighbors get angry.'

c. (La casa de Pineda)φ (se quedó vacía)φ
'The house in Pineda is empty.'

d. (El presidente de la Generalitat)φ (sufre)φ
'The president of the Generalitat is suffering.'

The groupings above are accounted for by the dominant role of ALIGN-XP,R, the constraint responsible for consistently placing a p-boundary after the subject phrase. In the tableaux in (20), the optimal outputs are always of the form (S)φ (VO)φ where the right candidate is the only one that satisfies both the right end-alignment requirement and the MAX-BIN (later in this section we will provide evidence that ALIGN-XP,R is ranked higher than MAX-BIN). Finally, note that the subordinate constraint WEIGHT-BAL does not play any role in the cases in (20).

(20) a.

[[Javier]$_{NP}$ [visitó [Galicia]$_{NP}$]$_{VP}$]$_{IP/CP}$	ALIGN-XP,R	MAX-BIN	MIN-BIN
a. ( )φ	*!	*	
☞ b. ( )φ ( )φ			*
c. ( )φ ( )φ	*!		*

b.

[[Los vecinos [catalanes] $_{AP}$]$_{NP}$ [se enfadan]$_{VP}$]$_{IP/CP\ P}$	ALIGN-XP,R	MAX-BIN	MIN-BIN
a. ( )φ	*!	*	
☞ b. ( )φ ( )φ			*
c. ( )φ ( )φ	*!		*

Crucial evidence for the dominant role of ALIGN-XP,R in the hierarchy comes from the behavior of dative or adjunct PPs that do not depend directly on the preceding noun, that is, those that are non-locally attached to the higher node VP. In a structure like [V [NP]$_{NP}$ [PP]$_{PP}$]$_{VP}$ we can detect a right p-boundary between the accusative and dative objects. The examples in (21) and (22) show that non-local PPs are typically phrased on their own and resist being phrased together with preceding units. The same holds true of locative or temporal phrases. Right alignment of p-phrases with XP projections is thus enforced even when the first p-phrase contains three prosodic words, as in (*Compraba mapas de Barcelona*)φ (*para Ana*)φ. In these cases, two other phrasing options (typical of slower speech rates) are to group the utterance as 1+2+1 (*Compraba*)φ *(mapas de Barcelona*)φ (*para Ana*)φ or as 2+1+1 (*Compraba mapas*)φ *(de Barcelona*)φ (*para Ana*)φ. Significantly, something like *(*Compraba mapas*)φ (*de Barcelona para Ana*)φ with no p-boundary at the syntactic end of the VP projection is unattested in our data.

(21) [[V [NP]$_{NP}$ [PP]$_{PP}$]$_{VP}$]$_{IP/CP}$ → (V NP)φ (PP)φ
a. (Compraba mapas de Barcelona)φ (para Ana)φ
Slower speech: (Compraba)φ (mapas de Barcelona)φ (para Ana)φ
(Compraba mapas)φ (de Barcelona)φ (para Ana)φ
BUT: *(Compraba mapas)φ (de Barcelona para Ana)φ
'He/she used to buy maps of Barcelona for Ana.'
b. (Compró las películas de Woody)φ (en Londres)φ
Slower speech: (Compró)φ (las películas de Woody)φ (en Londres)φ
(Compró las películas)φ (de Woody)φ (en Londres)φ
BUT: *(Compró las películas)φ (de Woody en Londres)φ
'He/she bought Woody [Allen] films in London.'

(22) [N [PP [AP]$_{AP}$]$_{PP}$ [PP]$_{PP}$]$_{NP}$ → (N PP AP)φ (PP)φ or (N)φ (PP AP)φ (PP)φ
a. (Una botella de vino rosado)φ (de Londres)φ
Slower speech: (Una botella)φ (de vino rosado)φ (de Londres)φ
(Una botella de vino)φ (rosado)φ (de Londres)φ
BUT: *(Una botella de vino)φ (rosado de Londres)φ
'A bottle of rosé wine from London.'
b. (Un anillo de plata suiza)φ (para mi madre)φ
Slower speech: (Un anillo)φ (de plata suiza)φ (para mi madre)φ
(Un anillo de plata)φ (suiza)φ (para mi madre)φ
BUT: *(Una botella de plata)φ (suiza para mi madre)φ
'A ring made of Swiss silver for my mother.'

Figure 2 shows the waveform and intonation contour of the utterance (*Compró las películas de Woody*)φ (*en Londres*)φ 'She/he bought Woody [Allen] films in London', as pronounced by speaker AE. The intonation contour clearly illustrates that the first phonological phrase is pronounced on a high plateau that ends at the boundary of the first p-phrase (after *Woody*); after that, the second phonological phrase is pronounced in a low tone.

Remember that utterance (22a) is generally phrased as 3+1 (*Compraba mapas de Barcelona*)φ (*para Ana*)φ, and can be phrased in slower speech rates as 1+2+1 (*Compraba*)φ (*mapas de Barcelona*)φ (*para Ana*)φ or as 2+1+1 (*Compraba mapas*)φ (*de Barcelona*)φ (*para Ana*)φ. This example constitutes key evidence that ALIGN-XP,R is ranked higher than MAX-BIN and MIN-BIN because the phrasing *(*Compraba mapas*)φ (*de Barcelona para Ana*)φ is unattested. As the tableau in (23) illustrates, the latter options 1+2+1 and 2+1+1 are easily derived by the proposed ranking of constraints. Crucially, the winning candidates (e) and (f) are the only ones that do not violate either ALIGN-XP,R or MAX-BIN. Yet candidate (c), which is a possible outcome, is ruled out by MAX-BIN (where "⊗" means that the candidate should be co-optimal with (e,f) but is not).

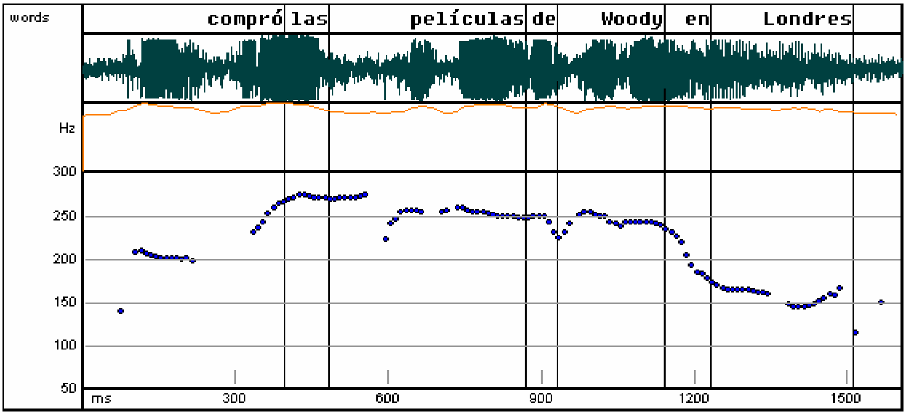


Figure 2. Waveform and intonation contour of the utterance (*Compró las películas de Woody*)φ (*en Londres*)φ '(S)he bought Woody [Allen] films in London', as pronounced by speaker AE.

(23)

[Compraba [mapas [de Barcelona]$_{PP}$]$_{NP}$ [para Ana]$_{PP}$]$_{VP}$	Align-XP,R	Wrap-XP
a. ( )φ	NP!	*
b. ( )φ ( )φ	NP!	*
⊗ c. ( )φ ( )φ		*!
d. ( )φ ( )φ	NP!	
☞ e. ( )φ ( )φ ( )φ		
☞ f. ( )φ ( )φ ( )φ		

At this juncture, we claim that phrasings such (*Compró las películas de Woody*)φ (*en Londres*)φ in (21) and (22) constitute crucial evidence that Max-Bin should be restricted to the end of the utterance: indeed, longer phrases (that is, p-phrases that contain 3 or more prosodic words) tend to appear in utterance-initial position. Similarly, when subjects are long, a p-boundary is placed after the subject, even if it is made up of by four/five prosodic words and the following verbal projections contains just a single word (see (24)). Note that other phrasing options are possible, namely, (*Los vecinos catalanes*)φ (*del Ebro*)φ (*se enfadan*)φ or (*Los vecinos*)φ (*catalanes del Ebro*)φ (*se enfadan*)φ 'The Catalan neighbors from the Ebro region get angry'.

(24) a. (Los vecinos catalanes del Ebro)φ (se enfadan)φ
'The Catalan neighbors from the Ebro region get angry.'
b. (La casa de Pineda de Mar)φ (se quedó vacía)φ
'The house in Pineda de Mar is empty.'
c. (El presidente de la Generalitat de Cataluña)φ (sufre)φ
'The president of the Generalitat of Catalonia is suffering.'

The phrasing patterns above advocate for the substitution of Max-Bin with a more specific restriction on the maximum size of p-phrases Max-Bin(IP Head), stated in (25). This condition is sensitive to phrasal position: it restricts the binarity constraint to p-phrases located at the end of the utterance. In this connection, Frascarelli (2000:67ff) has proposed that in Italian the Min-Bin requirement is restricted to p-phrases with sentential or emphatic stress. Intuitively, prominent constituents within prosodic domains want to be branching, hence minimally and maximally binary.

(25) Max-Bin (IP Head)
A phonological phrase which is the head of an IP constituent must be binary (at the ω level).

In the case of the Spanish data at hand, if we consider Max-Bin to be restricted to the end of the utterance then we can obtain the right phrasing outcomes in (21), (22), and (24). In the following tableaux in (26), Max-Bin (IP Head) penalizes candidates (a) and (b) but candidates in (d), namely (*Compraba mapas de Barcelona*)φ (*para Ana*)φ and (*Los vecinos catalanes del Ebro*)φ (*se enfadan*)φ, are crucially not penalized by this constraint. The three winning candidates coincide indeed with the three optional outputs. However, in order to choose from these three candidates speech rate effects will have to be taken into account (see summary Section 2.6).

(26) a.

[Compraba [mapas [de Barcelona]$_{PP}$]$_{NP}$ [para Ana]$_{PP}$]$_{VP}$	MAX-BIN (IP Head)	ALIGN-XP,R
a. ( )φ	*!	*
b. ( )φ ( )φ	*!	*
⊗ c. ( )φ ( )φ		*!
d. ( )φ ( )φ		
☞ e. ( )φ ( )φ ( )φ		
☞ f. ( )φ ( )φ ( )φ		

b.

[[Los vecinos [catalanes [del Ebro]$_{PP}$]$_{AP}$]$_{NP}$ [se enfadan]$_{VP}$]$_{IP/CP}$	MAX-BIN (IP Head)	ALIGN-XP,R
a. ( )φ	*!	NP
b. ( )φ ( )φ	*!	NP
⊗ c. ( )φ ( )φ		NP!
☞ d. ( )φ ( )φ		
☞ e. ( )φ ( )φ ( )φ		
☞ f. ( )φ ( )φ ( )φ		

So far, the Spanish phrasing data have been straightforwardly accounted for by the following constraint hierarchy. Note that reference to syntax is obtained through ALIGN-XP,R and the remaining of the constraints have the goal of maintaining prosodic well-formedness.

(27) Basic hierarchy of constraints
MAX-BIN (IP Head) >> ALIGN-XP,R

2.5 The unexpected behavior of subjects

As the examples in (28) show, Spanish subjects can display some unexpected phrasing properties. In our data, SVO structures display various patterns of optionality when verbal projections are long enough (i.e., they contain three prosodic words): (S)(VO), (SV)(O) and (SVO) are all possible phrasings. While the first two options are possible at normal speech rates, the latter is typical of fast speech rates. That is, verbs can be grouped together with preceding subjects at normal speech rates when objects are long. The phrasing options for slower speech rates are given in (29).

(28) Normal/rapid speech rate
[[NP]$_{NP}$ [V [N [PP] $_{PP}$]$_{NP}$]$_{VP}$]$_{IP/CP}$ → (S V)φ (O)φ
a. (Juan leerá)φ (novelas de aventuras)φ
(Juan)φ (leerá novelas de aventuras)φ
(Juan leerá novelas de aventuras)φ
'John will read adventure novels.'
b. (El periodista comunicó)φ (la noticia del dia)φ
(El periodista)φ (comunicó la noticia del dia)φ
(El periodista comunicó la noticia del dia)φ
'The journalist reported the news of the day.'

c. (Javier visitó)φ (la Galicia de sus sueños)φ
(Javier)φ (visitó la Galicia de sus sueños)φ
(Javier visitó la Galicia de sus sueños)φ
'Javier visited his beloved Galicia.'

(29) Slow speech rate
$[\,[\mathrm{NP}]_{NP}\ [\mathrm{V}\ [\mathrm{N}\ [\mathrm{PP}]_{NP}]_{NP}]_{VP}]_{IP/CP} \rightarrow (\mathrm{S})\varphi\ (\mathrm{V})\varphi\ (\mathrm{O})\varphi$

a. (Juan)φ (leerá)φ (novelas de aventuras)φ
(Juan)φ (leerá novelas)φ (de aventuras)φ
'John will read adventure novels.'

b. (El periodista)φ (comunicó)φ (la noticia del dia)φ
(El periodista)φ (comunicó la noticia)φ (del dia)φ
'The journalist reported the news of the day.'

c. (Javier)φ (visitó)φ (la Galicia de sus sueños)φ
(Javier)φ (visitó la Galicia)φ (de sus sueños)φ
'Javier visited his beloved Galicia.'

Figure 3 shows the waveform and intonation contour of the utterance (*Juan leerá*)φ (*novelas de aventuras*)φ 'John will read adventure novels', as pronounced by speaker AE. In the intonation contour, the continuation rise is placed after the verb and clearly exemplifies an (SV)(O) grouping.

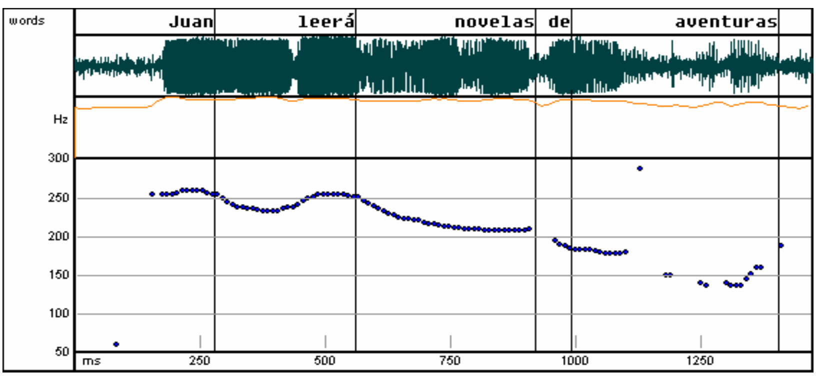


Figure 3. Waveform and intonation contour of the utterance (*Juan leerá*)φ (*novelas de aventuras*)φ 'John will read adventure novels', as pronounced by speaker AE.

While this special behavior of subjects has been systematically reported for Catalan (see Prieto 1997, 2005, Elordieta *et al.* 2003 and D'Imperio *et al.* 2005)[4] and for Japanese (Hirose 2002, in press)[5], for Spanish we find two contradicting reports. On the one

4. Catalan displays a strong tendency to create prosodic units of similar sizes, thus when subjects are short and objects are long (SV)(O) phrasings are more common. The Catalan results in Elordieta *et al.* (2003) reveal that (SV)(O) phrasings increase both when subjects are short and when objects are long (between an 8%–24% increase in the short subject and long object conditions).

5. In Japanese, a structure like "subject NP + object NP + adverb + verb + dative NP" is generally produced by placing a major prosodic boundary after the subject when it consists of two NPs. But when the subject is made up of a single NP, the boundary is placed after the object NP.

Table 2. Percentages of (SV)(O), (S)(VO) and (SVO) patterns in sentences with short subjects (one prosodic word) followed by long objects (3 prosodic words), for the four speakers.

Speaker	(SV)(O)	(S)(VO)	(SVO)
MN	70%	23%	7%
CA	33%	33%	33%
AE	71%	7%	22%
CG	77%	1%	22%

hand, Nibert (2000) concludes that the default type of phrasing in Spanish is (SV)(O). On the other hand, Elordieta *et al.* (2003, 2005) obtain a large majority of (S)(VO) intonational phrasings and conclude that a default (S)(VO) phrasing predominates regardless of whether objects are long or short. Table 2 shows the total percentages of (SV)(O), (S)(VO) and (SVO) patterns produced in utterances with short subjects (one prosodic word) followed by long objects (3 prosodic words), for the four speakers. A total of 16 sentences have been analyzed per speaker, for both normal and fast speech rates. The results show variation depending on the speaker: while one speaker (CA) displays a balance between the two options, the other three display a strong tendency to produce (SV)(O) phrasings and maintain similar phrase sizes.

We thus conclude that in Spanish both (SV)(O) and (S)(VO) phrasings are possible when the "weight" conditions are favorable (that is, when there are enough number of words in the object), and that there are individual differences among speakers. In our data, the fact that the same utterance was grouped differently across repetitions (even by the same speaker) indicates that there is a certain degree of freedom among different phrasings.

This behavior of these subjects is not predicted under a theory of syntax-phonology interface that takes only Align-XP/Wrap-XP constraints into account: neither the order Align-XP,R >> Wrap-XP nor Wrap-XP >> Align-XP,R would explain an output such as (*Juan leerá*)φ (*novelas de aventuras*)φ 'John will read adventure novels' with no phrase break after the subject.

The constraint hierarchy proposed so far (see tableau (30)) accounts for the two possible phrasings in slow speech (i.e., the phrasings in (29)). The optimal candidates (e) and (f) are the ones that satisfy both Max-Bin(IP Head) and Align-XP. Yet candidate (d), which is a possible outcome, is ruled out by Align-XP (where "⊗" means that the candidate should be co-optimal with (e,f) but is not).

(30)

[[Juan]$_{NP}$ [leerá [novelas [de aventuras]$_{PP}$]$_{NP}$]$_{VP}$]$_{IP/}$	Max-Bin (IP Head)	Align-XP,R
a. ( )φ	*!	*
b. ( )φ ( )φ	*!	
c. ( )φ ( )φ		*!
⊗ d. ( )φ ( )φ		*!
☞ e. ( )φ ( )φ ( )φ		
☞ f. ( )φ ( )φ ( )φ		

How do we obtain the phrasing patterns obtained in more rapid speech? We propose to capture the effects of speech rate on phrasing through the constraint stated in (31), MIN-N-PHP = MINIMIZE NUMBER OF PHONOLOGICAL PHRASES, which is only active in fast speech. This constraint penalizes, in a gradual way, outputs with a higher number of p-phrases containing a maximum of 4 prosodic words within a p-phrase. This indeed responds to the universal tendency to have fewer phonological phrases at faster speech rates.[6]

(31) MIN-N-PHP (RAPID SPEECH)
In rapid speech, minimize the number of phonological phrases within an IP.

In tableau (30), MIN-N-PHRASES would penalize twice the output forms with more than two p-phrases (candidates (e) and (f)), and penalize once the output forms with two p-phrases (candidates (b), (c) and (d)). Thus, the best candidate in fast speech would be the one that grouped all four prosodic words into one p-phrase (ωωωω)φ. Among the possible candidates with two p-phrases (b-d), the optimal candidates are (c) and (d). Although only one right output is obtained, this leaves open the possibility of having optional reorderings of constraints within a given rate of speech.

2.6 Summary of OT analysis of p-phrasing in Spanish

This section contains a summary of the OT analysis of Spanish phrasing defended throughout this article. (32) illustrates the basic hierarchy of constraints for normal/slow speech rates. As shown in the preceding section, the main difference between a normal speech rate and fast speech rates is stated through the constraint MIN-N-PHP (minimize the number of p-phrases within an intonational phrase). For fast speech rates, MIN-N-PHP would be added as a gradual evaluator of the potential candidates:

(32) Normal/slow speech rate
MAX-BIN (IP Head) >> ALIGN-XP,R >> MIN-BIN

The tableaux in (33) show a summary of the possible outputs in normal/slow speech rates taking into account the complete ranking of constraints. The example types follow the order of their presentation in this article.

(33) a.

[Compraba [mapas [de Barcelona] $_{PP}$] $_{NP}$] $_{VP}$	MAX-BIN (IP Head)	ALIGN-XP,R	MIN-BIN
a. ( )φ	*!		
☞ b. ( )φ ( )φ			*
☞ c. ( )φ ( )φ			*

6. As an anonymous reviewer has pointed out, another possibility for analyzing the rapid speech effects is to treat them as phonetics-phonology mismatches (in the spirit of Blevins 1995).

b.

[Compraba [mapas [de la Barcelona [antigua] $_{AP}$] $_{PP}$] $_{NP}$] $_{VP}$	Max-Bin (IP Head)	Align-XP,R	Min-Bin
a. ( )φ	*!		
b. ( )φ ( )φ	*!		
c. ( )φ ( )φ			*
☞ d. ( )φ ( )φ			
e. ( )φ ( )φ ( )φ			*

c.

[[Javier] $_{NP}$ [visitó [Galicia] $_{NP}$] $_{VP}$] $_{IP/CP}$	Max-Bin (IP Head)	Align-XP,R	Min-Bin
a. ( )φ	*!	*	
b. ( )φ ( )φ		*!	*
☞ c. ( )φ ( )φ			*!

d.

[Compraba [mapas [de Barcelona] $_{PP}$] $_{NP}$ [para Ana] $_{PP}$] $_{VP}$	Max-Bin (IP Head)	Align-XP,R	Weight-Bal
a. ( )φ	*!	*	*
b. ( )φ ( )φ	*!	*	*
c. ( )φ ( )φ		*!	
☞ d. ( )φ ( )φ			*
☞ e. ( )φ ( )φ ( )φ			*
☞ f. ( )φ ( )φ ( )φ			*

e.

[[Los vecinos [catalanes [del Ebro] $_{PP}$] $_{AP}$] $_{NP}$ [se enfadan] $_{VP}$] $_{IP/CP}$	Max-Bin (IP Head)	Align-XP,R	Weight-Bal
a. ( )φ	*!	NP	
b. ( )φ ( )φ	*!	NP	*
c. ( )φ ( )φ		NP!	
☞ d. ( )φ ( )φ			*
☞ e. ( )φ ( )φ ( )φ			*!
☞ f. ( )φ ( )φ ( )φ			*

3. Conclusions

The Spanish phrasing data provides critical evidence that prosodic well-formedness constraints play a major role in phrasing decisions, often overriding the syntactic constraints. Following up on Ghini's reanalysis of Italian phrasing, our analysis shows that p-phrase construction in Spanish cannot rely solely on syntactic information but must also obey two prosodic well-formedness constraints: Max-Bin (IP Head) (a binary phonological weight preference at the end of the utterance), and Min-Bin (a minimality requirement on the prosodic parsing of utterances). These prosodic conditions can be understood as constraints which have the role of increasing the eurhythmic properties of sentences in the sense of creating regular and balanced stress periods. Of course, the constraints that connect syntax to prosody (such as end alignment Align-XP,R) are still relevant. We have demonstrated that Spanish displays no wrapping effects in the data at hand and that the apparent wrapping effects in other sentences can be explained through a prosodic well-formedness constraint on weight balancing. Finally, optimal outputs in fast speech rates are obtained through a constraint (Min-N-PhP) which minimizes the number of phonological phrases in this style of speech. In summary, an adequate theory of prosodic phrasing has to recognize the complex interaction and contribution between syntactic and prosodic (and eurhythmic) effects on phrasing together with crosslinguistic and intralinguistic variation.

References

Beckman, M.E. and Hirschberg, J. 1994. The ToBI Annotation Conventions. http://www.ling.ohio-state.edu/~tobi/ame_tobi/annotation_conventions.html

Blevins, J. 1995. The syllable in phonological theory. In *Handbook of Phonological Theory*, J. Goldsmith, 206–244. Londong: Basil Blackwell.

D'Imperio, M., Elordieta, G., Frota, S., Prieto, P. and Vigário, M. 2005. Intonational phrasing in Romance: The role of syntactic and prosodic structure. In *Prosodies*, S. Frota, M. Vigário and M.J. Freitas (eds), 59–98. The Hague: Mouton de Gruyter.

Elordieta, G., Frota, S., Prieto, P. and Vigário, M. 2003. Effects of constituent length and syntactic branching on intonational phrasing in Ibero-Romance. In *Proceedings of the XVth International Congress of Phonetic Sciences*. M-J. Solé, D. Recasens and J. Romero (eds), Vol. 1, 487–490. Barcelona: Causal Productions.

Elordieta, G., Frota, S. and Vigário, M. 2005. Subjects, objects and intonational phrasing in Spanish and Portuguese. *Studia Linguistica* 59(2–3): 110 –143, (Special issue on *Boundaries in Intonational Phonology*, M. Horne and M. van Oostendorp (eds)).

Frascarelli, M. 2000. *The Syntax-Phonology Interface in Focus and Topic Constructions in Italian*. Dordrecht: Kluwer.

Ghini, M. 1993a. Phonological Phrase Formation in Italian. MA thesis, University of Toronto.

Ghini, M. 1993b. φ-formation in Italian: A new proposal. *Toronto Working Papers in Linguistics* 12: 41–77.

Hellmuth, S. Forthcoming. Prosodic weight and phonological phrasing in Cairene Arabic. *Proceedings of the 40th Annual Chicago Linguistics Society*. Chicago IL: CLS.

McCarthy, J. and Prince, A. 1993a. Generalized alignment. In *Yearbook of morphology 1993*. G. Booij and J. van Marle (eds), 79–153. Dordrecht: Kluwer.

McCarthy, J. and Prince, A. 1993b. *Prosodic Morphology* I: *Constraint interaction and satisfaction*. New Brunswick NJ: Center for Cognitive Science.

Nespor, M. and Vogel, I. 1986. *Prosodic Phonology*. Dordrecht: Foris.

Nespor, M. and Vogel, I. 1989. On clashes and lapses. *Phonology* 6: 69–116.

Nibert, H. 2000. Phonetic and Phonological Evidence for Intermediate Phrasing in Spanish Intonation. PhD dissertation, University of Illinois at Urbana-Champaign.

Post, B. 1999. Restructured phonological phrases in French. Evidence from clash resolution. *Linguistics* 37: 41–63.

Post, B. 2000. Tonal and Phrasal Structures in French Intonation. PhD dissertation, Katholieke Universiteit Nijmegen. (LOT series, Netherlands Graduate School of Linguistics 34).
Prieto, P. 1997. Prosodic manifestation of syntactic structure in Catalan. In *Issues in the Phonology of the Iberian Languages,* F. Martínez-Gil and A. Morales-Front (eds), 179–199. Washington DC: Georgetown University Press.
Prieto, P. 2005. Syntactic and eurhythmic constraints on phrasing decisions in Catalan. *Studia Linguistica* 59(2–3): 194–222.. (Special issue on *Boundaries in Intonational Phonology*, M. Horne and M. van Oostendorp (eds)).
Rao, R. Forthcoming. On intonation's relationship with pragmatic meaning in Spanish. In *Proceedings of the 8th Hispanic Linguistics Symposium*. Somerville MA: Cascadilla.
Sandalo, F. and Truckenbrodt, H. 2002. Some notes on phonological phrasing in Brazilian Portuguese. *MIT Working Papers in Linguistics* 42: 285–310.
Selkirk, E. 1986. On derived domains in sentence phonology. *Phonology Yearbook* 3: 371–405.
Selkirk, E. 2000. The interaction of constraints on prosodic phrasing. In *Prosody: Theory and experiment. Studies presented to Gösta Bruce*, M. Horne (ed.), 231–261. Dordrecht: Kluwer.
Selkirk, E. 2005. Comments on intonational phrasing in English. In *Prosodies*. S. Frota, M. Vigário and M.J. Freitas (eds), 11–58. The Hague: Mouton de Gruyter.
Truckenbrodt, H. 1995. Phonological Phrases: Their relation to syntax, focus, and prominence. PhD dissertation, MIT.
Truckenbrodt, H. 1999. On the relation between syntactic phrases and phonological phrases. *Linguistic Inquiry* 30: 219–255.

Appendix

Encuesta agrupación prosódica

Nombre, edad y lugar de nacimiento: ____
____

Lea las siguientes frases en dos veces separadas. La primera a una velocidad más bien lenta (es decir, si la frase no es muy corta, agrupando la frase en varias partes) y la segunda a una velocidad más bien rápida. Es importante que imagine que está leyendo información nueva, al estilo noticia (es decir, imagine que son frases respuesta a una pregunta como *¿Qué pasa?*

1. Le nombraron profesor
2. Le nombraron profesor de filología
3. Le nombraron profesor de filología románica

4. Saldrán dos volúmenes
5. Saldrán dos volúmenes importantes
6. Saldrán dos volúmenes importantes de verdad

7. Recibió la felicitación
8. Recibió la felicitación de amigos
9. Recibió la felicitación de amigos personales

10. Compraré yogures
11. Compraré yogures de la sierra
12. Compraré yogures de la sierra de Gredos

13. He visto el circo
14. He visto el circo lleno
15. He visto el circo lleno de cebras

16. Comeré pasteles
17. Comeré pasteles de chocolate
18. Comeré pasteles de chocolate amargo

19. Compraba mapas
20. Compraba mapas de Barcelona
21. Compraba mapas de la Barcelona antigua

22. Sacó a los tigres
23. Sacó a los tigres de la jaula
24. Sacó a los tigres fuera de la jaula

25. Compraba mapas para Ana
26. Regaló el libro a María
27. Empujó a Juan dentro del agua
28. Envió besitos a Ana
29. Compró las películas de Woody
30. Compró las películas en Londres
31. Compró las películas de Woody en Londres

32. Comprarán un anillo de plata
33. Comprarán un anillo de plata en Suiza
34. Comprarán un anillo de plata suiza

35. Una botella de vino
36. Una botella de vino rosado
37. Una botella de vino rosada

38 .Un anillo de plata
39. Un anillo de plata suiza
40. Un anillo de plata suizo

41. La nena quiere
42. La nena quiere los regalos
43. La nena de María no quiere los regalos
44. La nena boliviana de María no quiere los regalos

45. La casa se quedó vacía
46. La casa de Pineda se quedó vacía
47. La casa de Pineda de Mar se quedó vacía

48. El presidente sufre
49. El presidente de la Comunidad de Madrid sufre
50. El presidente de la Comunidad de Madrid sufre por los resultados
51. El presidente de la Generalitat de Catalunya sufre

52. Los vecinos catalanes se enfadan
53. Los vecinos catalanes del Ebro se enfadan
54. Los vecinos catalanes del otro lado del Ebro se enfadan
55. El discurso terminó
56. El discurso del norteamericano terminó

57. El discurso del Secretario de Estado Colin Powell terminó
58. El discurso del Secretario de Estado norteamericano Colin Powell terminó

59. El periodista comunicó la noticia
60. El periodista comunicó la noticia del día
61. El periodista comunicó la emotividad de la noticia

62. Javier visitó Galicia
63. Javier visitó Galicia en bicicleta
64. Javier visitó la Galicia de sus sueños
65. Javier visitó la Galicia de sus sueños en bicicleta

66. María bebió agua destilada
67. María bebe agua destilada
68. María bebía agua destilada
69. María vende peras de Valencia
70. María vendía peras de Valencia
71. Juan leerá novelas de aventuras
72. Juan leerá libros de aventuras

73. Compraba mapas de Barcelona
74. Compraré mapas de Barcelona
75. Compraré pasteles de chocolate
76. Compraba flanes de chocolate
77. Compraré flanes de chocolate
78. Saldrán volúmenes importantes
79. Saldrán cartas importantes
80. Recibirá la felicitación de amigos
81. Recibirá cartas de amigos
82. Compraré yogures de la sierra
83. Compraré peras de Lérida
84. Leyó novelas de aventuras
85. Leyó libros de aventuras

Hiatus resolution and incomplete identity

Eric Baković
University of California, San Diego

Potential vowel hiatus between words in Chicano Spanish is always resolved using one of several strategies, the choice among these strategies being influenced by several factors. One of these is the avoidance of adjacent segment identity, but complete identity appears not to be required: differences with respect to the feature [±high] are ignored in a specific set of cases. The analysis of these facts presented here supports the general proposal advanced by Baković (2005) that the avoidance of adjacent similar segments is due to the simultaneous satisfaction a constraint No-Long, which penalizes completely identical adjacent segments only, and other independently motivated constraints in the grammar.

Keywords: hiatus, glide, vowel, Chicano Spanish, length

0. Introduction

In the Chicano variety of Spanish spoken in South Texas, potential vowel hiatus between words is always resolved using one of several strategies of hiatus resoultion (Hutchinson 1974, Reyes 1976, Clements & Keyser 1983, Schane 1987, Martínez-Gil 2000, 2004).[1] The choice among these different strategies is influenced by several factors, one of which is the avoidance of adjacent segment identity. Adjacent identical segments are often actively avoided or repaired by phonological processes (McCarthy 1986, Borowsky 1987, Yip 1988), but in some cases, as in the case of hiatus resolution in Chicano Spanish, complete segmental identity is not required: differences with respect to certain features may sometimes be ignored, as if merely *similar* adjacent segments were avoided.

---

1. I first became aware of these data by way of a problem set in John McCarthy's class notes (see McCarthy's *Introductory OT on CD-ROM*; a demo is available as ROA-371, http://roa.rutgers.edu/). I thank John for further directing me to Hutchinson (1974) and Reyes (1976), and to Fernando Martínez-Gil for directing me to later work, especially his own. Many thanks are also due to Cindy Kilpatrick for invaluable research assistance, and to two reviewers for constructive commentary. Any remaining errors are mine.

The pattern of hiatus resolution in Chicano Spanish is fairly straightforward to describe.[2] One simplifying factor is something that differentiates Chicano Spanish from other varieties (such as Standard Spanish; Navarro Tomás 1957, Stockwell & Bowen 1965, Contreras 1969ab, Harris 1969, 1970): in Chicano Spanish, the otherwise expected stress on the vowels involved is irrelevant to the hiatus resolution strategy employed; if either vowel would otherwise be stressed, then the resulting vowel is stressed; otherwise, it is unstressed. In other Spanish varieties, the otherwise expected stress pattern directly influences the choice of hiatus resolution strategy (or even whether there is one).

First, as can be seen in (1), sequences of identical vowels are simplified to a single vowel. (Spanish orthography is close enough to underlying forms for present purposes; *guV* = /gV/, *qu* = /k/, *h* is silent.) We cannot decide *a priori* whether these examples exhibit deletion of the first vowel, deletion of the second, or coalescence of the two, but I maintain on analysis-internal grounds in §2 that it is coalescence and not deletion.

(1) Coalescence of identical vowels

a.	*lo odio*	[loðjo]	$/o_1 \# o_2/ \rightarrow [o_{1,2}]$	'hate-1SG it/him'
b.	*mi hijo*	[mixo]	$/i_1 \# i_2/ \rightarrow [i_{1,2}]$	'my son'
c.	*era así*	[eɾasi]	$/a_1 \# a_2/ \rightarrow [a_{1,2}]$	'it was like that'
d.	*se escapó*	[seskapo]	$/e_1 \# e_2/ \rightarrow [e_{1,2}]$	'escaped-3SG'
e.	*tu uniforme*	[tunifoɾme]	$/u_1 \# u_2/ \rightarrow [u_{1,2}]$	'your uniform'

Second, a word-final low ([+low]) vowel is deleted before any word-initial vowel.

(2) Deletion of low vowels

a.	*la iglesia*	[liɣlesja]	$/a_1 \# i_2/ \rightarrow [i_2]$	'the church'
b.	*paga Evita*	[paɣeβita]	$/a_1 \# e_2/ \rightarrow [e_2]$	'Evita pays'
c.	*casa humilde*	[kasumilde]	$/a_1 \# u_2/ \rightarrow [u_2]$	'humble home'
d.	*niña orgullosa*	[niœoɾɣujosa]	$/a_1 \# o_2/ \rightarrow [o_2]$	'proud girl'

Third, if the first vowel is high ([+high]), it becomes a glide (/i/ → [j], /u/ → [w]). The result of hiatus resolution here is thus a rising-sonority diphthong.

(3) Gliding of high vowels

a.	*mi ultima*	[mjultima]	$/i_1 \# u_2/ \rightarrow [j_1u_2]$	'my last one-FEM.'
b.	*mi hebra*	[mjeβɾa]	$/i_1 \# e_2/ \rightarrow [j_1e_2]$	'my thread'
c.	*mi obra*	[mjoβɾa]	$/i_1 \# o_2/ \rightarrow [j_1o_2]$	'my deed'
d.	*mi árbol*	[mjaɾβol]	$/i_1 \# a_2/ \rightarrow [j_1a_2]$	'my tree'
e.	*tu hijo*	[twixo]	$/u_1 \# i_2/ \rightarrow [w_1i_2]$	'your son'
f.	*tu epoca*	[twepoka]	$/u_1 \# e_2/ \rightarrow [w_1e_2]$	'your time'
g.	*su Homero*	[swomeɾo]	$/u_1 \# o_2/ \rightarrow [w_1o_2]$	'your Homer'
h.	*tu alma*	[twalma]	$/u_1 \# a_2/ \rightarrow [w_1a_2]$	'your soul'

2. Hutchinson (1974) distinguishes the results of hiatus resolution in two rates of speech, *andante* and *allegretto* (Harris 1969). I focus here on the grammar of the more "casual, colloquial" allegretto pattern, as do all the authors cited in the text.

The behavior of mid ([–high, –low]) vowels is of particular interest here. If the first vowel is mid and the second vowel differs from it in [±low] or [±back], the first vowel glides — again resulting in a rising-sonority diphthong, as above.[3]

(4) Gliding of mid vowels

a.	*me urge*	[mjuɾxe]	$/e_1 \# u_2/ \rightarrow [j_1 u_2]$	'it is urgent to me'
b.	*pague ocho*	[paɣjotʃo]	$/e_1 \# o_2/ \rightarrow [j_1 o_2]$	'that s/he pay eight'
c.	*porque aveces*	[poɾkjaβeses]	$/e_1 \# a_2/ \rightarrow [j_1 a_2]$	'because sometimes'
d.	*tengo hipo*	[teŋgwipo]	$/o_1 \# i_2/ \rightarrow [w_1 i_2]$	'I have the hiccups'
e.	*como Eva*	[komweβa]	$/o_1 \# e_2/ \rightarrow [w_1 e_2]$	'like Eva'
f.	*lo habla*	[lwaβla]	$/o_1 \# a_2/ \rightarrow [w_1 a_2]$	'speaks it'

However, if the first vowel is mid and the second vowel disagrees only in [±high], then (as I maintain on analysis-internal grounds in §3) there is coalescence, not gliding.

(5) Coalescence of mid + high vowels

a.	*se hinca*	[siŋka]	$/e_1 \# i_2/ \rightarrow [i_{1,2}]$	'kneels'
b.	*como uvitas*	[komuβitas]	$/o_1 \# u_2/ \rightarrow [u_{1,2}]$	'like grapes-DIM.'

The last set of data here in (5) demonstrates the avoidance of adjacent similar segments that is the main focus of this paper. An underlying sequence of a mid vowel followed by an otherwise identical high vowel does not undergo gliding, as might otherwise be expected based on the behavior of mid vowels in (4); instead, this type of sequence undergoes the same process undergone by an underlying sequence of identical vowels (1); namely, coalescence. The feature [±high] thus appears to be ignored in the determination of adjacent segment identity: adjacent segments differing in this feature alone are similar enough to undergo coalescence as opposed to gliding. In cases like this, what counts as 'similar' must apparently be stipulated to include certain features and to ignore others. I follow Baković (2005) in arguing that the avoidance of adjacent similar segments in Chicano Spanish hiatus resolution is instead the result of the simultaneous satisfaction of several independently motivated constraints.[4]

1. Representational and other assumptions

Before turning to the analysis of these facts it is necessary to make a few background assumptions clear. First, I make the relatively standard assumption that glides are featurally identical to corresponding high vowels and that they are distinguished only by their syllabification. Thus, when high vowels /i, u/ are realized as glides [j, w], there

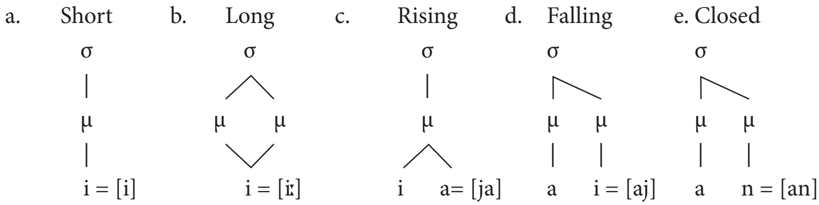
3. Whatever is said about [±back] here and in what follows applies equally (and redundantly) to [±round].

4. As it turns out, the resulting analysis is in essential respects quite similar to the one independently proposed by Martínez-Gil (2004), who undertakes a somewhat more comprehensive analysis of Chicano Spanish hiatus resolution. The focus in the present paper is on how the analysis of these facts supports the hypothesis of Baković (2005) that partial identity avoidance is reducible to complete identity avoidance.

is no featural change, but when mid vowels /e, o/ are glided, there is a change from [−high] to [+high].[5]

Following Schane (1987) and Hualde (1991), I assume that rising-sonority diphthongs have the branching nucleus (here, branching mora) structure shown in (6c) below, whereas falling-sonority diphthongs (6d) have the same branching rime (here, branching syllable) structure as closed syllables (6e). Note that long vowels (6b) and rising diphthongs (6c) share the structural property of a many-to-one relationship between moras and segments (or a branching nucleus, in Schane (1987) and Hualde (1991)). Note also that high vocoids in open (6a,b) or closed (6e) syllables are phonetically realized as vowels; otherwise, they are phonetically realized as onglides (6c) or as offglides (6d).

(6) Syllable structure assumptions (ignoring onsets)



Another assumption is implicit here: that glides cannot be featurally identical to nonhigh vowels.[6] Output candidates with nonhigh glides are assumed to be systematically ruled out by undominated markedness constraints. Substitutes for nonhigh glides that are sometimes observed in other languages, such as [ʔ] for /a/ in Ilokano (Hayes & Abad 1989, Rosenthall 1994), must also be ruled out by undominated constraints.

Next, I assume that long vowels and rising diphthongs violate a markedness constraint demanding a one-to-one relationship between moras and segments (One-to-One, (7a)), while falling diphthongs and closed syllables violate a markedness constraint against syllables ending in anything other than a true vowel (No-Coda, (7b)).[7]

(7) Constraints violated by complex syllable rimes

a. One-to-One
Let μ be some mora and ξ some segmental melody such that μ dominates ξ.
Assign a violation if either (i) μ also dominates some other segmental melody ξ′ or (ii) ξ is also dominated by some other mora μ′.

5. Whether or not the realization of any underlying vowel as a glide violates some kind of faithfulness constraint — that is, in addition to the faithfulness constraint(s) violated by any featural changes — is not germane to the present analysis. (This depends in part on whether glides contrast with high vowels; see Hualde (2004) and references therein.)

6. That is, in allegretto (see fn. 2). At the more "careful, but natural" andante rate, the first vowel shortens but apparently remains qualitatively intact (Hutchinson 1974).

7. Whether or not there are separate constraints violated by rising diphthongs or closed syllables alone is not at issue here.

b. No-Coda
Let σ be some syllable dominating two moras μ_1 and μ_2. Assign a violation if μ_2 dominates a segmental melody that is not also dominated by μ_1.

Two facts lead me to conclude that No-Coda dominates One-to-One in Chicano Spanish. First, the second of two vowels in potential hiatus across word boundaries never becomes a glide; in other words, the result of hiatus resolution is never a falling diphthong.[8] Second, a sequence of two nonidentical high vocoids is realized as a rising diphthong, not a falling one: *ciudad* [sjuðað], *[siwðað]; *cuidado* [kwiðaðo], *[kujðaðo].

(8) No-Coda >> One-to-One

Candidates	No-Coda	One-to-One
a. ☞ /iu/ → [ju], /ui/ → [wi]		*
/iu/ → [iw], /ui/ → [uj]	*!	

Like other varieties of Spanish, though, there are falling diphthongs in Chicano Spanish: (i) those in which the first vocoid is [−high] (*jaula* [xawla], *peine* [pejne]), and (ii) those in which the sequence is word-final (*muy* [muj], *ley* [lej]).[9] I assume that the first class of cases is due to the markedness of non-high glides and faithfulness to the feature [±high], and that the second class of cases is due to an independent preference for words not to end in vowels (which could be attributed to Final-C; McCarthy 1993).

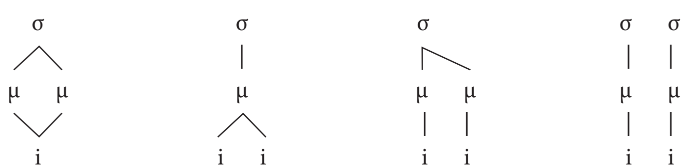
Spanish lacks long vowels. In addition to violating One-to-One, I assume that long vowels violate the following markedness constraint.

(9) No-Long
Let ζ_1 and ζ_2 be two adjacent segmental melodies or moras. Assign a violation if $\zeta_1 = \zeta_2$ (i.e., if ζ_1 and ζ_2 are featurally identical segmental melodies, or if ζ_1 and ζ_2 are moras that dominate the same segmental melody).

The featural identity of high vowels and corresponding glides is relevant to the definition of the No-Long constraint and the representations that it penalizes.

(10) Representations violating No-Long

a. Long b. Rising c. Falling d. Hiatus



8. The second of two vowels never deletes, either. I assume that this is due to an undominated faithfulness constraint penalizing deletion of word-initial segments/vowels (Casali 1996, 1997, Beckman 1998; *cf.* Martínez-Gil's (2004) use of Anchor-L).

9. Preterite verb forms such as *fuí* [fwi] have final rising diphthongs due to the uniformity of stress in verbal paradigms (Harris 1983).

Since glides are assumed to be nothing more nor less than the phonetic interpretation of a [+high] vocoid in a branching mora (10b) or syllable (10c), the representation of a long [+high] vowel (10a) is equivalent to the representation of a rising diphthong consisting of two [+high] vocoids (10b); both violate ONE-TO-ONE as well as NO-LONG. The falling diphthong syllabification in (10c) is technically distinct, violating NO-LONG and NO-CODA, and the hiatus syllabification in (10d) violates NO-LONG and ONSET.[10]

(11) ONSET
Let σ be some syllable dominating some mora μ, which in turn dominates some segmental melody ξ. Assign a violation if μ is not preceded by another mora μ′ dominated by σ and ξ is not preceded by another segmental melody ξ′ dominated by σ.

NO-LONG and ONSET are the centerpieces of the analysis presented in the next two sections, where I show that the apparent avoidance of incompletely identical adjacent segments in Chicano Spanish is the result of the simultaneous satisfaction of both of these constraints as opposed to the result of some constraint directly penalizing adjacent similar segments, where "similar" must be stipulated to ignore some features but not others.

2. Hiatus resolution

The prime mover in any analysis of hiatus resolution is the constraint ONSET (McCarthy 1993; *cf.* Borroff 2003). Hiatus is never tolerated in Chicano Spanish — at least not across a word boundary, where I am restricting our attention — and ONSET is thus undominated in the ranking. As noted in my description and superficial analysis of the facts in §0, there are three different strategies for hiatus resolution in Chicano Spanish: deletion, coalescence, and gliding. Each strategy results in violation(s) of different constraints in different contexts, and so all of these constraints must be dominated by ONSET.

(12) Resolution strategies and their constraint violations

a.	Coalescence under identity	(1).	UNIFORMITY[11] Let ξ_1 and ξ_2 be two segmental melodies in the input. Assign a violation if ξ_1 and ξ_2 correspond to the same output segment $\xi_{1,2}$.
b.	Low vowel deletion	(2).	MAX-V Let V be a vowel in the input. Assign a violation if V has no output correspondent.

10. Word-initial and intervocalic [+high] vocoids are recruited as onsets and are consonantized (Harris 1983, Hualde 1991), thereby circumventing a NO-LONG violation.

11. As a central part of his program to derive the lexical OCP from the interaction of output constraints alone, Keer (1999) proposes that there is no UNIFORMITY constraint. Coalescence under identity is thus violation-free in Keer's theory, but only intramorphemically — coalescence across morpheme boundaries violates another constraint requiring morphemes to be disjoint (Keer 1999:52*ff*). The role of UNIFORMITY in the analysis in the text would be attributed to this latter constraint under Keer's proposal.

c.	Gliding (3), (4).	One-to-One (see definition in (7a)).
d.	Mid vowel gliding (4).	Ident(high) Let ξ_i be an input segment, and ξ_o its output correspondent. Assign a violation if ξ_i and ξ_o differ in their value of [±high].
e.	Coalescence of mid + high (5).	Uniformity, Ident(high)

When the vowels across a word boundary are identical, there is coalescence (12a) rather than deletion or gliding. This means that Uniformity must be the lowest-ranked of the constraints identified in (12) (with the notable exception of Ident(high), which is not violated by any serious competitor to coalescence under identity).

(13) Coalescence under identity

Candidates	Onset	Max-V	Id(high)	1-to-1	Unif
a. $/e_1 \# e_2/ \rightarrow [e_1e_2]$	* !				
b. $/e_1 \# e_2/ \rightarrow [j_1e_2]$			* !	* !	
c. $/e_1 \# e_2/ \rightarrow [e_2]$		* !			
d. ☞ $/e_1 \# e_2/ \rightarrow [e_{1,2}]$					*

Note that No-Long could in principle substitute for Onset in the tableau above (and for One-to-One in the case of identical adjacent high vowels; e.g., $/i_1 \# i_2/ \rightarrow [i_{1,2}]$, $*[j_1i_2]$). The independent justification for Onset's undominated ranking comes from the remaining cases of potential hiatus in which the input vowels are not identical.

Gliding of both high (12c) and mid (12d) vowels is the next best thing to coalescence. One-to-One and Ident(high) must be ranked below Max-V, in order to rule out deletion in these cases; One-to-One and Ident(high) must also be ranked below Ident(back), in order to rule out coalescence between vowels differing in [±back].

(14) Ident(back)
Let ξ_i be an input segment, and ξ_o its output correspondent. Assign a violation if ξ_i and ξ_o differ in their value of [±back].

This is shown in (15) with a particularly informative example, two mid vowels differing only in [±back]. (Despite how it looks in this tableau, there is no necessary ranking between Onset and Ident(back); both are undominated, but Ident(back) does not crucially dominate Max-V in the way that Onset does.)

(15) Gliding of (high and) mid vowels

Candidates	Ons	Max-V	Id(bk)	Id(hi)	1-to-1	Unif
a. $/e_1 \# o_2/ \rightarrow [e_1o_2]$	* !					
b. $/e_1 \# o_2/ \rightarrow [o_{1,2}]$			* !			*
c. $/e_1 \# o_2/ \rightarrow [o_2]$		* !				
d. ☞ $/e_1 \# o_2/ \rightarrow [j_1o_2]$				*	*	

This leaves deletion of low vowels (12b) and coalescence of mid + high vowels (12e) to be accounted for. Low vowels are deleted rather than glided because the latter strategy would involve a fatal featural change. Changing a low vowel to a glide would violate not only One-to-One and Ident(high), but Ident(low) as well.[12]

(16) Ident(low)
Let ξ_i be an input segment, and ξ_o its output correspondent. Assign a violation if ξ_i and ξ_o differ in their value of [±low].

Ident(low) must thus also be undominated; unlike Ident(back), however, Ident(low) must crucially dominate Max-V, as shown in (17).

(17) Deletion of low vowels

Candidates	Id(lo)	Ons	Max-V	Id(hi)	1-to-1	Unif
a. /a_1 # e_2/ → [a_1e_2]		* !				
b. /a_1 # e_2/ → [$^j/_{w1}e_2$]	* !			*	*	
c. /a_1 # e_2/ → [$e_{1,2}$]	* !					*
d. ☞ /a_1 # e_2/ → [e_2]			*			

Whether a sequence of vowels differing only in [±high] undergoes coalescence or gliding is determined by undominated No-Long and Onset, as I show in §3 below.

3. Incomplete identity

High + mid and mid + high sequences are resolved in crucially different ways in Chicano Spanish. In the high + mid case, gliding occurs because the result is a high glide + mid vowel sequence and this does not violate undominated No-Long. This is shown in (18).

(18) Gliding of high vowels in high + mid sequences

Candidates	No-Long	Ons	Max-V	Id(hi)	1-to-1	Unif
a. /i_1 # e_2/ → [i_1e_2]		* !				
b. /i_1 # e_2/ → [$e_{1,2}$]				* !		*
c. /i_1 # e_2/ → [e_2]			* !			
d. ☞ /i_1 # e_2/ → [j_1e_2]					*	

In the mid + high case, gliding fails because here the result would be a branching mora consisting of two identical high vocoids, and this *does* violate No-Long — in addition to Ident(high) and One-to-One, both of which we know from (15) to be ranked below Max-V. The result is coalescence, escaping violation of No-Long and violating both Ident(high) and Uniformity instead, as shown in (19).

12. Ident(back) might also be violated, depending (a) on the value of this feature on the low vowel (which is phonetically central) and (b) on which glide the low vowel becomes (as represented by the ambiguous symbol '$^j/_w$' in (17b)).

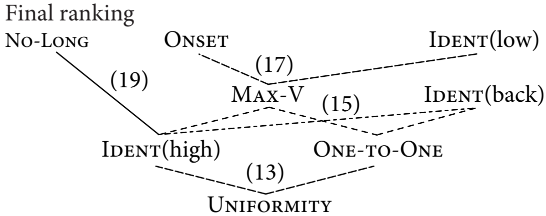
(19) Coalescence of mid + high sequences

Candidates	No-Long	Ons	Max-V	Id(hi)	1-to-1	Unif
a. $/e_1 \# i_2/ \rightarrow [e_1 i_2]$		* !				
b. $/e_1 \# i_2/ \rightarrow [j_1 i_2]$	* !			*	*	
c. $/e_1 \# i_2/ \rightarrow [i_2]$			* !			
d. ☞ $/e_1 \# i_2/ \rightarrow [i_{1,2}]$				*		*

Both gliding (19b) and coalescence (19d) of an underlying mid + high sequence violate Ident(high). This constraint thus fails to decide between the two candidates, and so the decision falls to the ranking of One-to-One above Uniformity, which was independently motivated by coalescence under identity (13). Max-V must also outrank Uniformity in order to rule out deletion (19c); this ranking follows by transitivity from the independently motivated ranking of Max-V above Ident(high) by gliding (15), (18).

The final set of justified rankings is summarized in (20) below, with cross-references to each tableau in the presentation above that shows the relevant ranking(s).

(20) Final ranking



The overall analysis can be summarized as follows. Identical adjacent vowels — i.e., violations of No-Long and Onset — are avoided via coalescence, while other cases of hiatus — i.e., violations of Onset but not of No-Long — are avoided via gliding (if the first vowel is [–low]) or deletion (if the first vowel is [+low]). When adjacent vowels are similar, differing only in their value of [±high], gliding successfully avoids both Onset and No-Long violations in one case (high + mid) but only avoids an Onset violation in the other (mid + high). To avoid violation of No-Long in this latter case, it is handled in the same way that identical adjacent vowels are handled: via coalescence.

4. No-Long vs. No-Similar

One of the consequences of the analysis proposed here — that the avoidance of incomplete identity is the result of a constraint against complete identity (No-Long) and its interaction with other constraints — is that these other constraints must be independently active in the grammar in question: if they are high-enough ranked to help No-Long enforce incomplete identity avoidance, then they are in a position to crucially rule out candidates even in situations when No-Long is not at stake. The primary such constraint in this analysis is Onset, which is indeed independently active; one needn't search beyond the basic data considered here to find ample evidence for that activity.

Compare this analysis with the arguably more direct alternative, in which some *ad hoc* constraint that I will call No-Similar penalizes adjacent similar segments. By definition, any feature ignored by a No-Similar constraint is arbitrary; there is no necessary link between what is ignored by No-Similar and the rest of the grammar. This means that the No-Similar alternative does not rely on the activity of other constraints. Under the No-Similar view, an incomplete identity effect is relatively independent of other aspects the grammar of which it forms a part precisely because it does not depend on the ranking of other constraints to help define the feature or features that it ignores.

This difference between these two approaches has significant empirical consequences. For example, consider the same constraints and rankings proposed for Chicano Spanish above except that No-Long is replaced by No-Similar, which (arbitrarily) ignores any difference in [±high]. On the face of it, this would appear not to have any consequences since differences in [±high] are indeed ignored for the purposes of hiatus resolution. But recall that this ignorance is asymmetrical: mid + high sequences behave as if they are identical, but high + mid sequences do not. Both sequences would behave the same with the relevant No-Similar constraint, as shown here for the high + mid case.

(21) Coalesence, not gliding, if No-Similar ignores [±high]
(Actual Chicano Spanish output candidate with gliding indicated with '⧗'.)

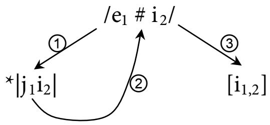
Candidates	No-Sim	Ons	Max-V	Id(hi)	1-to-1	Unif
a. /i_1 # e_2/ → [i_1e_2]	*!	*!				
b. ⧗ /i_1 # e_2/ → [j_1e_2]	*!				*	
c. /i_1 # e_2/ → [e_2]			*!			
d. ☞ /i_1 # e_2/ → [$e_{1,2}$]				*		*

When one considers the fact that sequences differing in [±back] still do undergo gliding, the overall pattern predicted here is intuitively rather strange: why should [je] and [wo] be excluded but [we]/[wi] and [jo]/[ju] allowed? By contrast, the asymmetrical ignorance of [±high] is explained rather than stipulated by the proposed analysis; gliding of mid + high incorrectly leads to complete identity but gliding of high + mid does not.

5. Counterfactual derivation

Another interesting aspect of the proposed analysis is that it requires that the conditions for coalescence be dependent on a *counterfactual result*. Specifically, it must be known what *would* happen to an underlying mid + high vowel sequence *if* it underwent gliding as otherwise expected, in order to determine whether there should have been coalescence in the first place. To appreciate this point, it is useful to consider what this analysis would have to look like in conventional derivational terms, as I show in (22).

(22) Counterfactual derivation



① = counterfactual gliding, resulting in disallowed adjacent identical segments

② = backtracking step to underlying form

③ = coalescence, resulting in surface form

The underlying form /e_1 # i_2/ here has a pair of adjacent vowels differing in [±high]. In order to determine whether coalescence is necessary, gliding "applies" and the result is a pair of adjacent identical vocoids. This *counterfactual derivation* is crucial to establish that coalescence should have applied instead. The derivation must thus backtrack to its prior state in order to then correctly undergo coalescence.

The proposed analysis highlights a crucial advantage of Optimality Theory over derivational approaches to phonological generalizations. The counterfactual output of gliding in (22) is simply another suboptimal output candidate in the OT analysis, and the correct choice between this candidate and the optimal one is made by comparing them and other suboptimal candidates in parallel against the set of ranked constraints, as shown in (19).

References

Baković, E. 2005. Antigemination, assimilation and the determination of identity. *Phonology* 23:279–315.

Beckman, J. 1998. Positional Faithfulness. PhD dissertation, University of Massachusetts, Amherst.

Borowsky, T. 1987. Antigemination in English Phonology. *Linguistic Inquiry* 18: 671–678.

Borroff, M.L. 2003. Against an ONSET analysis of hiatus resolution. Ms., *Rutgers Optimality Archive*.

Casali, R.F. 1996. Resolving Hiatus. PhD disseration, UCLA.

Casali, R.F. 1997. Vowel elision in hiatus contexts: Which vowel goes? *Language* 73: 493–533.

Clements, G.N. and Keyser, S.J. 1983. *CV Phonology: A generative theory of the syllable.* [Linguistic Inquiry Monographs 9]. Cambridge MA: The MIT Press.

Contreras, H. 1969a. Simplicity, descriptive adequacy, and binary features. *Language* 45: 1–8.

Contreras, H. 1969b. Vowel fusion in Spanish. *Hispania* 52: 60–62.

Harris, J.W. 1969. *Spanish Phonology.* Cambridge MA: The MIT Press.

Harris, J.W. 1970. Sequences of vowels in Spanish. *Linguistic Inquiry* 1: 129–134.

Harris, J.W. 1983. *Syllable Structure and Stress in Spanish: A Nonlinear Analysis.* Cambridge MA: The MIT Press.

Hayes, B. and Abad, M. 1989. Reduplication and syllabification in Ilokano. *Lingua* 77: 331–374.

Hualde, J.I. 1991. On Spanish syllabification. In *Current Studies in Spanish Linguistics*, H. Campos and F. Martínez-Gil (eds), 475–493. Washington DC: Georgetown University Press.

Hualde, J.I. 2004. Quasi-phonemic contrasts in Spanish. In *WCCFL 23 Proceedings*, B. Schmeiser, V. Chand, A. Kelleher and A. Rodriguez (eds). Somerville MA: Cascadilla.

Hutchinson, S.P. 1974. Spanish vowel sandhi. In *Papers from the Parasession on Natural Phonology*, A. Bruck, R.A. Fox and M.W. La Galy (eds), 184–327. Chicago IL: Chicago Linguistic Society.

Keer, E. 1999. Geminates, the OCP, and the Nature of CON. PhD dissertation, Rutgers University.

Martínez-Gil, F. 2000. La estructura prosódica y la especificación vocálica en español: El problema de la sinalefa en ciertas variedades de la lengua coloquial contemporánea. In *Panorama de la fonología española actual*, J. Gil Fernández (ed.), 511–560. Madrid: Arco Libros, S.L.

Martínez-Gil, F. 2004. Hiatus resolution in Chicano Spanish. Paper presented at *Linguistics Symposium on Romance Languages XXXIV*, University of Utah.

McCarthy, J. 1986. OCP effects: Gemination and antigemination. *Linguistic Inquiry* 17: 207–263.

McCarthy, J. 1993. A case of surface constraint violation. *Canadian Journal of Linguistics* 38: 127–153.

Navarro Tomás, T. 1957. *Manual de pronunciación española.* New York NY: Hafner Publishing.

Reyes, R. 1976. Studies in Chicano Spanish. PhD dissertation, Harvard University.

Rosenthall, S. 1994. Vowel/Glide Alternation in a Theory of Constraint Interaction. PhD dissertation, University of Massachusetts, Amherst.

Schane, S. 1987. The resolution of hiatus. In *Papers from the 23rd Annual Regional Meeting of the Chicago Linguistic Society,* Part Two: *Parasession on Autosegmental and Metrical Phonology*, A. Bosch, B. Need and E. Schiller (eds), 279–290. Chicago IL: Chicago Linguistic Society.

Stockwell, R. and Bowen, J.D. 1965. *The Sounds of English and Spanish.* Chicago IL: The University of Chicago Press.

Yip, M. 1988. The obligatory contour principle and phonological rules: A loss of identity. *Linguistic Inquiry* 19: 65–100.

Depalatalization in Spanish revisited*

Maria-Rosa Lloret and Joan Mascaró
Universitat de Barcelona and Universitat Autònoma de Barcelona

A well-known fact of the phonology of Spanish is the non-occurrence of palatal nasals and laterals in syllable-final position (e.g., *desdén-desdeñar*, *clavel-clavellina*). Some scholars have recently claimed that they are lexical remnants that should be treated in terms of allomorphy (cf. Pensado 1997, Harris 1999). In this paper, we examine the empirical basis of depalatalization, we provide evidence for maintaining depalatalization as an actual phenomenon by appealing also to the phonology of borrowings and to other cases of place centralization, and we provide a parallel OT account of these facts. Overapplication of depalatalization in onset position in plural and diminutive forms (e.g., *desdenes*, *claveles*, *clavelito*) is analyzed as an output-output effect, in line with work by Baković (1998, 2001) with respect to the plural cases. In our view, however, this output-output effect extends to diminutives because it is restricted by the strongest version of 'base' proposed in Kager (1999a,b).

Keywords: Allomorphy, base, base-identity, borrowings, centralization, delabialization, depalatalization, diminutive, output-output correspondences, plural, overapplication, xenonym, Spanish.

> Anda, y que te ondulen
> con la 'permanén',
> y pa suavizarte
> que te den 'col-crém'.
> Se lo pués pedir
> a Victoria Kent,
> que lo que es a mí,
> no ha nacido quién.
>
> From the zarzuela *Las Leandras* by F. Alonso, E. González del Castillo and J. Muñoz Román.

* We would like to thank an anonymous reviewer, Eulàlia Bonet, Jesús Jiménez, and specially Eric Baković for insightful comments and questions on an earlier version of this work. Both the presentation and content of the analysis have been improved as a result of responding to these comments. Any errors of fact or interpretation are, of course, our responsibility. Our work has been supported by the Ministerio de Educación y Ciencia and the FEDER (research projects HUM2004-01504/FILO and BFF2003-06590) and by the Generalitat de Catalunya (research groups 2005SGR01046 and 2005SGR00150, and 2004XT00078).

1. The (scarcity of) data

It is common in natural languages that the set of possible final consonants is a subset of the set of possible segments in all positions, and that an underlying segment that is not possible in final position is (minimally) changed to one of the subset. One such case is final depalatalization in Spanish, a process that has received wide attention in the phonological literature.

In Spanish, nasals and laterals contrast in place of articulation; nasals show a three-way contrast and laterals, a two-way contrast:[1]

(1)	ca[m]a	'bed'	po[l]o	'pole'
	ca[n]a	'white hair'	po[ʎ]o	'chicken'
	ca[ɲ]a	'cane'		

Castilian Spanish, the variety on which we base our analysis, shows not only depalatalization but generalized centralization of any place to alveolar in word-final position (other varieties, such as Mexican Spanish, accept final [m], but all disallow palatals; cf. Harris 1984). There is no word with the form in (2), for any sequence X.

(2) *X[m] *X[ɲ] *X[ʎ]

Contreras (1977), following the generalization first posited by Alonso (1945), proposed a rule of nasal and lateral depalatalization that turns /ɲ/ into [n] and /ʎ/ into [l] before consonant and in word-final position. Harris (1983) used similar data to reformulate the rule in terms of syllable structure by replacing {C, #} by reference to the rhyme.[2] Nasal depalatalization provided an argument for cyclic application (as exemplified by the now famous triplet *desdén–desdenes–desdeñes* 'disdain (noun, singular) — disdains (noun, plural) — you disdain (subjunctive)'), which has been much quoted in subsequent literature (Kiparsky 1982, 1985; Kenstowicz 1994; Cole 1995; Bakovič 1998; Peperkamp 1997; Bermúdez-Otero 2006). First to argue against Spanish depalatalization was Pensado (1997), basically on psycholinguistic grounds. She was followed by Harris (1999) who gives detailed argumentation to "debunk once and for all the legend of Nasal Depalatalization" (47). In this paper we reconsider the empirical status of Spanish centralization (i.e., /m/ → [n], /ɲ/ → [n], /ʎ/ → [l]) and propose a phonological analysis within Optimality Theory.

When we take a close look at Spanish centralization, we find that it is based on a rather fragile empirical foundation (although this is not the kind of argument used by those authors who claim that it does not exist).[3] Harris (1983) gives four examples for

1. The majority of Spanish varieties have replaced by now all instances of [ʎ] by [j] (or other variants like [ʒ]). Whatever we say about [ʎ] in the paper refers to the varieties that still retain it.

2. Harris (1984) examines depalatalization again, but there is no significant change.

3. Pensado (1997) argues that some of the pairs that have been used as evidence for the process are not derivationally connected because their semantic relatedness is extremely distant.

/ʎ/ and three for /ɲ/. Pensado (1997) gathers more putative empirical support, with eleven cases of each.

Another kind of evidence is, of course, the nonexistence of [m], [ɲ], and [ʎ] in word-final position (and in syllable rhyme except under assimilation), but this alone does not imply that there is an active process of centralization. When we look for other kinds of evidence, namely alternations, we are faced with the fact that the cases are extremely limited.

Notice that scarcity of evidence can be of two sorts. There might be few cases because there are counterexamples ('exceptions'), i.e., in this case words ending in [m], [ɲ] or [ʎ]; or the lexicon might just lack, except for a few cases, pairs of morphologically related words in which underlying /m/, /ɲ/ or /ʎ/ appear as onsets in one member of the pair and in final position in the other. Spanish is an instance of the latter. This is due to the fact that in Spanish the main source of final /m/, /ɲ/, /ʎ/, namely bare stem nominals and verbs, yields very few cases. For verbs, only irregular forms like second-person singular imperative *sal* 'go out' or *ten* 'have', and a few others have bare stems. In nominals, certain stem final consonants, including /m/, /ɲ/, /ʎ/, normally require an inflective gender vowel — or an epenthetic vowel, for some authors (henceforth, *ñ* = [ɲ], *ll* = [ʎ]): *ramo* 'bouquet', *paño* 'cloth', *pan* 'bread'; *tallo* 'stem', *talle* 'waist', *tal* 'such'.

Historically (Menéndez-Pidal 1968: 170; see also Pensado 1997), final consonants arise through the loss of final *e* which took place only if the consonant was *d*, *n*, *l*, *r*, *s*, *z* (i.e., present-day phonetic [d], [n], [l], [ɾ], [s], [θ]; we refer to this class as C√); for other consonants, class C*, the *e* was retained. Cases of final C* without *-e* (like *chef* and *match*) are sporadic and have different historical origins (mainly word borrowing). Moreover, in many of these cases historical centralization to *n*, *l* took place but related forms in onset environments centralized also analogically. These are most typically old borrowings like *bajel* 'vessel', *cordel* 'cord', *pincel* 'paintbrush', *betún* 'shoe polish' (from Catalan: *vaixell*, *cordill*, *pinzell*, *betum*); *Adán*, *imán* 'magnet', *Jerusalén*, *Joaquín* (from Semitic sources ending in [m]); *ron* (from English: *rum*), and words that escaped conservation of the vowel through proclisis (*don* 'Mister', *él* 'he', *aquel* 'that', *mil* 'thousand', from the older forms *dom*, *ell*, *aquell*, *mill*). Some derived words from the previous examples are *bajelero* 'vessel's owner', *cordelería* 'cordage', *pincelada* 'brush-stroke', *betunero* 'bootblack'; *adanita* 'Adam's descent', *jerusalenita* 'from Jerusalem', *joaquinismo* '(derived nominal)'; *ronero* 'rummy'.

If the alternations don't exist or if they are sufficiently limited or problematic, we might conclude that there is no active process: proposing a depalatalization rule would be similar to positing a putative rule of final *n*, *l* deletion after [j] on the sole basis of *rey* — *rein-a*, *rein-ad-o* 'king — queen, kingdom' and *fray* — *frail-e*, *frail-un-o* 'preverbal term of address for a monk — monk, monkish'. So we should carefully analyze how extensive alternations involving [m]–[n], [ɲ]–[n], [ʎ]–[l] are. Although this has not always been common practice, in this and other cases as well, when presenting a phonological process, care should be taken to ascertain its generality. This means stating whether there are exceptions or not and how extensive they are, and how many lexical items are affected productively by the phenomenon.

We have compiled a list of lexical items that are related, or might be thought to be related, by one of these alternations. The list might not be totally exhaustive, but it should come close to it.[4] We have disregarded some items with quite remote semantic relationship.[5] We leave out for the moment [m]–[n] alternations, for which we offer examples in (7) below. In (5) we also consider assimilatory environments which might be argued to support the process too. (The following abbreviations are used: A = adjective, N = noun, MASC = masculine, FEM = feminine, NEUT = neuter, PL = plural.)

(3) [n]–[ɲ] alternations:

Word-final	*Non-final in inflection*		*Non-final in derivation*	
[n]	[n], [ɲ]		[ɲ]	
desdén	desdenes	'disdain(s)'	desdeñar	'to disdain'
			desdeñoso	'disdainful'
don	dones	'Mister(s)'		
	doña	'Madam'		
bretón	bretones	'Breton'	Bretaña	'Brittany'
catalán	catalanes	'Catalan'	Cataluña	'Catalonia'
champán	champanes	'champagne(s)'	champañería	'ch. bar'
			champañera	'for ch. (A)'

(4) [l]–[ʎ] alternations:

Word-final	*Non-final in inflection*		*Non-final in derivation*	
[l]	[l], [ʎ]		[ʎ]	
él	ella(s)	'he', 'she(PL)'		
	ello(s)	'it/they-MASC'		
aquel	aquella(s)	'that-MASC','that-FEM(PL)'		
	aquello(s)	'that-NEUT/those-MASC-PL'		
doncel	donceles	'male virgin(s)'		
	doncella(s)	'female virgin(s)'	doncellez	'virginity'
clavel	claveles	'carnation(s)'	clavellina	'carn.-like plant (genus dianthus)'
piel	pieles	'skin(s)'	pellejo	'skin'
			pelliza	'pelisse'
Sabadell		'town name'	sabadellense	'from Sabadell'
mil	miles	'thousand(s)'	millón	'million'
			millar	'thousand'
tropel	tropeles	'mob(s)'	atropellar	'to run over'
útil	útiles	'useful'	utillaje	'tool equipment'

4. We have gathered the data from the relevant literature mentioned in this paper, as well as from Bosque and Pérez Fernández's (1987) reverse dictionary and our own compilation of borrowings.

5. More dubious examples can be found in Saporta (1959), a very good source for alternations in general, and Pensado (1997), who argues convincingly for the non-relatedness of some cases.

(5) *Assimilatory environments*:

[l], [n]		[ʎ], [ɲ]	
beldad	‘beauty’	bello	‘beautiful-MASC’
humilde	‘humble’	humillar	‘to humiliate’
cabalgar	‘to ride’	caballo	‘horse’
tinte	‘tint (N)’	teñir	‘to tint’
cinto	‘girdle (N)’	ceñir	‘to girdle’
rencilla	‘quarrel (N)’	reñir	‘to quarrel’
Valderobles	‘Oak Valley’	valle	‘valley’
Caldevilla	‘Town Street’	calle	‘street’

The cases of putative alternation are already severely limited, but, in addition, many of these cases should be discarded for different reasons: dubious semantic/morphological relationship, presence of independent allomorphy or existence of counter-alternations.

The numeral *mil* is not transparently related to *millón*, but it is to *millar* (like *cien–centenar* ‘a hundred–hundred’); but at the same time we have *milenio* ‘millennium’ (cf. *decenio* ‘decade’, *trienio* ‘period of three years’), *milésimo* ‘thousandth’ (cf. *centésimo* ‘hundredth’, *veintésimo* ‘twentieth’, *millonésimo* ‘millionth’) with unexpected *l*. Pairs like *tropel–atropellar*, *útil–utillaje*, and *humilde–humillar* in (5) are very distant semantically, and once again we have counter-cases with onset *l*: *tropelía* ‘outrage’, *utilísimo* ‘useful (superlative)’, *utilidad* ‘usefulness’. Other cases present morphological problems. For *n–ñ*, the roots *bretón- – Bretañ-*, *catalán- – Cataluñ-* show independent allomorphy that makes it impossible to posit a single lexical underlying form (and at the same time we have, for *catalán, catalanismo, *catalañismo*). The same applies to the roots in assimilatory cases: *humild- – humill-*, *cabalg- – caball-*, *tint- – teñ-*, *cint- – ceñ-*, *renc- – reñ-*. Note also that *don–doña* are regularly related, but *dones* is obsolete.

We are left with three clear cases for the nasals (6a) and six for laterals (6b) (we can add *beldad*, if the *l* is not attributed to assimilation, (6c)).

(6)

	Word-final	*Non-final in inflection*	*Non-final in inflection&derivation*
a.	[n]	[n]	[ɲ]
	desdén	desdenes	desdeñar, desdeñoso
	don		doña
	champán	champanes	champañería, champañera
b.	[l]	[l]	[ʎ]
	él		ella(s), ello(s)
	aquel		aquella(s), aquello(s)
	doncel	donceles	doncella(s), doncellez
	clavel	claveles	clavellina
	piel	pieles	pellejo
	Sabadell		sabadellense
c.	*Assimilatory environments*		
	beldad		bello

In the case of [m]–[n], alternations (7) are more numerous (recall that *m*-centralization is not general; it applies in Castilian Spanish and close varieties).

(7)

isla[n]	'Islam'	islámico	'islamic'
íte[n]	'item'	itemización	'itemization'
oh[n]	'ohm'	óhmico	'ohmic'
tóte[n]	'totem'	totemismo	'totemism'
Abrahán	'Abraham'	abrahámico	'abrahamic'
Vietna[n]	'Vietnam'	vietnamita	'Vietnamese'
Amsterda[n]	'Amsterdam'	amsterdamés	'Amsterdamese'
Surina[n]	'Surinam'	surinamés	'Surinamese'
Fro[n]	'Fromm'	frommiano	'Frommian'

The scarce number of alternations seems to cast some doubt on the existence of the process of centralization, but crucial evidence can be gathered from situations in which a lexical representation with final *ñ*, *ll* is forced by expansion of the lexicon.[6] The most typical, but not the only source, is foreign loans, which today show, for consonants in final position, the following behavior: (a) loss of p, t, k, or their adaptation to [β̥], [ð̥], [ɣ̊], respectively (*beep*, *déficit*, *coñac*); (b) conservation or loss of b, g (*Jacob* 'Jakob', *blog*); (c) conservation of f, x, t͡ʃ (*chef*, *sij* 'Sikh', *match*), along with historical class C√ = d ([ð̥]), n, l, ɾ, s, θ; (d) exceptionless centralization of m and ɲ to n and of ʎ to l (cf. (8)). Notice that stops are only adapted for voicing/spirantization, and that centralization of palatals usually extends also to ʃ, ʒ, as in [at͡ʃís] < [haʃíʃ] 'hashish', [béjs] < [bɛ́ʒ] 'beige'. There are indications of older centralization, like *ron*, *champán*, *detal*, cited above (and the more recent English borrowing *cold-cream* > '*col-crém*' [kolkɾén] that appears at the beginning of the zarzuela lyrics), but today the process is fully operative: speakers invariably centralize loans with final m, ɲ to n, and ʎ (for those who have ʎ in their inventory) to l; here the option of deletion that is found for p, t, k, or other changes, is never instantiated.

(8)

m → n	ɲ → n	ʎ → l[7]
Prim	champagne	Sabadell
Grimm	seny	Maragall
réquiem	Montseny	Coll
eslálom	Capmany	Urgell
módem	Fortuny	Llull
referéndum	Montmany	Collell
médium	Jubany	Bofill
boom	Ferreny	Tusell
tedéum	Sispony	Creixell
fórum	Montgrony	Moll

For borrowing from Catalan, when the loan enters through the orthographic form ([ɲ] = *ny*, [ʎ] = *ll*), Catalan *ny* is regularly rendered, as expected, [ni], but onset *m*,

6. It is revealing that in older periods the result of borrowings with final C* was not centralization, but addition of an epenthetic (or inflectional) *-e*: *azabache* < Arabic [azzabád͡ʒ], *bagaje* < French [bagáʒ]; also *miriñaque*, *debate*, *jefe*, *yate*, *detalle*.

7. Most are well-known places or family names. Glosses for the rest are 'requiem', 'slalom', 'modem', 'referendum', 'medium', 'boom', 'Te Deum', 'forum', 'champagne', 'good judgement'.

ll as [m], [ʎ], respectively: *Fortuny* is [foɾtúɲ] if the source is phonetic, and [foɾtúni] if it is orthographic, but *Mollerussa* is always rendered as [moʎeɾúsa]. Notice that some loans contain [ʎ] both in the onset and finally: *Llull* [ʎúl], *Collell* [koʎél]. In the case of *m*, the examples are much more numerous, since final *m* is much more common in the languages that are the sources of loans.

We now discuss briefly the arguments against centralization/depalatalization in the literature.

Harris's (1999) rejection of depalatalization is not based on the scarcity of data, but on the phonology of epenthesis and the morphology of gender inflection. His argument goes as follows. There is a rule of final epenthesis (9d) that inserts *e* after a set of final consonants that cannot be syllabified as codas. Members of this set (we will denote it by C–, and its complement by C+) cannot be syllabified as a rhyme. For C+, syllabification of this final consonant as a coda makes epenthesis unnecessary (this is incorporated in the rule by the requirement that the final C be syllabically unparsed):[8]

(9) a. C– = p, t, k, b, g, f, t͡ʃ, x, m, ɲ, ʎ

b. C+ = ɾ, l, n, d, s, θ or $\begin{bmatrix} \text{+cor} \\ \text{+ant} \\ \left\{ \begin{matrix} \text{+voice} \\ \text{+cont} \end{matrix} \right\} \end{bmatrix}$

c. "Syllabify as codas only consonants in C+"

d. ℑ (ℑ = "thematic suffix")

Ø → e / C___]$_X$o "Epenthesize after stray C–" *nube*, *toque*, *jefe*, *eje*, *madre*, *dulce*
(with ℑ linked to the epenthetic position, and C not linked to σ)

e. /kaʎ/ /kal/
Syllabification: kaʎ (ʎ unsyllabified) kal (all linked to σ)

f. Epenthesis: kaʎ e (ʎ unsyllabified) kal (all linked to σ)

Since there are numerous examples of words ending in C– (*esnob*, *coñac*, *déficit*, *chef*, *golf*, *zigzag*, *bloc* 'pad', *sij*, *match*, etc.), they are included in a special class ("xenonyms") whose members are described as follows:[9]

> xenonyms … are borrowings … plus certain onomatopoeic words. … [They] vary from speaker to speaker, and they come and go at the whim of popular culture and the news on TV. Xenonyms have easily-spotted formal characteristics: they have no

8. This "anomalous" C– set is different from our "anomalous" C*, since we consider final consonants like [f], [t͡ʃ], and [x] as synchronically "normal".

9. There is a general tendency by many authors in the literature on Spanish phonology to minimize without justification the importance of adapted loans and new words in general.

> form-class morpheme in either singular or plural, and they may have final consonants and consonant clusters … not found in native Spanish words … they are not fully integrated into the morphophonological system of Spanish. (Harris 1999: 57)

Thus a word like *chef*, even though [f] ∈ C–, has no form-class morpheme because it is a "xenonym", and hence it does not undergo (9d).

It follows that if a word with underlying final C–, like /desdeɲ/ or /eʎ/, is not a xenonym, then it is subject to epenthesis, and should end up as *[dezðéɲe] and *[éʎe], respectively. Harris (1999: 63) concludes that, since this is not the case, the underlying forms are /desden/ or /el/, and the alternations should be treated under an irregular allomorphic analysis (by a "readjustment rule", in Distributed Morphology terminology, which turns /ɲ/ into [n] in the context $[[$*desde* ___$]_{\surd}\,]_N$, $[[$*do* ___$]_{\surd}\,]_N$, etc.).

The case of "xenonyms" deserves more careful empirical attention. We have to distinguish historical borrowings and new words (onomatopoeic, but also acronyms, truncated forms, etc.) from synchronic ones. Historical borrowings are usually fully nativized, since the language learner cannot find in the primary linguistic data indications of foreign origin — unless they behave differently from the rest of the vocabulary, and do it in a *homogenous* way, with respect to a *set* of grammatical properties. As Itô and Mester (1998: 62) put it, "native" and other strata should be "distinct subsets whose members behave alike with respect to several different criteria within the grammar". In addition, most onomatopoeic words, truncated words, acronyms, etc. are usually incorporated as nativized.

As far as we know, the rest of phonological processes of Spanish apply to putative xenonyms and to the rest of the vocabulary in a similar way: initial epenthesis (*[e]stock*, *[e]spaguetis*), spirantization (*clu[β]*), voice assimilation (*zi[xθ]ag* 'zigzag', *puzzle* [púðle]), place assimilation (*ping-pong* [pimpón]), glide formation (*réqu[j]em*), ɾ/r distribution (*CD-[r]om*, *b[ɾ]ut*), glide fortition (*[ᵍw]isqui* 'whisky', *[ᵈj]ak* 'yak').

Here is a sample of additional examples with final C– = p, t, k, b, g, f, t͡ʃ (*tsch*, *tch*, *dge*), x (*j*):

(10)	club	'club'	mamut	'mammoth'	Rif	'Rif'
	esnob	'snob'	robot	'robot'	NIF	'identity number'
	Job	'Job'	bulldog	'bulldog'	chef	'chef'
	ketchup	'ketchup'	zigzag	'zigzag'	naíf	'naive'
	crep	'crepe, crêpe'	grog	'grog'	puf	'pouf"
	hábitat	'habitat'	boutique	'dressshop'	rosbif	'roast beef'
	argot	'slang'	anorak	'parka'	kitsch	'kitsch'
	suite	'suite'	ad hoc	'ad hoc'	match	'match'
	entrecot	'entrecôte'	coñac	'brandy'	zarevich	'czarevitch'
	accésit	'additional prize'	stock	'stock'	bridge	'bridge'
	cénit	'zenith'	tictac	'tick tock'	sij	'sikh'
	input	'input'	bloc	'writing pad'	boj	'boxwood'

As for the external characterizations in terms of speaker to speaker variation and popularity, this may apply to a restricted subset, but there is a large number of words with final C– that are fixed and invariable within Castilian Spanish, and the same applies to other dialects.[10] The core of Harris's arguments lies in the adduced formal characteristics of xenonyms. These are the following: (a) they can end in C–, (b) they have no class morpheme in singular or plural. But here we are left with a *single* property of the class, namely (b), since (a) is the *facta probanda* to justify the syllabification rule. Even worse, (b) is false: new words ending in unstressed *a, e, o* (and even *i*) are regularly adapted by analyzing this vowel as a gender marker (there are also cases with this vowel interpreted as belonging to the root, but they are much more limited: *maoísmo*, *taoísmo*, *laísmo* 'use of *la* instead of *le*', *dequeísmo* 'improper use of *de que*', *egoísmo*, *anecoico*).

(11)	pizz-a		pizz-ería, pizz-ero	'pizza place', 'pizza maker'
	eusker-a	'Basque'	eusker-ización	'Basquization'
	folklor-e		folklor-ismo, folklór-ico	'(derived nominals)'
	Goeth-e		goeth-iano	'(derived adjective)'
	(violon)cell-o		(violon)cell-ista	'cello player'
	atrezz-o		atrezz-ista	'atrezzo handler'
	perestroik-a		perestroik-izar	'(derived verb)'
	Sarajev-o		sarajev-ita	'(derived adjective)'
	güisqu-i	'whisky'	güisqu-ería	'whisky bar'
	sid-a	'AIDS'	sid-oso, sid-atorio	'AIDS-affected', 'AIDS hospital'

Pensado's (1997) rejection of depalatalization (summarized with some comments in Eddington 2004: 50–52) is based on a set of psycholinguistic experiments designed to establish phonological relatedness of some of the examples used to argue for depalatalization. The subjects were 53 undergraduate Spanish Philology students. Some of the tasks consisted of asking what is the word which is the base of a derivative like *desdeñoso*, *pellejo*; asking for a definition of a word like *desdeñoso* using a related word; and asking for a specific derivative of words like *don* and *él*. In another experiment subjects were given two related nonce words (e.g., *siparén–sipareñar*) and were asked to give the form of related words (the plural, the participle in *-ado*, the derivative in *-oso*). Pensado concedes that "these data are too sketchy to be conclusive" (598). This is quite true, because many parameters were not properly controlled. Search for a definition might favor one of the words related to the stimulus because it might be easier to define it on its basis. In other cases the existence of different senses or phonological closeness can influence choice. *Tinte,* for instance, means 'dye, dyeing' or 'dry-cleaner's', but the latter is more common and might favor taking *tintorería* 'dry-cleaner's' as the cognate against *teñir*. *Tinta* and *tintar* could also have been favored because they are closer to *tinte* than *teñir* 'to dye'. In the experiment with nonce words the pairs of

10. So-called xenonyms are very frequent in native speakers' internalized lexicons. By ranking his classes in (13) by "increasing number of words of each type", Harris (1999: 57) claims that class I-x (i.e., feminines ending in *-o*) is larger than the class of xenonyms. This is clearly not the case, under any reasonable definition of "xenonym". The class of feminines in *-o* is much more restricted. There might be two or three dozen feminines in *-o*, some of which are also "xenonyms" (e.g., *soprano*), and many of which do not have related words to test whether *-o* is a gender morph (as in *mano–manita*) or not (as in *ego–egoísta*).

stimuli, one with the palatal, the other with the alveolar consonant, were given in the two possible orderings (*enapil–enapillar* and *enapillar–enapil*; *siparén–sipareñar* and *sipareñar–siparén*), so that the effect of ordering of stimuli could be controlled. But there was no such control for the answers, which were given in fixed ordering: plural — participle in *-ado* — derivative in *-oso*. Thus the answer to the plural could have biased the answer to the other two related forms in the same direction. There is in fact an interesting result of this experiment that can be derived from the data given in the paper. We can compare the effect of ordering of stimuli for ɲ and ʎ cases globally as compared to control cases (which contained [ɾ]–[l] and [aw]–[o] alternations, which are clearly irregular). If we take number of cases with no allomorphy in the answers, the ratio between orderings is 1.47 for the palatals and 4.83 for the control cases. This suggests that ordering is the basic factor in the control cases, but that there is something else going on in the case of [ɲ] and [ʎ]. Another necessary control in experiments of this sort is to run pairs of similar experiments in which the regular phonological character and the irregular allomorphic character of the alternations being tested are not at all in doubt. Only thus could we be certain of the correct interpretation of the results obtained for unclear cases such as depalatalization in Spanish.

Our analysis, which we develop in detail in Section 3, is based on the following descriptive observations. First, although the number of real alternations is scarce, the absolute impossibility of final ʎ, ɲ (and m in some varieties) and the treatment of borrowings are sufficient to justify an active process. Second, there is a large set of fully nativized words ending in consonants other than ɾ, l, n, d, s, θ, which cannot be ascribed to a special lexical stratum. They aren't phonologically "illegal", "ill-formed" or "not fully integrated". Some of them remain unchanged in final position, like fricatives and affricates; others undergo whichever processes are active in the language, as in the case of centralization of sonorants.

2. Previous OT analyses of 'depalatalization'

As previously mentioned, within derivational phonology Spanish depalatalization is a well-known example of cyclic application (Harris 1983). In the parallel version of Optimality Theory, one way of dealing with cyclic effects has been to enrich the theory with output-output (OO) correspondence relations, which are responsible for paradigmatic effects between morphologically related forms. Of particular interest is the base-oriented approach, according to which one form acts as a base and imposes its characteristics onto other related forms (cf., among others, Benua 1995, 1997 and Kenstowicz 1996, 2002, based on McCarthy and Prince's 1995 insights on correspondence relations). With regard to the depalatalization issue in Spanish, Bakovič (2001), based on work by Bakovič (1998), has followed up this line of research. Under his view, and following Beckman's (1998) work on positional faithfulness, the coda condition against palatals is accounted for by the constraints and ranking in (12):[11]

11. Here, for the sake of illustration, the intervening markedness constraint used is *Palatal, which only bans palatal nasals and laterals.

(12) a. • IO-Identity(Place) (Id(Pl)): The specification for place of articulation of an I must be preserved in its O correspondent.
• IO-IdentityOnset(Place) (IdOns(Pl)): The specification for place of articulation of an I segment must be preserved in its O correspondent if the segment in question is parsed as an onset.
• *Palatal (*Pal): Do not have a palatal place of articulation.
b. *Ranking*: IdOns(Pl) >> *Pal >> Id(Pl)

The ranking IdOns(Pl) >> *Pal >> Id(Pl) ensures that input palatal segments are maintained in onset position but not in codas, as the tableaux in (13) illustrate. (N = noun, V = verb; in the tableaux throughout the paper, we use for convenience orthographic transcription except for the consonants under discussion.)

(13)

desdeɲ (N)	IdOns(Pl)	*Pal	Id(Pl)
desdeɲ		*!	
☞ desdén			*

desdeɲ-es (V)	IdOns(Pl)	*Pal	Id(Pl)
☞ desdeɲes		*	
desdenes	*!		*

Overapplication of depalatalization in plurals (as in *desdenes*, *claveles*) is captured by considering that surface resemblance between plural and singular forms is due to the effect of an OO faithfulness constraint that enforces place faithfulness of the affixed form with respect to its base in this morphological context. Bakovič (2000: 23), based on Benua's (1997) Transderivational Correspondence Theory (TCT), defines the stem-affixed form faithfulness constraints as follows:[12]

(14) Stem/Affixed-Identity[F] (SA-Id[F]): A segment in an affixed form [*Stem+affix*] must have the same value of the feature [F] as its correspondent in the stem of affixation [*Stem*].

Bakovič (2001) uses a specific SA-Id[F] constraint that involves the place features, SA-Id(Pl), to account for the Spanish data. By ranking SA-Id(Pl) high, the alveolar character of the nasal/lateral segment is carried over stem-faithfully from the singular to the plural form, as the tableaux in (15) show.

(15)

desdeɲ (N) *Stem*: —	SA-Id(Pl)	IdOns(Pl)	*Pal	Id(Pl)
desdeɲ			*!	
☞ desdén				*

desdeɲ-es (N) *Stem*: desdén	SA-Id(Pl)	IdOns(Pl)	*Pal	Id(Pl)
desdeɲes	*!		*	
☞ desdenes		*		*

12. The linear order of *stem* and *affix* in (14) is not relevant. In TCT, any morphological relation (prefixation, suffixation, truncation, etc.) is covered by this definition.

In this analysis, it is crucial that the OO relation is formulated in a way such that it is restricted to this morphological context (i.e., plural with respect to singular in nouns) in order to prevent it from applying to verbal forms: *desdenes* (N), *desdeñes* (V). One possibility is to require that OO correspondences be actual words, the position taken in Bakovič (1998) based on Benua's (1995, 1997) base hypothesis, according to which OO correspondence relations only hold between independently occurring surface forms. This hypothesis reproduces in parallel terms Brame's (1974) *Natural Bracketing Hypothesis*, followed by Kiparsky 1982, Selkirk 1982, and Inkelas 1989, among others. In Bakovič's (1998) analysis, the bound root in *desden-es* (N) is forced to be similar to the root in *desdén* (N) because *desdén* is an independent word, while the bound root in *desdeñ-es* (V) has no base to resemble because all verbal forms are suffixed bound roots. Although such an analysis holds for the *desdén–desdenes–desdeñes* triplet (the cases analyzed in Baković's work), it runs into problems when a wider empirical base is taken into account. First, there are some nominal inflected forms that unexpectedly do not show up with depalatalization. These are pairs such as *don–doña*, *doncel–doncella*, *él–ella, ello, ellos, ellas*, and *aquel–aquella, aquello, aquellos, aquellas*. Second, depalatalization extends to diminutives (e.g., *clavelito*) and to other evaluative forms (e.g., the augmentative form *clavelazo* and the alternative diminutive form *clavelín*), but not to other derived forms (e.g., *clavellina*).[13]

In what follows, we provide an alternative base-oriented account for all these cases built on the more specific notion of 'base' proposed by Kager (1999a,b), which derives from Benua (1995, 1997) and previous literature.

3. An alternative OT base-priority approach

Before developing our analysis, let us summarize the data to be accounted for. The crucial patterns of Castilian Spanish are given in Table 1. Each row shows a family of related words; (c) and (c') exemplify different varieties, the latter belonging to more formal registers. 'Coronal' refers to dento-alveolars and '–Coronal' includes other places of articulation. For simplicity, we do not mark the assimilated dental character of the nasal next to the *-cit* /θit/ diminutive suffix.[14]

Palatal nasals and laterals behave alike. Depalatalization occurs in coda position and extends to onset position in plural and diminutive related forms, except in *ellos* and *aquellos* (cf. (a), (b) in Table 1). In the case of palatal nasals, though, the effects of

13. Another OT analysis is developed in Kikuchi (1999), who discards an OO correspondence approach and provides an alternative Sympathy approach (cf. McCarthy 1999) for these problematic plural forms. We will not discuss this analysis here, because it only covers the singular–plural cases like *desdén–desdenes* and *doncel–donceles*, and because given that the OO constraints seem to be well supported, resorting to Sympathy seems unnecessary.

14. Since this work is based on Castilian Spanish, we do not deal with the velar nasal varieties that systematically show word-final [ŋ] instead of [n]. (See Baković 2001 and Shepherd 2003 for the interaction of the velar nasal realization and depalatalization.)

Table 1. Patterns of non-coronal nasals and laterals for Castilian Spanish.

	Coda position	Onset position	
	coronal	coronal	−coronal
a. /ɲ/	desdé[n] champá[n], champa[n]cito	desde[n]es (N) champa[n]es	desde[ɲ]ar, desde[ɲ]es (V), desde[ɲ]oso champa[ɲ]era, champa[ɲ]ería
b. /ʎ/	donce[l] clave[l] é[l] aque[l]	donce[l]es, donce[l]ito clave[l]es, clave[l]ito	donce[ʎ]a, donce[ʎ]as, donce[ʎ]ez clave[ʎ]ina e[ʎ]os, e[ʎ]a, e[ʎ]as, e[ʎ]o aque[ʎ]os, aque[ʎ]a, aque[ʎ]as, aque[ʎ]o
c. /m/	tóte[n], tóte[n]s, tote[n]cito	*also* tóte[n]es	tote[m]ismo, toté[m]ico
c′. /m/	tóte[n], tote[n]cito		tóte[m]es, tote[m]ismo, toté[m]ico

overapplying depalatalization to diminutives in onset position are not seen because this consonant does not surface in prevocalic position. As is well-known after work by Jaeggli (1980), polysyllabic words ending in [n] add the diminutive allomorph *-cit* (*canción–cancioncita* 'song') and in this context the nasal assimilates to the place of the following consonant: *cancio[nθ]ita* and also *champa[nθ]ito*. Monosyllabic words with a stem ending in [n] do add a vowel initial allomorph, i.e., *-ecit* (as in *tren–trenecito* 'train'). However, no monosyllabic word with an -/ɲ/ stem has a familiar diminutive form (the word *don*, for example, does not have a common diminutive form that speakers can reliably judge). The facts about labial nasals are more complex (cf. (c), (c') in Table 1). The nasal delabializes in coda position and further assimilates pre-consonantally. On the basis of prescription, the standard plural of *-m* [n] words acquire *-es* and the labial is maintained (*tóte[m]es*, and also *álbu[m]es*, *tam-ta[m]es*, *Abraha[m]es*; cf. (c') in Table 1). However, except for *álbumes*, the other words more commonly show plurals in *-s*, with an assimilated nasal (*tóte[n]s*, *ta[n]-ta[n]s*, *Abraha[n]s*, and less frequently *álbu[n]s*; cf. (c) in Table 1). As for the *-es* plurals, most speakers extend delabialization to onset position (*tóte[n]es*, *ta[n]-ta[n]es*, and the most usual form *álbu[n]es*; cf. (c) in Table 1). Delabialization is not encountered in onset position in diminutives because, as mentioned with respect to palatals, the allomorph *-cit* is added to -[n] stems (*tote[n]cito*, *albu[n]cito*, *Abraha[n]cito*; cf. (c), (c') in Table 1).[15]

15. It should be noted that although some speakers accept as possible any diminutive in *-cit* from *-m* words, others are reluctant to create diminutives (and also some plurals) for reasons other than phonological. The forms *albu[n]cito*, *tote[n]cito*, and *Abraha[n]cito* are nevertheless accepted by almost all speakers (some speakers with *tóte[m]es* also accept *tote[m]ito*). No reliable augmentative or alternative diminutive form with a vowel initial affix is encountered either. This data limitation does not alter our results because our concern is on the phonological facts, which are regular once such evaluative forms are originated. (On the compatibility of diminutive formation with certain words in Castilian Spanish, see Lázaro Mora 1999: §71.3; the situation is quite different in American Spanish, where the use of diminutives is very common. For an overall review of plural formation, see Ambadiang 1999: §74.3.)

A few further facts concerning the distribution of non-coronal segments are to be taken into account in the analysis. First, since nasals assimilate place in pre-consonantal position, places of articulation other than coronal are possible in the coda (*tren pequeño* [m p] 'small train', *tren grande* [ŋ g] 'big train').[16] Second, in no variety does the alveopalatal affricate become alveolar word-finally; therefore, palatal consonants are not completely lacking in word-final position but only sonorants (i.e., -[t͡ʃ], as in *match* or *Rostropovich*, but *-[ɲ] and *-[ʎ]). Lastly, recall from §1 that word-final obstruents are not categorically disallowed (e.g., *che[f]*, *Jo[β]*). Hence, any general ban against obstruents or non-coronal consonants in word-final position is too strong and does not reflect the real facts of Castilian Spanish and most other dialects.[17]

In light of the previous data, it is clear that depalatalization is not to be seen as an independent phenomenon but is an instance of a general process of place neutralization affecting nasals and laterals in coda position. Overapplication of nasal/lateral depalatalization and delabialization in onset position is an OO effect, as already suggested by Bakovič (1998, 2001). In our view, however, this OO effect is restricted by the specific notion of base proposed by Kager (1999b: 282), drawn on Kager (1999a):

(16) *Definition of 'base'*:
  a. The base is a free-standing output form — a *word*.
  b. The base contains a subset of the grammatical features of the derived form.

According to the first criterion (16a), the base must always be an output itself, an existing word (in line with Kenstowicz's 1996, 2002 and Benua's 1995, 1997 work). According to the second criterion (16b), the base is compositionally related to the affixed word in a morphological and semantic sense, and is in a subset relation with it. It must be, obviously, a proper subset since otherwise base and derived form would be identical lexical items. Kager's proposal restricts the number of possible correspondence relations and predicts that base-identity relations cannot be established when the two criteria for base-hood are not satisfied. In our view, the morphological relation of a plural form with respect to a singular form (i.e., its base) is included in this definition (e.g., *clavel* [NOUN, MASCULINE], *claveles* [NOUN, MASCULINE, PLURAL]), as well as that of a diminutive form with respect to the non-diminutive form (i.e., its base) (e.g., *clavel* [NOUN, MASCULINE], *clavelito* [NOUN, MASCULINE, DIMINUTIVE]). Other morphologically related forms (e.g., feminine with respect to masculine, one inflected verbal form with respect to another inflected verbal form, a derived form with respect to the non-derived one) do not match both criteria for base-hood. They have no base, and thus the relevant base-identity constraint is irrelevant for candidate selection.

---

16. As is well-known, laterals only assimilate to coronals. This is viewed as an effect of the undominated context-free markedness constraint LATERAL/CORONAL ("All laterals are coronal"). We will not further discuss this issue here.

17. For present purposes, we attribute the different behavior of palatal sonorants and (alveo)palatal obstruents to their manner features. An alternative is to attribute it to their place features. (See also note 21.)

The fact that plurals satisfy the two criteria for base-hood is not controversial. On the compositional side, the number category can be assumed to be a single privative feature [PLURAL] (arguments in the literature in favor of this view are found, among others, in Harris 1992). Hence, the base (i.e., the singular word) clearly contains a proper subset of the grammatical (semantic, morphological) features of the derived form (i.e., the plural word). As for the shape of the base, the plural is always formed over the singular; it is the singular word (with its gender markers) plus the plural morph. We will not discuss here whether the additional *e* vowel that appears in plurals like *desdenes* or *claveles* is epenthetic or part of the plural morph. As we shall see, both views are compatible with our analysis of depalatalization. The situation is quite different in masculine–feminine pairs. In particular, the masculine form, which could be appropriate as base in a morphological compositional sense under an interpretation of gender as a single privative feature [FEMININE], is not a proper subset of the semantic features of the feminine form: for most cases masculine–feminine pairs lack a clear semantic correlate, in the case of sex distinctions inclusion should be out of question. Additionally, the feminine form is not formed over the free-standing masculine output; rather it is built over the stem (e.g., *gat-o*, *gat-a* 'cat (male, female)'). The masculine–feminine pairs fail the criteria for base-hood; thus, they cannot undergo the base-identity constraints.

Diminutive forms, in contrast, have bases by both criteria: the diminutives contain all morpho-semantic features of their corresponding non-diminutive forms and have as base a free-standing output. The compositional criterion is well-accepted; the output criterion needs independent evidence since, at first sight, diminutive formation looks like gender formation, in the sense that the diminutive morph appears next to the stem and not next to the free-standing form of the source (cf. *gat-o*, *gat-it-o*; *gat-a*, *gat-it-a*). The dependence of diminutive formation on the form of the free-standing non-diminutive word is proven, among other facts, by allomorph selection. For instance, in general, monosyllabic words add the allomorph *-ecit* (17a) while polysyllabic words add *-(c)it* (17b) (see, among others, Jaeggli 1980).

(17)	a.	-ecit :	sol → solecito	'sun'	tren → trenecito	'train'
	b.	-(c)it :	solo → solito	'alone'	canción → cancioncita	'song'

Furthermore, in general, in polysyllabic words the *-cit* allomorph is chosen when the non-diminutive word ends in [r] or [n] (18a), while *-it* is chosen when it ends in [r] or [n] that are followed by an inflectional vowel (18b). According to Kenstowicz (2002), based on work by Aguero-Bautista (1998), the reason for this allomorph selection is to maintain the syllabic profile of the non-diminutive source. That is, *-cit* locks the final consonant of the stem in the coda while *-it* draws it into the onset; hence the diminutive stems end up having the same syllabification as their source.[18]

18. Although it is true that none of the aforementioned criteria (and others mentioned in the literature) for allomorph selection handles all the data, most authors agree in the dependence of diminutive formation on the shape of the source word (cf., among others, Jaeggli 1980; Prieto 1992; Lloret 1995, 1998; Ambadiang 1996; Aguero-Batista 1998; Kenstowicz 2002).

(18) a. -cit : amor → amorcito 'love' canción → cancioncita 'song'
b. -it : loro → lorito 'parrot' corona → coronita 'crown'

Another piece of evidence comes from restrictions on diminutive formation. Several authors have noticed the apparently unrelated fact that nominals ending in *-s* that do not have a different plural form do not have a diminutive derivative either, and in this case the restriction on diminutive formation is not semantically or pragmatically grounded (cf. Varela 1990: 133).

(19) francés — franceses — francesito 'French'
lunes — lunes (*lúneses) — *lunecito 'Monday'
tesis — tesis (*tésises) — *tesecita 'thesis'
Cf. domingo — domingos — dominguito 'Sunday'
artículo — artículos — articulito 'article'

Lloret (1995, 1998) pointed out that this correlation is not fortuitous but is connected to the morphological structure of the non-diminutive source. From the descriptive point of view, these are the observed generalizations: if *-s* is part of the stem, the nominal has a different plural form and a corresponding diminutive form (20a). If *-s* is plural inflection, as in *pluralia tantum* words (20b) and in compounds whose second element contains a plural (20c), the nominals do not have a surface distinct plural form but do have diminutives. However, if *-s* belongs to the marginal *-(V)s* nominal ending (where *s* is not affiliated to the plural morpheme), the words have no different plural form and no corresponding diminutive (20d).

(20) a. [francés]$_{\text{STEM}}$ [[[francés]$_{\text{STEM}}$ it] o]
b. [[[tijer] a] s$_{\text{PLURAL}}$] [[[[tijer] it] a] s$_{\text{PLURAL}}$] 'scissors, (dim)'
c. [[[par] a] [[[ray] o] s$_{\text{PLURAL}}$]] [[[par] a] [[[ray] it] o] s$_{\text{PLURAL}}$] 'lightning rod, (dim)'
d. [[tes]$_{\text{STEM}}$ is] *[[[tes]$_{\text{STEM}}$ (ec)it] a]

The precise formal explanation of these facts is not at issue here, but it is clear from the data above that diminutive formation depends on the form of the non-diminutive free-standing word, i.e., the base in Kager's terms.[19]

Table 2 summarizes the cases where the base-identity correspondence relation holds (a) or does not hold (b).

In this table the only odd elements are the pairings *él–ellos* and *aquel–aquellos*. Below we provide an explanation based on the fact that *él* and *aquel* cannot function as bases for *ellos* and *aquellos* because they differ in the gender marker (-Ø vs. *-o*).

19. Some authors (Prieto 1992, Ambadiang 1996) consider that diminutives like *lunecito* and *tesecita* are possible (yet admittedly rare). Interestingly enough for our purposes, though, the fact that these words select *-ecit* instead of *-(c)it*, as would be predicted on the basis that their source words are polysyllabic (*lunes*, *tesis*), is also explained through the morphological structure of the whole non-diminutive words. (There are no recordings of such cases in the CREA; neither are there for diminutives such as *tesiscita*, *dosiscita*, *lunescito*. For an overall review of diminutive formation, see Lázaro Mora 1999.)

Table 2. Patterns of base-identity relations.

a. Base identity	SINGULAR → PLURAL	desdé[n] → desde[n]es donce[l] → donce[l]es
	NON-DIMINUTIVE → DIMINUTIVE	clave[l] → clave[l]ito
b. No base identity	MASCULINE — FEMININE	do[n] — do[ɲ]a donce[l] — donce[ʎ]a é[l] — e[ʎ]a
	SINGULAR — PLURAL	é[l] — e[ʎ]os aque[l] — aque[ʎ]os
	X(inflected verb) — Y(inflected verb)	desde[ɲ]ar — desde[ɲ]es
	X (simplex) — Y(derived)	desdé[n] — desde[ɲ]oso clave[l] — clave[ʎ]ina

The base-identity constraint that comes into play is defined in (21a). The regressive assimilatory effects encountered in [nasal + consonant] sequences are captured through the markedness constraint defined in (21b).

(21) a. IDENTITY-BASE(PLACE) (ID-BA(PL)): Let α be a segment in the base, and β be a correspondent of α in the affixed form. If α is [γPlace], then β is [γPlace].
b. AGREE(PLACE) (AGR(PL)): NC clusters must agree in place.

For the varieties of Castilian Spanish with systematic nasal/lateral depalatalization in diminutives and plurals and delabialization of /m/ in the same contexts (i.e., (a), (b), and (c) in Table 1, repeated here as (23)), the ranking at work is the one given in (22). Here we use, following Bakovič (2001), *−CORONAL ("Do not have a place of articulation other than coronal", adapted from Prince and Smolensky 1993) to restrict all places of articulation except coronal (the unmarked place).[20] This constraint captures the facts of dialects that only show alveolar nasals and laterals in coda position, unless under assimilation. In order for *−CORONAL to affect nasals and laterals but not necessarily other consonants, we need to circumscribe the effects of IDENT(PLACE) to specific manners of articulation. We follow Padgett (1997), upon work by Jun (1994), in assuming that the faithfulness IDENT constraints can refer to manner and place of articulation simultaneously. Under this approach, the IDENT(OBSTRUENTPLACE) constraint is considered to be universally ranked higher than other manner-place faithfulness constraints, because obstruents resist assimilations more than other consonants. On the contrary, IDENT(NASALPLACE) is considered to occupy a low position in the ranking because the place cues of nasals in codas are very weak and therefore they easily assimilate. For our purposes, it is sufficient to identify the low position of IDENT(SONORANTPLACE) (ID(SONPL)) with respect to certain place markedness constraints.[21] (Although the ranking of the IDENT(OBSTRUENTPLACE) constraint is

20. *−COR compacts the universal hierarchy of place markedness: *LABIAL, *DORSAL >> *CORONAL (cf., among others, Padgett 1997, Lombardi 2003).

21. The singularity of sonorant consonants with respect to obstruents as far as place of articulation is concerned is typologically grounded by different facts. Many languages, for example, have palatal

not at issue here, note that in the varieties where non-coronal coda obstruents, including those in word-final position, are maintained without becoming coronal, IDENT(OBSTRUENTPLACE) would be ranked above *−COR.)

(22) *Ranking*: AGR(PL) >> ID-BA(PL) >> IDONS(PL) >> *−COR >> ID(SONPL)

(23) a. /ɲ/: desdé[n], desde[n]es (N)
desde[ɲ]ar, desde[ɲ]es (V), desde[ɲ]oso
b. /ɲ/: champá[n], champa[n]es, champa[n]cito
champa[ɲ]era, champa[ɲ]ería
c. /ʎ/: clave[l], clave[l]es, clave[l]ito
clave[ʎ]ina
d. /ʎ/: é[l]; aque[l]
e[ʎ]os, e[ʎ]a, e[ʎ]as, e[ʎ]o; aque[ʎ]os, aque[ʎ]a, aque[ʎ]as, aque[ʎ]o
e. /m/: tóte[n], tóte[n]es (*also* tóte[n]s), tote[n]cito
tote[m]ismo, toté[m]ico

Centralization in the singular forms of items like *desde/ɲ/* (23a), *champa/ɲ/* (23b), *clave/ʎ/* (23c), and *tóte/m/* (23e) is explained by the ranking of *−COR above ID(SONPL) (cf. (24)). The maintenance of the non-coronal input places of articulation in onset positions is explained by the ranking of IDONS(PL) above *−COR (cf. (25)). The fact that centralization of nasals and laterals is carried over the onset position in plurals and diminutives is due to the higher ranking of the base-identity constraint ID-BA(PL) (cf. (26)). Note that the base-identity constraint is irrelevant for candidate selection in the case of other inflected and derived forms, because they do not satisfy the two criteria for base-hood that were previously stated (cf. (25)).

(24)

desdeɲ (N) *Base*: —	ID-BA(PL)	IDONS(PL)	*−COR	ID(SONPL)
desdéɲ			*!	
☞ desdén				*

totem *Base*: —	ID-BA(PL)	IDONS(PL)	*−COR	ID(SONPL)
tótem			*!	
☞ tóten				*

obstruents but not palatal sonorants (they have ʃ, ʒ, t͡ʃ or d͡ʒ but not ɲ or ʎ). Moreover, languages that have palatal obstruents and sonorants often centralize the latter in codas but not the former. For example, Alguerese Catalan shows systematic /ɲ/, /ʎ/ centralization but there is not a corresponding phenomenon for obstruents: *ba[n]–ba[ɲ]ar* 'bath–to bathe', *fi[l]–fi[ʎ]a* 'son–daughter' but *pe[ʃ]* 'fish', *mi[t͡ʃ]* 'middle' (for an OO analysis along the lines put forward here, see Jiménez and Lloret 2006). Palatal and labiovelar glides are excluded from centralization because, among other reasons, there are not corresponding dento-alveolar glides. As said, in our analysis, the lack of centralization of some obstruents (f, t͡ʃ, etc.) is easily accounted for by ordering IDENT(OBSTRUENTPLACE) before IDENT(SONORANTPLACE)). The centralization in borrowings of final ʃ, ʒ (as in [at͡ʃís] < [haʃíʃ] 'hashish', [béjs] < [bɛ́ʒ] 'beige') is explained by the fact that Castilian Spanish lacks such sounds and is accounted in OT terms by ranking *ʃ, *ʒ high.

claveʎ *Base*: —	Id-BA(Pl)	IdOns(Pl)	*–Cor	Id(SonPl)
claveʎ			*!	
☞ clavel				*

(25)

desdeɲ-es (V) *Base*: —	Id-BA(Pl)	IdOns(Pl)	*–Cor	Id(SonPl)
☞ desdeɲes			*	
desdenes		*!		*

totem-ico *Base*: —	Id-BA(Pl)	IdOns(Pl)	*–Cor	Id(SonPl)
☞ totémico			*	
toténico		*!		*

claveʎ-ina *Base*: —	Id-BA(Pl)	IdOns(Pl)	*–Cor	Id(SonPl)
☞ claveʎina			*	
clavelina		*!		*

(26)

desdeɲ-es (N) *Base*: desdén	Id-BA(Pl)	IdOns(Pl)	*–Cor	Id(SonPl)
desdeɲes	*!		*	
☞ desdenes		*		*

totem-es *Base*: tóten	Id-BA(Pl)	IdOns(Pl)	*–Cor	Id(SonPl)
tótemes	*!		*	
☞ tótenes		*		*

claveʎ-es *Base*: clavel	Id-BA(Pl)	IdOns(Pl)	*–Cor	Id(SonPl)
claveʎes	*!		*	
☞ claveles		*		*

claveʎ-ito *Base*: clavel	Id-BA(Pl)	IdOns(Pl)	*–Cor	Id(SonPl)
claveʎito	*!		*	
☞ clavelito		*		*

The constraint Id-BA(Pl) is irrelevant in the pairings *él–ellos* and *aquel–aquellos* (23d) because, although these pairs satisfy the compositional singular–plural relation, the plurals are not formed over independent words. That is, *ellos* and *aquellos* do not have as base masculine singular forms like *ello* and *aquello* (which do exist as neuter forms but not as masculines); they are related instead to *él* and *aquel* (without the masculine *o* allomorph) (cf. (27)).

(27)

eʎ *Base*: —	Id-BA(Pl)	IdOns(Pl)	*–Cor	Id(SonPl)
eʎ			*!	
☞ el				*

eʎ-o-s *Base*: —	Id-BA(Pl)	IdOns(Pl)	*–Cor	Id(SonPl)
☞ eʎos			*	
elos		*!		*

The allomorphy regarding the masculine morpheme (i.e., Ø in the singular but *o* in the plural) prevents the base-correspondence relation from being properly established. As (28) shows, the plural *desdenes* properly includes the singular, which is not the bare root [desdén], but the root plus the null gender marker: [[*desdén*] Ø]. Similarly, *ellos* differs from its singular by the presence of the plural marker, which clearly does not include the gender marker -*o*-. Since the singular is not the plural minus the plural marker, i.e. [[*él*] Ø] ≠ [[*él*] *o*], the pair cannot establish a proper subset relation. Note that this does not alter the relation of the singular forms ending in consonant and their corresponding -*es* plural forms (e.g., *desdén–desdenes*), since whether we interpret the vowel of -*es* as epenthetic or as part of the plural morph, it cannot be parsed as part of the singular word (i.e., the base).[22]

(28) [[desdén] Ø] [[[desdén] Ø] es]
 [[él] Ø] [[[eʎ] o] s]

The assimilated nasal realizations in pre-consonantal position are accounted for by the ranking of Agr(Pl) above Id-BA(Pl), as the tableaux (29) illustrate.

(29)

tótem suyo *Base*: tóten	Agr(Pl)	Id-BA(Pl)	IdOns(Pl)	*–Cor
…m s…	*!	*		*
☞ …n s…				

tótem mío *Base*: tóten	Agr(Pl)	Id-BA(Pl)	IdOns(Pl)	*–Cor
☞ …m m…		*		**
…n m…	*!			*

Diminutives in -*cit* and plurals in -*s* (and not in -*es*) from base words with a final nasal can also be accounted for with the same ranking, due to the effect of the highly ranked Agr(Pl) constraint (cf. (30)).

22. Our interpretation of the facts goes against an explanation of these *e* vowels that only appear in the plural forms as class markers, because under this view the *o* segment in *ellos* and *aquellos* and the *e* segment in *desdenes* and *claveles* have the same morphological status. Therefore, the contrast between the palatal in the former and the alveolar in the latter would remain unexplained. For discussion on the epenthetic or lexical character of these vowels, see, among others, Bonet (2006).

(30)

totem-cito *Base*: tóten	Agr(Pl)	Id-BA(Pl)
totemcito	*!	*
☞ totencito		

totem-s *Base*: tóten	Agr(Pl)	Id-BA(Pl)
tótems	*!	*
☞ tótens		

Notice that in the case of *-m* words, an underlying form with -/m/ is chosen in items like *tótem* on the basis of the alternations that surface in derived words (cf. *tóte[n]* but *tote[m]ismo*, *toté[m]ico*). However, in cases like *ad infinitum* -[n], which do not have any related derived word, or in words like *álbum* -[n] in the varieties that do not show any related derived word with [m], the right candidate is selected whether we choose an underlying form with a labial or one with an alveolar segment. Given the theory of richness of the base (ROTB), this is a desirable consequence of the analysis. The tableaux in (31) illustrate this point with respect to two attested plural forms of the word *álbum*: *álbu[n]s* and *álbu[n]es*.

(31)

album-s *Base*: álbun	Agr(Pl)	Id-BA(Pl)
álbums	*!	*
☞álbuns		

albun-s *Base*: álbun	Agr(Pl)	Id-BA(Pl)
álbums	*!	
☞álbuns		

album-es *Base*: álbun	Agr(Pl)	Id-BA(Pl)
álbumes		*!
☞ álbunes		

albun-es *Base*: álbun	Agr(Pl)	Id-BA(Pl)
álbumes		*!
☞ álbunes		

Other Castilian Spanish varieties show the same facts that we have reported up to now except that centralization of word-final labial nasals does not extend to other morphologically related words (cf. (c′) in Table 1, repeated here as (32a)). In this case, the more specific positional faithfulness constraint IdentOnset(Labial) (IdOns(Lab)), which enforces the preservation of the labial segments of the input when they are parsed as onsets, is ranked before the more general constraint IdOns(Pl), and it crucially dominates the base-identity constraint too. The ranking in (32b) dictates this distribution of the labials.

(32) a. /m/: tóte[n], tote[n]cito *but* tóte[m]es, tote[m]ismo, toté[m]ico
b. Agr(Pl), IdOns(Lab) >> Id-BA(Pl) >> IdOns(Pl) >> *−Cor >> Id(SonPl)

The tableaux in (33) illustrate the effects of this ranking in morphologically base-related pairs as far as labials are concerned.

(33)

totem *Base*: —	IdOns (Lab)	Id-BA(Pl)	IdOns(Pl)	*−Cor	Id(SonPl)
tótem				*!	
☞ tóten					*

totem-es *Base*: tóten	IdOns (Lab)	Id-BA (Pl)	IdOns(Pl)
☞ tótemes		*	
tótenes	*!		*

totem-cito *Base*: tóten	Agr (Pl)	IdOns (Lab)	Id-BA (Pl)	IdOns(Pl)	*–Cor	Id(Son Pl)
totemcito	*!		*		*	
☞ totencito						*

The cases of centralization in new lexical items that were crucial for defending the active status of the process can be handled straightforwardly. A word like *módem* 'modem', if set up with underlying /m/, will have the coda /m/ centralized to give [móðen]. Lexicon Optimization (cf. Prince and Smolensky 1993, Itô et al. 1995) will prefer /n/, if no alternations exist, but in any case *[móðem] is dictated by the ordering of constraints. Whenever alternations exist, related words with the non-coronal lateral or nasal in the onset will be enough to overcome Lexicon Optimization to establish the non-coronal in the lexical form, as in *isla[n]–islá[m]ico*, both from the root /islam/.

For the sake of comparison, we finally include the analysis of other Spanish varieties that disallow palatal nasals and laterals word-finally (and in the base-related forms) but not [m] (34a). The proposed ranking to account for this distribution is given in (34b). In this case, the compact *–Cor constraint that we have been using for simplicity has to be replaced by the two more specific constraints *Palatal (*Pal) and *Labial (*Lab). The more marked character of the palatal segments with respect to the labial ones justifies the higher position of *Pal in the ranking (cf. Padgett 1997).[23]

(34) a. /m/: tóte[n]s (*tóte[n]es) *but* tóte[m], tote[m]ismo, toté[m]ico
b. Agr(Pl) >> Id-BA(Pl) >> IdOns(Pl) >> *Pal >> Id(SonPl) >> *Lab

Tableaux (35)–(36) illustrate how this ranking handles the crucial data involving palatals and labials, respectively.

(35)

desdeɲ (N) *Base*: —	Id-BA (Pl)	IdOns(Pl)	*Pal	Id(Son Pl)
desdeɲ			*!	
☞ desdén				*

desdeɲ-es (N) *Base*: desdén	Id-BA (Pl)	IdOns(Pl)	*Pal
desdeɲes	*!		*
☞ desdenes		*	

23. Recall from the discussion on the ranking presented in (22) that the maintenance of non-coronal final obstruents such as -[f] and -[t͡ʃ] is handled by ranking Identity(ObstruentPlace) before *Palatal, and hence before Identity(SonorantPlace) and *Labial for the ranking in (34b).

(36)

totem *Base*: —	Agr (Pl)	Id-BA (Pl)	IdOns(Pl)	*Pal	Id(Son Pl)	*Lab
☞ tótem						*
tóten					*!	

totem-s *Base*: tótem	Agr (Pl)	Id-BA (Pl)
tótems	*!	
☞ tótens		*

4. Conclusion

Although Castilian Spanish displays few cases with morpho-phonological alternations ([n]–[m], [n]–[ɲ], [l]–[ʎ]), we have provided evidence showing that there is an active process of centralization. We have presented an OT analysis based on positional faithfulness and OO faithfulness constraints (extending previous works by Bakovič 1998, 2001). We have further shown that these asymmetric OO constraints are to be established using the strongest version of base proposed by Kager (1999a,b), echoing Brame (1974).

Many other Spanish varieties show more limited effects of centralization, but our analysis extends, under appropriate modifications, to them as well. The same analysis can also be extended to other languages, such as Occitan, which systematically shows nasal place centralization (*fu[n]–fu[m]ar* 'smoke–to smoke', *ba[n]–ba[ɲ]ar* 'bath–to bathe'), and Alguerese Catalan, in which there is systematic centralization with palatal nasals and laterals but not with labials (*ba[n]–ba[ɲ]ar*, *fi[l]–fi[ʎ]a* 'son–daughter' but *fu[m]–fu[m]ar*).

References

Aguero-Bautista, C. 1998. Cyclic and identity effects in Spanish diminutives and augmentatives. Unpublished Phonology Generals paper, MIT, Cambridge MA.

Alonso, A. 1945. Una ley fonológica del español; variabilidad de las consonantes en la tensión y distensión de la sílaba. *Hispanic Review* 13: 91–101.

Ambadiang, T. 1996. La formación de diminutivos en español: ¿fonología o morfología? Lingüística Española Actual XVIII(2): 175–211.

Ambadiang, T. 1999. La flexión nominal. Género y número. In *Gramática Descriptiva de la Lengua Española*, I. Bosque and V. Demonte (eds), Vol. 3, 4843–4913. Madrid: Espasa Calpe.

Bakovič, E.J. 1998. Spanish codas and overapplication. In *Romance Linguistics: Theoretical perspectives (Selected papers from the 27th Linguistic Symposium on Romance Languages, 1997)*, A. Schwegler, B. Tranel and M. Uribe-Etxebarria (eds), 13–23. Amsterdam: John Benjamins.

Bakovič, E.J. 2000. Harmony, Dominance and Control. PhD dissertation, Rutgers University. (Available online at: http://roa.rutgers.edu, No. 360.)

Bakovič, E.J. 2001. Nasal place neutralization in Spanish. In U Penn Working Papers in Linguistics 7(1): Proceedings of the 24th Annual Penn Linguistics Colloquium, M. Minnick Fox, A.

Williams and E. Kaiser (eds), 1–13. Philadelphia PA: PWPL. (Available online at: http://roa.rutgers.edu, No. 386.)

Beckman, J. 1998. Positional Faithfulness. PhD dissertation, University of Massachusetts, Amherst. (Available online at: http://roa.rutgers.edu, No. 234.)

Benua, L. 1995. Identity effects in morphological truncation. In *Papers in Optimality Theory* [University of Massachusetts Occasional Papers in Linguistics 18], J. Beckman, L. Walsh Dickey and S. Urbanczyk (eds), 77–136. Amherst MA: Graduate Linguistic Student Association.

Benua, L. 1997. *Transderivational Identity: Phonological Relations between Words*. PhD dissertation, University of Massachusetts, Amherst. (Published as *Phonological Relations between Words*. New York NY: Garland, 2000.)

Bosque, I. and Pérez Fernández, M. 1987. *Diccionario inverso de la lengua española*. Madrid: Gredos.

Brame, M. 1974. The cycle in phonology: Stress in Palestinian, Maltese, and Spanish. *Linguistic Inquiry* 5: 39–60.

Cole, J. 1995. The cycle in phonological grammar. In *Handbook of Phonological Theory*, J. Goldsmith (ed.), 70–113. Cambridge MA: Basil Blackwell.

Contreras, H. 1977. Spanish epenthesis and stress. *University of Washington Working Papers in Linguistics* 3: 9–33.

CREA = *Corpus de Referencia del Español Actual*. Real Academia Española. (Available online at: http://corpus.rae.es/.)

Eddington, D. 2004. *Spanish Phonology and Morphology: Experimental and Quantitative Perspectives.* Amsterdam: John Benjamins.

Harris, J.W. 1983. Syllable Structure and Stress in Spanish: An autosegmental analysis. Cambridge MA: The MIT Press.

Harris, J.W. 1984. Theories of phonological representation and nasal consonants in Spanish. In *Papers from the XII Linguistic Symposium on Romance Languages,* P. Baldi (ed.), 153–168. Amsterdam: John Benjamins.

Harris, J.W. 1992. The form classes of Spanish substantives. In *Yearbook of Morphology 1991*, G. Booij and J. v. Marle (eds), 65–88. Dordrecht: Kluwer.

Harris, J.W. 1999. Nasal depalatalization *no*, morphological wellformedness *sí*; The structure of Spanish word classes. In *MIT Working Papers in Linguistics* 33: *Papers on Morphology and Syntax, Cycle one*, K. Arregi, B. Bruening, C. Krause and V. Lin (eds), 47–82. Cambridge MA: MITWPL.

Inkelas, S. 1989. Prosodic Constituency in the Lexicon. PhD dissertation, Stanford University.

Itô, J. and Mester, A. 1998. The phonological lexicon. In *A Handbook of Japanese Linguistics*, N. Tsujimura (ed.), 143–186. Oxford: Blackwell.

Itô, J. and Padgett, J. 1995. Licensing and underspecification in optimality theory. *Linguistic Inquiry* 26: 571–614.

Jaeggli, O.A. 1980. Spanish diminutives. In *Contemporary Studies in Romance Languages*, F.H. Nuessel (ed.), 142–158. Bloomington IN: Indiana University Linguistics Club.

Jiménez, J. and Lloret. M.-R. 2006. Asimetries en la interfície morfologia/fonologia. Paper presented at the VII Congrés de Lingüística General, Universitat de Barcelona, Barcelona. (To appear in *Actes del VII Congrés de Lingüística General*.)

Jun, J. 1994. A constraint-based analysis of place assimilation typology. *Studies in the Linguistic Sciences* 24: 263–277.

Kager, R. 1999a. Surface opacity of metrical structure in optimality theory. In *The Derivational Residue in Phonological Optimality Theory*, B. Hermans and M. van Oostendorp (eds), 207–245. Amsterdam: John Benjamins.

Kager, R. 1999b. *Optimality Theory*. Cambridge: CUP.

Kenstowicz, M. 1994. *Phonology in Generative Grammar*. Oxford: Blackwell.

Kenstowicz, M. 1996. Base-identity and uniform exponence: Alternatives to cyclicity. In *Current Trends in Phonology: Models and Methods*, J. Durand and B. Laks (eds), 363–393. Paris-X/Salford: European Studies Research Institute.

Kenstowicz, M. 2002. Paradigmatic uniformity and contrast. In *MIT Working Papers in Linguistics* 42: *Phonological Answers (and their corresponding questions)*, A. Csirmaz, Z. Li, A. Nevins, O. Vaysman and M. Wagner (eds), 141–164. Cambridge MA: MITWPL.

Kikuchi, S. 1999. Opacity and transparency in Spanish plurals: A sympathetic approach. *On'in Kenkyu* 2: 61–68.

Kiparsky, P. 1982. From cyclic phonology to lexical phonology. In *The Structure of Phonological Representations,* H. v.d. Hulst and N. Smith (eds), 131–175. Foris: Dordrecht.

Kiparsky, P. 1985. Some consequences of Lexical Phonology. *Phonology Yearbook* 2: 85–138.

Lázaro Mora, F.A. 1999. La derivación apreciativa. In *Gramática Descriptiva de la Lengua Española*, I. Bosque and V. Demonte (eds), Vol. 3, 4645–4681. Madrid: Espasa Calpe.

Lloret, M.-R. 1995. Els diminutius i les marques de gènere. In *Estudis de lingüística i filologia oferts a Antoni M. Badia i Margarit*, Vol. III, 63–76. Barcelona: Universitat de Barcelona / Publicacions Abadia de Montserrat.

Lloret, M.-R. 1998. Sobre l'estructura morfològica dels noms en català i en castellà. *Atti del XXI Congresso Internazionale di Linguistica e Filologia Romanza*, G. Ruffino (ed.), Vol. II, 557–566. Tübingen: Niemeyer.

Lombardi, L. 2002. Coronal epenthesis and markedness. *Phonology* 19, 219–225 (Available online at: http://roa.rutgers.edu, No. 579.)

McCarthy, J.J. 1999. Sympathy and phonological opacity. *Phonology* 16: 331–399.

McCarthy, J.J. and Prince, A. 1995. Faithfulness and reduplicative identity. In *Papers in Optimality Theory* [University of Massachusetts Occasional Papers in Linguistics 18], J. Beckman, L. Walsh Dickey and S. Urbanczyk (eds), 249–384. Amherst MA: Graduate Linguistic Student Association.

Menéndez-Pidal, R. 1968. *Manual de gramática histórica española.* Madrid: Espasa Calpe.

Padgett, J. 1997. Partial class behavior and nasal place assimilation. In *Proceedings of the 1995 Southwestern Workshop on Optimality Theory* [Arizona Phonology Conference / Southwestern Optimality Theory. Conference Proceedings 5], K. Suzuki and D. Elzinga (eds), 145–183. Tucson AZ: University of Arizona. (Available online at: http://roa.rutgers.edu, No. 113.)

Pensado, C. 1997. On the Spanish depalatalization /ɲ/ and /ʎ/ in rhymes. In *Issues in the Phonology and Morphology of the Major Iberian Languages*, F. Martínez-Gil and A. Morales (eds), 595–618. Washington DC: Georgetown University Press.

Peperkamp, S. 1997. *Prosodic Words* [HIL dissertations 34]. The Hague: HAG.

Prieto, P. 1992. Morphophonology of the Spanish diminutive formation: A case for prosodic sensitivity. *Hispanic Linguistics* 5: 169–205.

Prince, A. and Smolensky, P. 1993. *Optimality Theory: Constraint Interaction in Generative Grammar*. New Brunswick NJ: Rutgers University Center for Cognitive Science. Technical report RuCCS-TR-2. (Revised version published by Malden MA/Oxford: Blackwell, 2004.)

Saporta, S. 1959. Morpheme alternants in Spanish. In *Structural Studies on Spanish Themes*, H.R. Kahane and A. Pietrangeli (eds), 15–162. Salamanca/Urbana IL: University of Illinois Press.

Selkirk, E. 1982. *The Syntax of Words*. Cambridge MA: The MIT Press.

Shepherd, M.A. 2003. Constraint Interactions in Spanish Phonotactics: An optimality theory analysis of syllable-level phenomena in the Spanish language. MA dissertation, California State University. (Available online at: http://roa.rutgers.edu, No. 639.)

Varela, S. 1990. *Fundamentos de morfología*. Madrid: Síntesis.

Upstepping vowel height

A constraint-based account of metaphony in Proto-Spanish and Lena Asturian*

Fernando Martínez-Gil
The Ohio State University

The main goal of this paper is to argue for a unified analysis of two stepwise vowel raising processes known as *metaphony*, those of Proto-Spanish and Lena Asturian, within the framework of Optimality Theory (*OT*). It is shown that previous serial accounts based on autosegmental spreading rules operating on vowel height features are unable to capture adquately the unitary nature of the metaphony shifts. Our OT approach stepwise vowel raising in both Proto-Spanish and Lena Asturian arises primarily in the interaction of two constraints, unranked with respect to each other. First, a markedness constraint which demands that the stressed vowel agree in vowel-height features with a following high vocoid within a word's dominant foot; and second, a local conjunction of identity constraints on contrastive vowel height features which enforces stepwise raising by effectively restricting unfaithfulness between input and output to at most one feature. Both the agreement and the constraint conjunction constraint dominate the individual faithfulness constraints requiring input-output identity of vowel height features. Finally, it is shown that this analysis can be easily extended to handle the somewwhat different metaphonic shifts in Nalón Valley Asturian, closely related to the Lena variety, by appealing to a different ranking of the same constraints proposed for the Lena variety, a desirable result predicted by factorial typology.

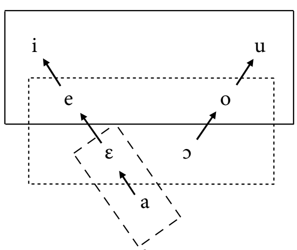
Keywords: local constraint conjunction, Lena Asturian, metaphony, Nalón Valley Asturian, partial vowel-height assimilation, Proto-Spanish, stepwise vowel raising, synchronic chain shifts

* A shorter version of this work was presented at the *29th Annual Linguistic Symposium on Romance Languages*, held at the University of Michigan in April, 1999. This paper has benefited from the valuable comments by two anonymous reviewers. My special thanks to professor Martin Maiden for his input on Italian metaphony. All errors are my own.

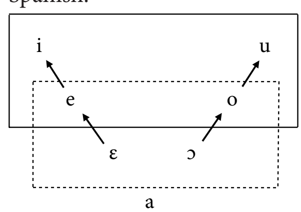
0. Introduction and background

The term *synchronic chain shifts* is commonly used to refer to phonological processes that involve stepwise movements along a certain phonetic dimension, such as vowel height, as illustrated in (1) by three representative vowel-raising patterns. Such phenomena have traditionally presented a significant challenge to rule-based approaches to phonological derivation, due to the formal difficulty of capturing their arguably unitary nature by means of a single formal statement that adequately encompasses the individual subparts. The types of stepwise vowel raising shown schematically in (1) can be taken as prototypical of seven-vowel systems with four degrees of vowel height, as in(1a–b), and of five-vowel systems with three degrees of vowel height, as in (1c). The three-link chain shift undergone by the non-high vowels in (1a) occurs in Nzɛbi, a Bantu language of Gabon (Guthrie 1968, Clements 1991: 35–38, Kirchner 1996); the two-step raising patterns in (1b–c) are found in Hispano-Romance: (1b) illustrates mid-vowel raising in Proto-Spanish, while the raising of non-high vowels portrayed in (1c) is found in the Lena dialect of Asturian (northern Spain).[1] For visual clarity, each of the individual raising shifts in (1) is depicted in a different box: raising of (upper) mid vowels to their corresponding high ones is enclosed in a solid line; raising of the lower-mid vowels to the upper mid ones is shown inside a dotted line; finally, raising of low vowels to mid ones is indicated in a broken line.

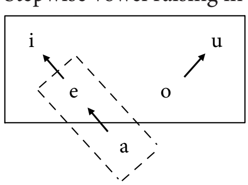
(1) a. Stepwise vowel raising in Nzɛbi:



b. Stepwise vowel raising in Proto-Spanish:



c. Stepwise vowel raising in Lena Asturian:



In all three instances in (1) vowel raising is stepwise because the two individual raising shifts apply in a counterfeeding fashion within the synchronic grammar, the source of a relatively common type of phonological opacity. For example, in Proto-Spanish,

1. Also known as Lena (Asturian-)Leonese or simply Lena *bable* (*bable de Lena*), a modern dialect of Asturian that descends from Old Leonese, the Hispano-Romance variety spoken during the Middle Ages in the kingdom of León, located to the west of the Old Spanish region (see Menéndez Pidal 1906/1990, Zamora Vicente 1996).

the tense mid vowels [e, o], derived from their lax counterparts /ɛ, ɔ/, did not, in turn, shift to high *[i, u]. Likewise, in Lena Asturian [e], derived by /a/-raising does not become *[i].Because they are typically conditioned by high vocoids, stepwise raising shifts in vowel height such as those in (1) are sometimes characterized as *partial vowel-height assimilation* (Clements 1991). In Romance linguistics, such raising phenomena are commonly known as *metaphony* (see Leonard 1978); they generally involve long-distance height assimilation of a stressed vowel to a high vocoid located in the following (word-final) syllable. As we will see later, Hispano-Romance metaphony can be characterized as a restricted type of vowel harmony (cf. Poser 1982), bound to a metrical domain, namely, the word's dominant foot (the foot headed by the vowel bearing primary stress).[2]

There are compelling reasons to assume that each individual raising step in both Proto-Spanish (1b) and Lena Asturian (1c) constitutes a particular manifestation of a more general, unified process of vowel-height assimilation, and not simply two independent (i.e., formally unrelated) processes. If this is indeed the case, an adequate phonological theory should be able to provide the formal mechanism(s) necessary to capture the unitary nature of both metaphony types. The formal challenge typically encountered by serial approaches to providing an adequate unitary account of

2. For general surveys of Romance metaphony, see Schürr (1936, 1964, 1970), Leonard (1978), and more recently, Kaze (1989), and Dyck (1995), and references therein; Rohlfs (1966) and (Maiden 1987, 1991) concentrate primarily on metaphony in Italian dialects. In its most common manifestations, Romance metaphony can be described a restricted type of vowel harmony involving anticipatory height assimilation of the stressed vowel to a high vocoid (vowel or glide) located in the following syllable, quite generally the last syllable of a word. The Proto-Spanish pattern in (1b), in which mid vowels are raised by one degree, is found in certain central Italian dialects, especially the southern dialects of central Italian regions of Lazio, Marche, and Umbria (Leonard 1978), including Servigliano (Kaze 1989, Dyck 1995, 1996, Nibert 1998), Pescasserolli (Saltarelli 1968, 1973), and south Umbrian (Calabrese 1988). In Italian dialectology, this type is often referred to as *arpinate* metaphony. A raising pattern similar to that of Lena Asturian (1c) is found in a number of southern Italian dialects (Leonard 1978, Maiden 1987, 1991). There exist, however, some significant departures from these patterns, primarily involving either the specific phonetic outcome of the metaphonic change (for instance, metaphony of lax mid vowels in many Italo-Romance dialects yields rising diphthongs, instead of tense mid vowels; cf. Leonard 1978, and Maiden 1987, 1991 for further details), or the particular phonological conditioning (for example, in many Italic dialects the phonetic motivation of metaphony is no longer transparent due to a number of historical changes, including lowering and deletion of the triggering high vowel; presumably in such dialects, metaphony can be better analyzed as being conditioned by morphosyntactic features such as number in nouns, and person and tense in verbs). Other metaphony variants attested, but are undoubtedly rarer, include: (a) raising of the upper mid vowels only; (b) complete height assimilation, whereby both lower and upper mid vowels are raised to high, as in Pugliese (Calabrese 1988: 52); and (c) metaphony sometimes is implemented by lowering, instead of raising, of vowel height (in Galician and Portuguese, for example, /o/ is changed to [ɔ] by assimilation to word-final /-a/, as in *form*[ó]*so* 'beautiful-MASC.' vs. *form*[ɔ́]*sa* 'beautiful-FEM.' (Williams 1962: 99, Hualde and Martínez-Gil 1994), but such lowering examples are rather rare; Leonard 1978: 122 labels such lowering *anti-umlaut*). The inventory of metaphonic variations just mentioned is by no means exhaustive; see Leonard (1978), Kaze (1989), and Maiden (1987, 1991) for a more complete taxonomy.

phenomena such as those illustrated in (1) derives from the apparent impossibility of obtaining stepwise raising of vowel height in a direct manner by resorting to the traditional binary vowel height features [high], [low], and [ATR]. For example, raising assimilation of mid vowels in Proto-Spanish (1b) to the trigger vocoid's [+high] specification incorrectly yields complete height assimilation, predicting that all mid vowels targeted by metaphony would become high. Similar considerations would apply to /a/-raising in Lena Asturian. Positing assimilation to the target's [+ATR] specification, on the other hand, is of no avail, because it would wrongly restrict raising to the lower mid vowels (of course, the upper mid vowels are already [+ATR], and therefore assimilation here would be vacuous). Similarly, height assimilation to the [−low] specification of the trigger in Lena Asturian would raise /a/ to a mid vowel, but it would neither produce raising of the mid vowels (which are already [−low]), nor, by itself, the observed concomitant fronting of /a/ to [e]. Attempts to overcome the formal difficulties of capturing the unitary nature of stepwise shifts include the introduction of scalar or multivalued features; such proposals, however, have not succeeded in gaining widespread acceptance among the mainstream of generative work.[3]

Rule-based autosegmental approaches to metaphony that appeal to binary vowel height features have attempted to capture the unitary character of stepwise vowel raising by positing a single rule that spreads the feature [+high] onto the target vowel; a number of *clean-out* rules involving delinking and default assignment of vowel height features are then invoked as repair mechanisms that correct malformed representations whenever these are created by the application of the [+high]-spreading rule. Although this approach accomplishes scalar raising, it does not ultimately succeed in providing an account of metaphony as a unified assimilation phenomenon, since it is typically the delink-and-default repair procedure, not the [+high]-spreading one, that is responsible for the one-step raising of the lower vowel height range (e.g., /ɛ, ɔ/ → [e, o] in Proto-Spanish, and /a/ → [e] in Lena Asturian).[4] As Cole (1998: 73) points out, a significant problem with such a clean-out mechanism is that it ultimately effaces the autosegmental configuration created by the primary [+high]-spreading rule. In sum, the paradoxical aspect of the autosegmental rule-approach lies in the fact that while the assimilatory one step-raising of the upper mid vowels is attained by [+high] spreading, the same process in the lower mid vowels or the low vowel is achieved by effectively obliterating the structural change effected by the spreading rule. In view of these difficulties, it is perhaps not surprising that some phonologists have abandoned altogether the idea that scalar raising shifts such as metaphony should be analyzed as a unified process of vowel-height assimilation (Cole 1998).

There is an alternative interpretation of metaphony, and of scalar vowel height assimilation processes in general, that brings out to light a fundamental insight about

3. See, for example, Wang (1968), Contreras (1969), Smith (1970/1971), Saltarelli (1973), Rivas (1977), Williamson (1977), Lindau (1978), and more recently Ladefoged (1989), Clements (1990, 1991), and Gnanadesikan (1997).

4. Autosegmental analyses of Romance metaphony along this lines include Calabrese (1988), Hualde (1989, 1992), Kaze (1989), Dyck (1995, 1996), and Nibert (1998), among others.

the nature of such phenomena, and which is extremely difficult (if possible at all) to express in a serial account, Namely, they can be better characterized as originating primarily in the conflict between two antagonistic forces presumably always at play in phonological structure. On the one hand, the articulatory inertia that leads to assimilation, which often promotes both the creation of surface alternations and the neutralization of underlying contrast; on the other, the pressure to preserve unaltered in phonetic structure the information encoded in underlying forms (also known by the term *input-output faithfulness* in Optimality Theory), thereby favoring both the avoidance of phonological alternations and the preservation of underlying contrast. When the articulatory factors that lead to assimilation of vowel height override the demand for underlying-surface faithfulness, complete raising takes effect, and the target vowels become high. The fact that this option is relative rare crosslinguisitically is due in part to functional factors, since its adoption can potentially lead to massive neutralization of underlying vowel height contrasts. If, on the other hand, the pressure to preserve underlying structure overrides the articulatory factors that favor assimilation, of course, nothing of interest happens. However, when the demand for satisfying the two opposing forces is relatively balanced, scalar raising emerges as some sort of middle ground compromise: the pull towards assimilation, a force that drives the output away from the input, is kept in check by faithfulness, thus minimizing the distance of the target from its underlying form. In our particular case of the metaphonic shifts, the compromise solution involves allowing raising assimilation to take place while limiting the disparity between underlying and surface forms to a *single* vowel-height feature change. Evidently, there are other factors, for example, markedness considerations such as the prohibition against lax high vowels in Proto-Spanish, that prevent such minimal (one-feature) change from being carried out uniformly by assimilation to [+high] throughout the set of non-low vowels, thereby raising lax mid vowels to high (e.g., /ɛ, ɔ/ → *[ɪ, ʊ]). Instead, raising of the upper mid vowels in Proto-Spanish is obviously achieved by assimilation to [+high], while raising of the lower mid vowels is apparently carried out by assimilation to [+ATR]. Similar considerations would apply to Lena Asturian: here, while raising of the upper mid vowels readily takes place by assimilation to [+high], the requirement of a minimal input-output departure, in conjunction with the lexical prohibition against both central and lax non-high vowels, dictates that the observed raising and fronting of the low vowel (/a/ → [e]) can only come about by assimilation to the [−low] specification of the trigger. In short, although assimilation to vowel height ultimately takes place in surface forms the fact that it is not uniform in terms of binary features results directly from the need to satisfy the requirement of a minimal departure from the corresponding input, as well as any relevant markedness constraints. If this analysis of metaphony is on the right track, one can readily make the argument that serial approaches to phonological derivation are not well equipped to express the balanced tension of the two opposite tendencies allegedly at work in scalar assimilation. By contrast, the formal interpretation of how such conflicts are resolved in the grammar of individual languages is precisely at the programmatic core of Optimality theory, as advocated in Prince and Smolensky (1993 [2004]), McCarthy and Prince (1993b), and much subsequent work.

The analysis of stepwise vowel raising as resulting from the competition between faithfulness and markedness constraints was first fully-articulated within the framework of Optimality Theory by Kirchner (1996) in his account of the Nzɛbi chain-shifts in (1a). Specifically, Kirchner proposes the use of local conjunction of feature identity constraints in order to restrict unfaithfulness in the input-output mapping to at most *one* feature, thus ruling ultimately out potential links in a chain shift involving total vowel height assimilation, such as /ɛ, ɔ/ → *[i,u], involving two feature changes: [−high] → [+high], and [−ATR] → [+ATR]. As Kirchner shows, constraint conjunction provides an adequate formal mechanism to express the individual links of chain shifts in a unified fashion, a result that cannot be matched by competing rule-based analyses.

The main goal of this paper is to argue explicitly for a unified analysis of the Proto-Spanish and Lena Asturian metaphony patterns within the constraint-based framework of Optimality Theory. In our account, vowel raising is enforced by a markedness constraint demanding that the stressed vowel agree in vowel-height features with a following high vocoid within a word's dominant foot. Following closely the account of the Nzɛbi chain shifts presented in Kirchner(1996), stepwise raising in Proto-Spanish and Lena Asturian is achieved by appealing to a local conjunction of identity constraints on contrastive vowel height features, thereby limiting the input-output mapping of such to a single feature change. Finally, both the agreement constraint and the constraint conjunction dominate the individual faithfulness constraints requiring input-output identity of vowel height features. A fundamental aspect of the analysis proposed in this paper is that the two dominant constraints, vowel-height agreement (markedness) and local conjunction (faithfulness), are unranked with respect to each other. The absence of crucial domination is intended to provide a direct formal expression of the balanced tension suggested earlier between faithfulness and markedness in the metaphonic phenomena, ultimately resulting in the stepwise raising of vowel height. This is one aspect in which our analysis of metaphony differs from Kirchner's account of Nzɛbi vowel raising, in which the locally conjoined faithfulness constraints crucially outranks the phonological constraint that enforces vowel raising.

The rest of the paper is organized as follows. Section 2 provides a comprehensive survey of the basic data on metaphony in Proto-Spanish and Lena Asturian. The two most influential rule-based autosegmental accounts of Hispano-Romance metaphony are discussed in Section 3, where it is shown that such an approach is unable to offer a unified account of the phenomenon. In Section 4, following Kirchner (1996), a solution is advanced within the Optimality theoretical model that appeals to the local conjunction of vowel-height feature identity constraints. It is shown that the proposed analysis can be easily modified in order to accommodate a slightly different type of metaphony found in the Nalón Valley dialect variety of Asturian, neighboring Lena (Hualde 1998), in which, unlike Lena, metaphony of /a/ results in the lax round mid vowel [ɔ]. Finally, Section 5 presents a summary and offers some concluding remarks.

2. Proto-Spanish and Lena Asturian metaphony

This section introduces the corpus of basic data on metaphony in both Proto Spanish and Lena Leonese. The discussion of the Proto-Spanish data includes an outline of all the relevant historical details. It is shown that in both instances assimilatory raising is restricted to the prosodic domain defined by the word's dominant foot, thus naturally accounting for the fact that metaphonic raising does not spread beyond the vowel bearing primary stress.

2.1 Metaphony in Proto-Spanish

In order to set Proto-Spanish metaphony within its historical context, it will be useful to review the regular development of stressed vowels from Latin to Spanish. A summary of the relevant historical stages is given diagrammatically in (2), where the Proto-Spanish stage reflects the reconstructed phonemic vowel system prior to the familiar diphthongization of stressed lax mid vowels, as assumed by most Hispano-Romance scholars. The phonemic inventories of the stressed vowels traditionally ascribed to the three relevant stages are given in (3).

(2)

Classical Latin:	iː	i	eː	e	aː	a	oː	o	u	uː
Vulgar Latin:	i	ɪ	e	ɛ	a		ɔ	o	ʊ	u
Proto-Spanish:	i	e		ɛ	a		ɔ	o		u
Old Spanish:	i	e		je	a		we	o		u

(3) a. *Classical Latin*:

i, iː u, uː
e, eː o, oː
a, aː

\>

b. *Vulgar Latin*:

i u
ɪ ʊ
e o
ɛ ɔ
a

\>

c. *Proto-Spanish*:

i u
e o
ɛ (> je) ɔ (> we)
a

Examples illustrating the developments outlined in (2) with some representative Latin-Modern Spanish (*MSp.*) correspondences are given in (4). For visual clarity, the vowel under discussion in (4) and in subsequent examples is shown in boldface in orthographic representations.

(4) General development of the stressed vowels from Latin to Modern Spanish (*MSp.*):

a.	/i/ (< Lat. *ī*) > /i/:			b.	/u/	(< Lat. *ū*) > /u/:	
	Latin	*MSp.*			*Latin*	*MSp.*	
	f**ī**cu	h**i**go	'fig'		f**ū**mu	h**u**mo	'smoke'
	v**ī**ta	v**i**da	'life'		n**ū**du	n**u**do	'knot'
c.	/e/ (< Lat. *ĭ, ē*) > /e/:			d.	/o/ (< Lat. *ŭ, ō*) > /o/:		
	p**ĭ**lu	p**e**lo	'hair		b**ŭ**cca	b**o**ca	'mouth'
	pl**ē**nu	ll**e**no	'full'		s**ō**le	s**o**l	'sun'

e. /ɛ/ (< Lat. *ĕ*) > /je/:

p**ĕ**tra	p**ie**dra	'stone'
m**ĕ**tu	m**ie**do	'fear'

f. /ɔ/ (< Lat. *ŏ*) > /we/:

r**ŏ**ta	r**ue**da	'wheel'
ŏvu	h**ue**vo	'egg'

g. /a / (< Lat. *ā, ă*) > /a/:

pr**ā**tu	pr**a**do	'meadow'
m**ă**nu	m**a**no	'hand'

Of special interest for our purposes are the two vowel lowering changes (henceforth *V-lowering*) that took place in Vulgar Latin and in the transition to Proto-Spanish. The first, apparently general in Vulgar Latin, is related to the loss of the phonemic length distinctions of Classical Latin, which in the spoken language were replaced by lax/tense contrasts: non-low long vowels became tense (or [+ATR]), while the corresponding short ones became lax (or [−ATR]). In a subsequent development, the lax high vowels merged with their tense mid counterparts, yielding the Proto-Spanish vowel system that preceded the diphthongization stage. There is abundant comparative evidence suggesting that the two V-lowering processes must have occurred historically prior to both metaphony and lax mid-vowel diphthongization (see Pensado Ruiz 1984 for extensive discussion). In addition, metaphony clearly must have preceded diphthongization chronologically, since the lax mid vowels affected by the metaphonic raising failed to undergo diphthongization. The historical developments in (2)–(3), together with subsequent metaphony and diphthongization, are summarized in (5), where the given order of these four changes reflects their relative chronology.

(5) Stressed-vowel lowering in Vulgar Latin:

a. First V-lowering:
/e, o/ > /ɛ, ɔ/
/i, u/ > /ɪ, ʊ/

b. Second V-lowering:
/ɪ, ʊ/ > /e, o/

c. Metaphony: /e, o/ → [i, u]; /ɛ, ɔ/ → [e, o]

d. Lax mid vowel diphthongization: /ɛ, ɔ/ > /je, we/

As suggested in (5), the Vulgar Latin lax mid vowels /ɛ, ɔ/ (derived historically by lowering of the Latin short mid vowels /e, o/) underwent metaphonic raising after the lax high vowels (derived historically from Latin short /i, u/) had already merged with the mid ones /e, o/. All relative chronologies we aware of, including those of Eastlack (1976), Hartman (1974), Menéndez Pidal (1980), Pensado Ruíz (1984), and Penny (2002), postulate that V-lowering preceded metaphony. In addition, both V-lowering processes in (5a–b) must have come about chronologically prior to metaphony since in order for the Proto-Spanish lax mid vowels to undergo metaphony they had to be created beforehand by the first V-lowering (5a). Similar considerations apply to the tense mid vowel reflexes of the Vulgar Latin high lax vowels bought about by the second V-lowering (5b).

Turning now to Proto-Spanish metaphony, this change is traditionally described as a process of anticipatory stepwise raising of vowel height (cf. Penny 2002: 47–51) that primarily affected stressed vowels when followed by a *yod* in the next syllable (quite generally, the last syllable of a word; see Krepinski 1962, Blaylock 1965, Foster 1967/68, Craddock 1980, Menéndez Pidal 1980, Lloyd 1987, Penny 1991, 2002, among others). The term *yod* is used in historical Romance linguistics to refer to a high front vocoid (a high vowel or a glide) derived historically from a variety of sources.[5] The most common type of yod responsible for the metaphonic shifts of Proto-Spanish stressed non-low vowels is an onglide located in the final syllable of a word. It came about in spoken imperial Latin by a systematic process of desyllabification of an unstressed short front vowel /e, i/ (*ĕ*, *ĭ*) immediately followed by a word-final vowel in proparoxitonic forms, as illustrated in (6). Thus compare the final heterosyllabic (also heteromorphemic) vowel sequence in Classical Latin *fŏ.lĭ.a* 'leaves' in (6a) (periods indicate syllable boundaries) with the tautosyllabic one in its corresponding reconstructed Vulgar Latin form **fo.l*[j]*a*. Desyllabification applied across morphological categories: in non-verb forms (6a), it targetted a stem-final front vowel (e.g., {*fŏ. lĭ*}- *a*); in verb forms (6b), it applied to the front theme vowel of the first person singular of the present, indicative and subjunctive, of the second, third, and fourth conjugations.

(6) Front-vowel desyllabificacion:

a.	*ClLat.*	*VLat.*		*ClLat.*	*VLat.*	
	fŏ. lĭ. a	fo. l[j]a	'leaves'	fŏ. vĕ . a	fo. v[j]a	'pit'
	pŏ. dĭ.u	po. d[j]o	'stone bench'	cē. rĕ . u	ce. r[j]o	'wax candle'
	la. bĭ. u	la. b[j]o	'lip'	a. rā. nĕ. a	a. ra. n[j]a	'spider'
b.	fŭ. gĭ. ō	fu. g[j]o	'I flee'	vĭ. dĕ. ō	vi. d[j]o	'I see'
	sĕn. tĭ. ō	sen. t[j]o	'I feel'	ha. bĕ. ō	ha. b[j]o	'I have'
	dŏr. mĭ. ō	dor. m[j]o	'I sleep'	im. plĕ. ō	im. pl[j]o	'I fill, cram'

From a historical point of view, a major consequence of metaphony was the disruption of the regular phonetic evolution of the Proto-Spanish stressed mid vowels (cf. (4c–f)). For example, by shifting their height one step up, metaphony prevented the otherwise regular process of lax mid-vowel diphthongization. A representative sample of the Proto-Spanish metaphonic shifts outlined earlier in (1b) (= (5c)) is provided by the Latin-Old Spanish (*OSp.*) correspondences in (7).[6]

5. The major historical sources of yod in Hispano-Romance are discussed in Menéndez Pidal (1964, 1980); further reelaborations and discussion can be found in Malkiel (1966), Foster 1967/68), Craddock (1980), Lloyd (1987), and Penny (1991, 2002).

6. In items such as *lĭmpĭdu* > *limpio* 'clean', and *tŭrbĭdu* > *turbio* 'cloudy' the early loss of the intervocalic /d/ left the preceding high vowel in contact with a following (word-final) vowel; this vowel also underwent desyllabification, and the resulting yod triggered raising of the preceding stressed vowel. In verb forms there are numerous counterexamples to metaphony which can be readily explained as the result of analogical leveling. In addition, in a handful of examples metaphony unexpectedly failed to occur, as in *corrĭgĭa* 'shoe lace' > (Osp.) *correya* 'leatherbelt, strap' (MSp. *correa*), *sŏmnĭu* > (OSp.) *sueño* 'dream', *calumnia* > (OSp.) *caloña* 'false accusation' *cĭlĭa* 'eyelids' > *ceja* 'eyelid', and *cuscŭlĭu* > *coscojo* 'kermes-oak gall'. According to the traditional view, in these items the yod palatalized the preceding consonant before it was lost at a stage prior to the advent of metaphony (the term traditionally used for yod loss in this context is *yod absorption*: the yod is *absorbed* by the palatal consonant). The problem with this account is that there are other items in Old Spanish also exhibiting a yod-triggered palatal consonant, in which metaphony must have preceded yod absorption: *ingĕnĭu* > *engeño*, *hŏdĭe* >*hoy* 'today', *cŭnĕa* > *cuña*, *navĭgĭ*u > *navío*, etc. In some forms metaphony seems to have involved complete assimilation (i.e., a two-degree raising of vowel height instead of one). Harris (1975)

(7) a. /e/ (< Lat. *ĭ*, *ē*) > /i/: b. /o/ (< Lat. *ŭ*, *ō*) > /u/:

Latin	*OSp.*		*Latin*	*OSp.*	
m**ĭ**lĭu	m**i**jo	'millet'	pl**ŭ**vĭa	ll**u**via	'rain'
l**ĭ**mpĭ(d)u	l**i**mpio	'clean'	c**ŭ**nĕa	c**u**ña	'wedge'
t**ĭ**nĕa	t**i**ña	'ringworm'	f**ŭ**gĭō	h**u**yo	'I flee'
v**ĭ**trĕu	v**i**drio	'glass'	r**ŭ**bĕu	r**u**bio	'blond'
vind**ē**mĭa	vend**i**mia	'wine harvest'	*vit**ō**nĕu	vid**u**ño	'grapevine'
s**ē**rvĭō	s**i**rvo	'I serve'	p**ŭ**tĭ(d)u	p**u**dio	'rotten'
s**ē**pĭa	x**i**bia	'cuttlefish'	**ō**rdĭu	**u**rdo	'warp'
c**ē**rĕu	c**i**rio	'wax candle'	*terr**ō**nĕu	terr**u**ño	'native soil'

discusses a type of raising, which he calls *third conjugation metaphony,* which apparently involves total height assimilation of the lower mid vowels to a yod in a small number of third conjugation verbs ([ɛ, ɔ] > [i, u]), as in ***sĕrvĭō*** > ***sirvo*** 'I serve', ***mŏllĭō*** > ***mullo*** 'I soften, fluff up', ***sĕntiāmus*** > ***sintamos*** 'we feel-SUBJ.', ***dŏrmiāmus*** > ***durmamos*** 'we sleep-SUBJ'; Harris is careful to distinguish this type of raising from that illustrated in (7)–(8), which he labels *phonetic metaphony*, because the former is heavily morphologized: it applies only within the third conjugation class, and the triggering yod is invariably the theme vowel. Other authors, however, have questioned the existence of third conjugation metaphony as a single sound change, positing instead an intermediate stage of diphthongization (Lloyd 1987: 293). In the latter view, the high vowel reflexes only came about as the final stage of historical development, namely, by monophthongization of the diphthongs, through a process of analogical leveling that related stem high vowels to the third conjugation class. Old Spanish dialectal variants such as *sierven*, *pieden* (Mod. Sp. *sirven*, *piden*), discussed by Malkiel (1966: 454–456) provide compelling evidence of such an intermediate state of diphthongization. There is at least one well-known example involving a non-verb form that apparently exhibits a two-step raising: ***tĕpĭdu*** > ***tibio*** 'lukewarm' (not **tebio*). Penny (2002: 49) assumes that here too the stressed vowel first underwent diphthongization and then monophthongized to /i/ under the pressure from the flanking yods: ***tĕpĭdu*** > [tjébjo] > ***tibio***. Finally, in a sizable number of lexical items in which the yod is almost invariably preceded by either a voiceless dental or a velar stop, were not affected by metaphony, even though the structural conditions that determined the process were apparently met. A representative sample is given in (i) (OSp. *z* = /d^{z}/, and *ç* = /t^{s}/).

(i) a. /e/ (< Lat. *ĭ*, *ē*): b. /o/ (< Lat. *ŭ*, ō):

Latin	*OSp.*		*Latin*	*OSp.*	
v**ĭ**tĭu	v**e**zo	'blemish'	l**ŭ**tĕa	l**o**za	'earthenware'
mal**ĭ**tĭa	mal**e**za	'underbrush'	p**ŭ**tĕu	p**o**zo	'well'
*cort**ĭ**cĕa	c**o**rt**e**ça	'rind'	**ŭ**rcĕa	**o**rça	'pitcher'
pigr**ĭ**tĭa	per**e**za	'laziness'	arb**ŭ**tĕu	alb**o**rço	'strawberry tree'

c. /ɛ/ (< Lat. *ĕ*) > /je/: d. /ɔ/ (< Lat. *ŏ*)> /we/:

*p**ĕ**ttĭa	p**ie**ça	'piece'	f**ŏ**rtĭa	f**ue**rça	'strength'
c**ĕ**rcĭu	c**ie**rço	'north wind'	post-c**ŏ**ccĕu	pesc**ue**ço	'neck'
l**ĕ**ntĕu	l**ie**nço	'fabric'	sc**ŏ**rtĕu	esc**ue**rço	'toad'
b**ĕ**ttĭu	b**ie**zo	'birch'	t**ŏ**rquĕo	t**ue**rzo	'I bend'

There is general agreement among historical linguists of Spanish that the examples in (i) do not actually constitute exceptions to metaphony, but simply instances in which the yod affricated/ palatalized the preceding consonant and then it was deleted before it could exert its metaphonic effect on the preceding stressed vowel.

c.	/ɛ/ (< Lat. *ĕ*) > /e/:			d.	/ɔ/ (< Lat*ŏ*) > /o/:		
	m**ĕ**dĭu	m**e**yo	'half-MASC'		m**ŏ**dĭu	m**o**yo	(measure)
	sup**ĕ**rbĭa	sob**e**rvia	'vainglory'		f**ŏ**vĕa	f**o**ya	'small ditch'
	n**ĕ**rvĭu	n**e**rvio	'sinew'		p**ŏ**dĭu	p**o**yo	'stonebench'
	ing**ĕ**nĭu	eng**e**ño	'invention'		sp**ŏ**lĭu	desp**o**jo	'spoils'
	*pr**ĕ**mĭu	pr**e**mio	'prize'		n**ŏ**vĭu	n**o**vio	'bridegroom'
	s**ĕ**dĕat	s**e**ya	'I am-SUBJ'		m**ŏ**llĭo	m**o**jo	'I wet, drench'
	t**ĕ**nĕo	t**e**ngo	'I have'		cord**ŏ**lĭu	cord**o**jo	'heartache'
	v**ĕ**nĭo	v**e**ngo	'I come'		f**ŏ**lĭa	h**o**ja	'leaf'

Another major source of metaphony in Proto-Spanish is a word-final nuclear /i/, generally derived from Latin long /iː/, in a morphologically restricted class of words, namely, the first person singular of Latin strong preterits, as well as a handful of singular imperative forms, before it subsequently underwent lowering (and shortening) to /-e/ by regular sound change, as illustrated by the Latin-Old Spanish correspondences in (8) (cf. Lloyd 1987: 308). Evidently, metaphony in all such cases must necessarily have taken place prior to word-final /i/-lowering.[7]

(8) a.	/e/ (< Lat. *ĭ, ē*) > /i/; /o/ (< Lat. *ŭ, ō*) > /u/:						
	Latin	*OSp.*			*Latin*	*OSp.*	
	f**ē**cī	f**i**ze	'I did, made'		c**ĭ**nxī	c**i**nxe	'I girded'
	v**ē**nī	v**i**ne	'I came'		trad**ŭ**xī	trad**u**xe	'I translated'
	st**ē**tī	est**i**de	'I was, stood'		p**ō**sŭī	p**u**se	'I placed'
	d**ē**dī	d**i**	'I gave'		cogn**ō**vī	con**u**vo	'I knew'
	t**ĭ**nxī	t**i**nxe	'I dyed'				
b.	/ɛ/ (< Lat. *ĕ*) > /e/;		/ɔ/ (< Lat. *ŏ*) > /o/:				
	Latin	*OSp.*			*Latin*	*OSp.*	
	v**ĕ**nī	v**e**n	'come!'		p**ŏ**tuī	p**u**de	'I was able'
	t**ĕ**nī	t**e**n	'have!'		c**ŏ**xī	c**o**xe	'I cooked'
	qu**ae**sī	qu**i**se	'I wanted'				

In sharp contrast with the mid vowels, the Proto-Spanish low vowel /a/ (< Lat. *ā, ă*), consistently failed to undergo metaphony under identical phonological conditions, as shown in (9).[8]

7. The dative marker *-ī* also exerted a metaphonic effect on the vowel of the personal pronouns *mĭhī* > *mí* 'to me' *tĭbī* > *tí* 'to you', *sĭbī* 'to him/her/them' (Penny 2002: 51). In addition, the Modern Spanish forms *estuve*, *cocí*, corresponding to Old Spanish *estide*, *coxi* in (8), respectively, are analogical. As for the apparent two-step rising of the root vowel in *pŏtuī* > *pude*, and *pŏsuī* > *puse* in (8b), Penny (2002: 226), following the suggestion by Menendez Pidal (1980: 316) that the exceptional two-step raising in these forms is triggered by the metathesis of the root-final round glide, and subsequent raising of raising of the root vowel: /pɔ́twi/ > */pɔ́wti/ > (OSp.) *pude*, where the root vowel /ɔ/ "was doubly raised to /u/ by the effect of the following glide [w] and the final ī." Lloyd (1987: 308) attributes such two-step raising changes to analogical extension.

8. It should be made clear that in this paper the term *metaphony* when referred to Proto-Spanish is used exclusively to designate the process of *long-distance* scalar raising of vowel height illustrated in (7)–(8), in which the stressed vowel undergoes anticipatory assimilation to a high vocoid in the following syllable. The common practice among Spanish historical linguists is to consolidate the meta-

(9)

Latin	OSp.		Latin	OSp.	
labĭu	labio	'lip'	grandĭa	grança	'bran (grain)'
palĭa	paja	'straw'	*rabĭa	rabia	'rage'
aranĕa	araña	'spider'	fagĕa	faya	'beech tree'
cavĕa	gavia	'topsail'	alĭu	ajo	'garlic'
badĭu	bayo	'bay (horse)'	exagĭu	ensayo	'attempt'

There is solid evidence metaphony was a *synchronic* phonological process at some early stage in Proto-Spanish, and not simply a historical change, as suggested by the presence of common Old Spanish alternations involving the shifted vs. the unshifted reflexes of the Proto-Spanish mid vowels, a representative sample of which is shown in (10): (10a) contains examples of the shifted ([i, u]) and the unshifted ([e, o]) alternants of the Proto-Spanish tense mid vowels /e, o/, while (10b) illustrates the mid-vowel vs. rising diphthong reflexes [e] ~ [je] (< PSp. /ɛ/) and [o]~ [we] (< PSp. /ɔ/) of the lax mid vowels; the first member of each alternating pair in (10) reflects the metaphonic raising of the stressed vowel, while the second exhibits the regular historical development.

phonic shifts in (7)–(8) with other cases of yod-induced vowel raising, lumping them together under the unifying term *inflexión* ('vowel raising'), following the original classification by Menéndez Pidal (1980), in which Proto-Spanish vowel raising is analyzed in terms of four general types of triggering yod according to its historical source. It should be pointed out that although metaphony constitutes a particular manifestation of vowel raising, there are many instances of vowel raising that do not involve metaphony. The distinction between metaphony and other types of vowel raising in Proto-Spanish is justified on both phonological and historical grounds. From a phonological perspective, for example, the low vowel /a/ is never affected by metaphony, as illustrated in (9), but it did regularly undergo raising and fronting to /e/ when in direct contact with following tautosyllabic yod, derived historically either by vocalization of a velar coda consonant (*lacte* > **la*[*j*]*te* > *leite* > (OSp. *leche* 'milk'), or by metathesis of a desyllabified front vowel and a preceding consonant (generally /r/, /s/, and /p/) whereby the yod migrates from the final to the penultimate syllable: *carrārĭa* > **carra*[*j*]*ra* > *carreira* > (OSp.) *carrera* '(cart) road'. Notice that the stages *leite*, *carreira* are still found in modern Galician-Portuguese). Similarly, although a *waw* (i.e., the back round glide /w/) almost never triggers metaphony, it did regularly raised and rounded a preceding /a/ > /o/, a sound change that many date back to spoken imperial Latin: *auru* > *ouro* > (OSp.) *oro*, 'gold', *causa* > *cousa* > (OSp.) *cosa* 'thing' (again, the stage *ouro*, *cousa* is still retained in modern Galician and Portuguese). From a historical point of view, the metaphonic shifts in (7)–(8) are undoubtedly unrelated to the /a/-raising shifts in contact with a following yod/waw: while the former took place in the proto-language, the latter are more recent. For example, unshifted variants of /a/ such as *layte*, *carrayra* are still recorded in Mozarabic documents of the 10th and 11th centuries (Galmés de Fuentes 1983, Zamora Vicente 1996: 33–35). Finally, long-distance vowel-raising by a yod does not *per se* entail metaphony. Thus, historically unrelated to the developments illustrated in (7)–(8)) are well-known examples of long-distance anticipatory assimilation of an unstressed vowel to a yod located in the stressed syllable, both when the yod is primary (*mŭlīĕre* > (OSp.) *mugier* 'woman', *pŭnctione* > (OSp.) *punçón* 'punch, awl', *tōnsione* > (OSp.) *tusón* 'fleece', *rēnione* > (OSp.) *riñón* 'kidney'), or secondary, te generally created by the diphthongization of stressed /ɛ/ > /je/ (*sēmĕnte* > *semiente* > (OSp.) *simiente* 'seed', *fĕnĕstra* > *feniestra* > (OSp.) *finiestra* 'window', *dĕcĕmbre* > *deciembre* > (OSp.) *diciembre* 'December', *gĕnĕsta* > *geniesta* > (OSp.) *hiniesta* 'broom plant' (notice that in the last three items there are two formally independent raisings; the shift /ɛ/ > /e/ in a first stage results from the regular neutralization of lower mid vowels in stressless syllables, while the final /e/ > /i/ raising is due to assimilation to the following yod).

Such alternations are heavily lexicalized in most cases, due in part to the historical loss of the triggering yod, as is typically the case in verb forms. The emergence of many other potential alternations, specially in verb forms, was thwarted by levelling analogical change.[9]

(10) a. Old Spanish shifted [i, u] vs. unshifted [e, o] (< Lat. *ĭ, ē*, and *ŭ, ō*, respectively)):

ç**i**rio ~ ç**e**ra	'wax' ~ 'wax candle'	ll**u**via ~ ll**o**ver	'rain (N.)' ~ 'to rain'
t**i**nxe ~ t**e**ñir	'I dyied' ~ 'to dye'	s**u**bo ~ s**o**bes	'I climb' ~ 'you climb'
c**i**nxe ~ c**e**ñir	'I girded' ~ 'to gird'	c**u**mplo ~ c**o**mples	'I fulfill' ~ 'you fulfill'
incho ~ **e**nchir	'I cram' ~ 'to cram'	s**u**ffro ~ s**o**ffres	'I suffer' ~ 'you suffer'
f**i**ze ~ f**e**ziste	'I did' ~ 'you did'	con**u**ve ~ con**o**çes	'I knew' ~ 'you know'
m**i**do ~ m**e**dir	'I measure' ~ 'to measure'	f**u**yo ~ f**o**es	'I flee' ~ 'you flee'

b. Old Spanish shifted [e, o] vs. unshifted [je, we] (< Lat. *ĕ, ŏ* respectively):

v**e**ngo ~ v**ie**nes	'I come' ~ 'you come'	n**o**vio ~ n**ue**vo	'newly wed ~ 'new
t**e**ngo ~ t**ie**nes	'I have' ~ 'you have'	c**o**xe ~ c**ue**ço	'I baked' ~ 'I bake'
s**e**yo ~ s**ie**yes	'I am' ~ 'you are'		

Finally, the data in (7)–(8) shows that Proto-Spanish metaphony was limited to a very specific prosodic domain, the dominant foot (F_Σ) of a word; clearly, its domain did not extend to the prosodic word (ω), as often found in other vowel-harmony processes, since pretonic vowels remained unaffected by metaphony, as shown in (11) (the boundaries of the relevant prosodic domain in the reconstructed Proto-Spanish forms are indicated in parenthesis; stress marks are provided for clarity):

(11)

Latin	*PSp.*		
vind**ē**mĭa	ven.(d**í**.mia)$_{F_\Sigma}$	'wine harvest'	not *(v**i**n.d**í**.mia)$_\omega$
sup**ĕ**rbĭa	so.(b**é**r.bia)$_{F_\Sigma}$	'vainglory'	not *(s**u**.b**é**r.bia)$_\omega$

2.2 Metaphony in Lena Asturian

The Lena dialect of Asturian-Leonese exhibits the five-member underlying vowel inventory in (1c): /i, u, e, o, a/. The stressed non-high vowels /e, o, a/ in this dialect undergo the stepwise raising shifts in (1c), triggered in most cases by the word-final masculine count marker /-u/;[10] accordingly, mid vowels are raised to high, and the low vowel /a/ is raised and fronted to /e/ (see Menéndez Pidal 1906/1990, Neira Martínez

9. As reflected in (10), such Old Spanish morphophonemic alternations are statistically more common in verb forms. A number of them have been preserved in the modern language, but many others have been eliminated by the extensive analogical leveling undergone by verbal paradigms in the transition to Modern Spanish. The scarcity of examples involving morphophonemic alternations in verb roots containing lower mid vowels in (10b) is also due to the regularizing effect of analogical leveling in the transition to Old Spanish. Note, furthermore, that both [i] ~ [e] ~ [je] alternations can sometimes be found in the same verb: *vine* 'I came' ~ *vengo* 'I come' ~ *vienes* 'you come'.

10. The final vowel /i/ can also trigger metaphony in Lena Asturian, as shown by examples such as *esta*; 'this one-FEM.' vs. *isti* 'this one-MASC.', *abro* 'I open', vs. *ebri* '(s)he opens', suggesting that the conditioning environment is, quite generally, a high vocoid. We are purposely oversimplifying the facts here because the examples illustrating metaphony by /i/ in the consulted sources are relatively scarce, in sharp contrast to those triggered by /u/.

1955, Hualde 1989, 1992, Kaze 1989, and Dyck 1995, among others). Illustrative examples, recorded in phonetic transcription, are given in (10).

(12) a. /e, o/ → [i, u]:

masc. sing.	*masc. pl.*	*fem. sing*	
nínu	nénos	néna	'child'
bwíno	bwénos	bwéna	'good'
korðíru	korðéros	korðéra	'lamb'
trwíβanu	trwéβanos	–	'beehive'
kúšu	kóšos	kóša	'cripple'
tˢúβu	tˢóβos	tˢóβa	'wolf '
palúmbu	palómbos	palómba	'dove'

b. /a/ → [e]:

gétu	gátos	gáta	'cat'
bléŋku	bláŋkos	bláŋka	'white'
beṇténu	beṇtános	beṇtána	'window'
péšaru	pášaros	pášara	'bird'
kéṇdanu	káṇdanos	–	'dry branch'

Although metaphonic raising in Lena Asturian occurs almost exclusively in masculine singular count forms, the process is not morphologically conditioned, as Hualde (1992, 1998) points out. In support of this assessment, Hualde presents two pieces of evidence. First, there are a handful of forms in which metaphony is triggered by word-final vowel /-i/, instead of /-u/ (cf. note 10); and second, masculine singular count forms that exceptionally end in a vowel other than /-u/ do not exhibit metaphony (cf. *toro* 'bull', not **túro*).

A remarkable property of Lena Asturian metaphony is that in forms with antepenultimate stress, such as *trwíβanu* 'beehive' in (12a), or *péšaru* 'bird' in (12b), the vowel located intervening between the stressed vowel and the triggering /-u/ (/a/ in all instances; no examples of /e/ or /o/ are provided by the primary data sources) is *transparent t*o raising, in the sense that it neither undergoes nor blocks metaphony (i.e., we do not find **trwíβenu*, **péšeru*). We will return to this interesting issue in our discussion of autosegmental serial approaches to metaphony in Section 3.2.Furthermore, as it was the case in Proto-Spanish, there are good reasons to conclude that metaphony in Lena Asturian is restricted to the dominant foot of a word, since pretonic vowels fail to undergo raising, as can be seen in (13).

(13)

béṇ.(té.nu)$_{F_\Sigma}$	'window'	not *(biṇ.té.nu)$_\omega$
kor.(ðí.ru)$_{F_\Sigma}$	'lamb'	not *(kur.ðí.ru)$_\omega$
pa.(lúm.bu)$_{F_\Sigma}$	'dove'	not * (pe.lúm.bu)$_\omega$

3. Serial accounts of metaphony

In this section, evidence is put forward which demonstrates that the stepwise raising of vowel height observed in the Proto-Spanish and Lena Asturian metaphony processes must be regarded a unitary assimilation phenomenon, a generalization that must be adequately captured by any theory claiming to attain descriptive adequacy. We then discuss the typical rule-based autosegmental approaches to metaphony that appeal to the traditional binary vowel-height features [high], [low] and [ATR], and conclude that they fail to capture adequately the unitary nature of metaphony.

3.1 Proto-Spanish and Lena Asturian metaphony as unified assimilation

Our main objective at this point is to show that each of the two individual links in the Proto-Spanish and Lena Asturian metaphonic shifts, repeated for convenience in (14) and (15), respectively, are indeed individual manifestations of one and the same assimilatory phenomenon. Consider metaphony with a corresponding formulation in terms of standard segmental rules. Our primary focus here is each rule's structural change, stated by means of distinctive features.

(14) Proto-Spanish metaphony:

a. Upper mid-vowel raising (*UMVR*):

$$/\text{é, ó}/ \rightarrow [\text{í, ú}] = \begin{bmatrix} \acute{\text{V}} \\ -\text{low} \end{bmatrix} \rightarrow [+\text{high}] \;/\_\_ \begin{Bmatrix} \text{C j V \#} \\ \text{C i \#} \end{Bmatrix}$$

b. Lower mid-vowel raising (*LMVR*):

$$/\text{ɛ́, ɔ́}/ \rightarrow [\text{é, ó}] = \begin{bmatrix} \acute{\text{V}} \\ -\text{low} \end{bmatrix} \rightarrow [+\text{ATR}] \;/\_\_ \begin{Bmatrix} \text{C j V \#} \\ \text{C i \#} \end{Bmatrix}$$

(15) Lena Asturian metaphony (cf. note. 10):

a. Mid-vowel raising (*MVR*):

$$/\text{é, ó}/ \rightarrow [\text{í, ú}] = \begin{bmatrix} \acute{\text{V}} \\ -\text{low} \end{bmatrix} \rightarrow [+\text{high}] \;/\_\_\,\text{C} \begin{bmatrix} \text{V} \\ +\text{high} \end{bmatrix} \#$$

b. Low-vowel raising (*LVR*):

$$/\text{á}/ \rightarrow [\text{é}] = \begin{bmatrix} \acute{\text{V}} \\ -\text{high} \end{bmatrix} \rightarrow \begin{bmatrix} -\text{low} \\ -\text{high} \end{bmatrix} \;/\_\_\,\text{C} \begin{bmatrix} \text{V} \\ +\text{high} \end{bmatrix} \#$$

Phonological theories based on serial derivations have utilized a number of basic criteria in order to determine the underlying unity of two or more phonological rules. For example, Kenstowicz and Kisseberth (1979: 379–383) designate formal similarity and adjacent ordering as the primary sources of internal evidence, the primary type of motivation in support of a given phonological analysis. In the two cases under consideration, formal similarity provides the most compelling argument for underlying unity. Consider, first, the two raising shifts in Proto-Spanish metaphony: (a) the input in both is the class of mid vowels; (b) they share the structural change: stepwise raising of vowel height; (c) they both apply in exactly the same conditioning environment (a high vocoid located in the word's final syllable); and finally, (d) they are both circumscribed to the same prosodic domain, the word's prominent foot. Clearly, they are manifestations of the same general process, rather than two independent rules. Similar considerations apply to Lena Asturian metaphony. As for adjacent ordering, there is some synchronic evidence of metaphony's interaction with other phonological processes in Proto-Spanish. Lower mid-vowel raising bled diphthongization, as already mentioned. On the other hand, the relative chronology of metaphony and word-final *-ī* lowering (cf. (8) above) shows conclusively that both upper and lower mid-vowel raising had already come about prior to the stage in which word-final high vowels underwent lowering. Finally, it is also reasonably well established that both metaphonic shifts took place around the same historical stage in Proto-Spanish (cf. Craddock 1980). In the face of such evidence, the burden of proof undoubtedly falls on an account claiming that two phonological processes sharing so many properties in common are in fact unrelated phenomena.[11]

Having established beyond reasonable doubt that the stepwise metaphonic chain shifts are a unified phenomenon, a rule-based analysis must be able to collapse them in a single formal statement. Within the earlier segmental generative model, this would be accomplished by the aid of complex rule schemata. In any event, whatever formal mechanism is utilized to collapse the two individual rules, it must be ensured that they apply in a counterfeeding order, a typical instance of opaque rule interaction. Rule-based theories commonly deal with such cases of opacity by means of extrinsic ordering, in our particular case, by stipulating that UMVR must apply before LMVR. Thus, as illustrated in (16), the tense mid vowels derived by LMVR do not in turn undergo UMVR (cf. (16a)); if the rules were ordered in an intrinsic (i.e., feeding) manner, nothing would

11. Cole's (1998) intriguing *deconstruction* analysis explicitly argues against metaphony as a unitary assimilation phenomenon, and proposes instead that it encompass two distinct mechanisms or *phases*. The first phase, essentially analogous to the [+high]-spreading rule of autosegmental approaches, is phonological in nature; it consists of a process of (long-distance) assimilation to the [+high] value of the trigger vocoid, and targets exclusively the upper mid vowels, turning them in to high ones. The second phase is allegedly of a merely phonetic nature, and involves an ensuing *drag-chain* that raises by one step the lower mid/low vowels, thereby filling the phonetic space left vacant by raising of their upper mid counterparts, following the functionally-based dynamics of sound change often observed in diachronic shifts (cf. Martinet 1952, 1955). Cole's hypothesis rests almost entirely on the observation that raising of the upper mid-vowels is apparently more common than raising of the lax mid or low ones, with the additional implication that there are languages in which the upper mid vowels undergo metaphonic raising, while the lax mid/low ones do not, but the converse does not seem to occur. We find three problems with Cole's analysis. First, since in this author's proposal the two links in a metaphonic chain involve formally independent operations, the overwhelming formal similarity between the two raising processes (discussed at the outset of this section) would have to be attributed to a mere accident, a position difficult to defend. Second, in Cole's analysis metaphony of the lower vowels stands in a direct cause-effect relationship with metaphony of the upper mid vowels, in that implementation of the latter is viewed as a *sine qua non* condition for the emergence of the former; thus, one would naturally expect to find evidence in either Proto-Spanish or Lena Asturian for an intermediate stage in which the upper mid/mid vowels have undergone raising while the lower mid/low counterparts remain unshifted. As far as we can determine, no such evidence can be found. Third, and most importantly, to characterize the raising of the upper mid vowels as a *phonological* process proper, and the raising of the lax mid/low vowels as a drag-chain *phonetic* side-effect, seems arbitrary. In fact, why not characterize it the other way round, and say that raising of the upper mid vowels is the (push-chain) phonetic result the phonological assimilation of the lax mid/low vowels to the advanced tongue root value of the trigger vocoid?

prevent the output of LMVR (13b) from being raised all the way to high, thus wrongly deriving complete height assimilation (cf. (16b)). The same reasoning can be applied, *mutatis mutandis*, to the metaphonic shifts in Lena Asturian, as illustrated in (17).

(16) a. Counterfeeding order: b. Feeding order:

Input:	/e, o/	/ɛ, ɔ/	*Input*:	/e, o/	/ɛ, ɔ/
1. *UMVR*:	i, u	–	1. *LMVR*:	–	e, o
2. *LMVR*:	–	e, o	2. *UMVR*:	i, u	i, u
Output:	i, u	e, o	*Output*:	i, u	*i, u

(17) a. Counterfeeding order: b. Feeding order:

Input:	/e, o/	/a/	*Input*:	/e, o/	/a/
1. *MVR*:	i, u	–	1. *LVR*:	–	e
2. *LVR*:	–	e	2. *MVR*:	i, u	i
Output:	i, u	e	*Output*:	i, u	*i

While the standard segmental model provides a wide variety of mechanisms to collapse two or more formally-related phonological rules, none of them can adequately combine each of the two-step chains in (14)–(15) into a single statement, such that the individual rules in each case to apply in the required order. In view of such difficulties, the task of collapsing a three-step shift such as that found in Nzɛbi would seem all but intractable.

3.2 Metaphony in autosegmental approaches that appeal to standard vowel height features

Having laid out the basic facts about Proto-Spanish and Lena Asturian metaphony, let us now consider a serial analysis within the more recent autosegmental framework. We may start with a characterization of the two vowel systems in terms of fully specified contrastive features, including vowel height, as in (18a) for Proto-Spanish, and (19a) for Lena Asturian. Following the theory of radical underspecification (Kiparsky 1982, 1985, Archangeli 1984, 1988, and much subsequent work), let us assume minimal specification of the two systems at the underlying level, as in (18b) and (19b), respectively. The fully specified in (18a) and (19a) are obtained by applying the relevant default rules in (20) (i.e., (20a–e) for Proto-Spanish, and (20a–c) for Lena Asturian).[12]

12. Of course, there are other possible ways of minimally specifying the inventories in (18)–(19). For example, we might take the features [high] and [low] to be privative, not equipollent, as in Kaze 1989, or Dyck 1995, 1996. The choice does not affect the basic force of the arguments to be made in this paper against a rule-based approach to metaphony. The default rules in (20) are justified on the grounds that in both Proto-Spanish and Lena Asturian [e] is the default vowel (the vowel that typically emerges in epenthesis processes). Notice that such default rules would be unnecessary if vowel height features are treated as privative; namely, the lack of any specification for [high] and [low] would be the trademark of upper mid vowels. This simplification, however, would be inconsequential, since default rules by definition come at no cost in individual grammars.

(18) Proto-Spanish underlying vowel system

a. Fully specified:

	i	u	e	o	ɛ	ɔ	a
[high]	+	+	–	–	–	–	–
[low]	–	–	–	–	–	–	+
[ATR]	+	+	+	+	–	–	+
[round]	–	+	–	+	–	+	–

b. Minimally specified:

	i	u	e	o	ɛ	ɔ	a
[high]	+	+					
[low]							+
[ATR]					–	–	
[round]		+		+		+	

(19) Lena Asturian underlying vowel system

a. Fully specified:

	i	u	e	o	a
[high]	+	+	–	–	–
[low]	–	–	–	–	+
[round]	–	+	–	+	–

b. Minimally specified:

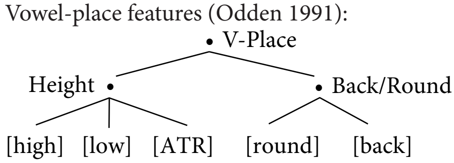
	i	u	e	o	a
[high]	+	+			
[low]					+
[round]		+		+	

(20) a. [ ] → [–high]
b. [ ] → [–low]
c. [ ] → [+ATR] / ___, –low]
d. [ ] → [–ATR] / ___, +low]
e. [ ] → [–round]

Rules (20a–d) assign the default vowel height features; (20e) does so for [round]. The analysis in (18)–(20) is based on the fact that the default vowel (the vowel that emerges in epenthesis processes) is invariably [e] in both Proto-Spanish and Lena Asturian.

For expository purposes, let us assume, following Odden (1991), that vowel place features are organized in the feature hierarchy according to the partial representation in (21). As far as we can determine, the particular vowel feature geometry chosen here is not crucial for the discussion of the issues addressed in this section.

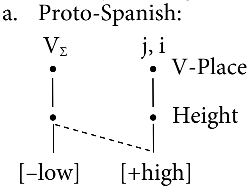
(21) Vowel-place features (Odden 1991):



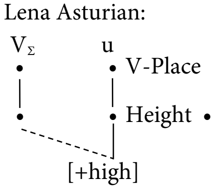
One of the fundamental assumptions of autosegmental phonology is that all assimilation processes are to be expressed by feature spreading. Within this premise in mind, a preliminary autosegmental alternative to the rules in (14)–(15) is given in (22) (V_{Σ} = the target stressed vowel).

(22) Metaphony as [+high]-spreading:

a. Proto-Spanish:



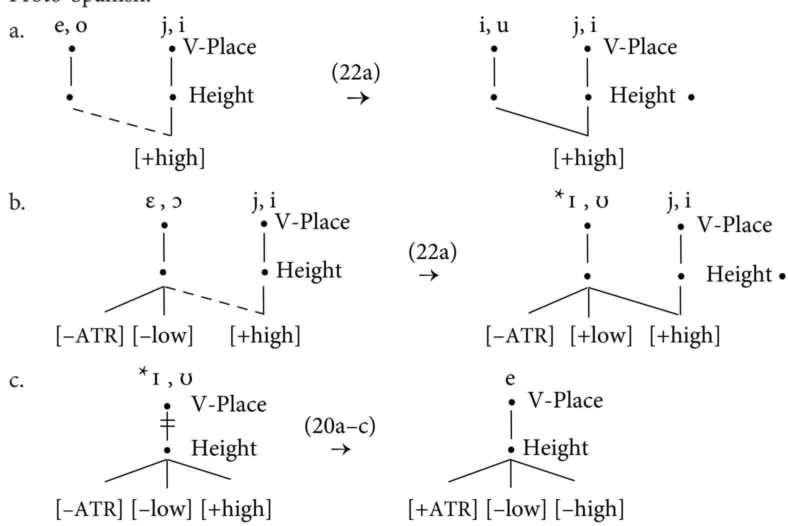
b. Lena Asturian:



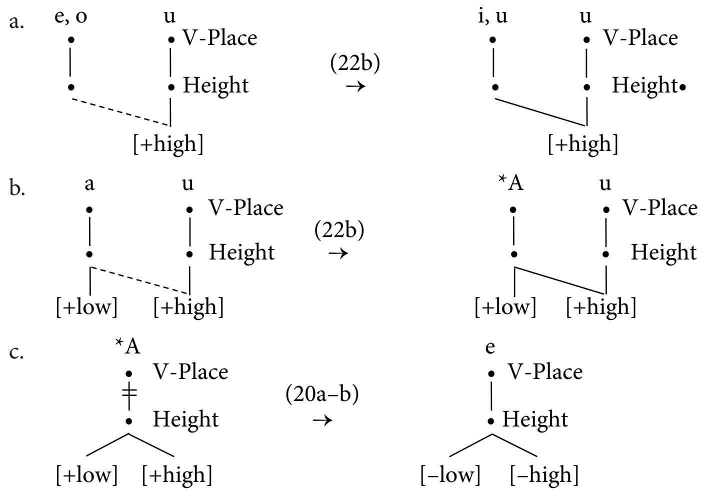
The fundamental problem that metaphony poses for a rule-based autosegmental account is the impossibility of achieving the observed upstep raising by means of a single formal statement, namely, by spreading either a single feature or a set of features included in the Height node. Thus, consider Proto-Spanish first. In order to raise tense mid vowels to high we need a rule that spreads [+high], as in (22). Spreading [+high] onto the lower mid vowels will wrongly produce lax high vowels; instead, the desired raising can only be achieved by spreading [+ATR] onto the target vowel. However, the problem now is that spreading [+ATR] onto the upper mid vowels does not succeed in raising them to high, since they are already [+ATR]. Lena Asturian, on the other hand, poses an even more complex problem. In order to capture the raising of mid vowels to high we need the [+high]-spreading rule (22b). However, the required raising and fronting of /a/ to [e] requires two seemingly unrelated operations: (a) the spreading of [−low] and concomitant delinking of [+low] in the target; and (b) the (non-autosegmental) change of [+back] to [−back]. Note that the alternative of spreading the trigger's Height node is not a feasible one, since it would wrongly result in complete height assimilation of the lower mid vowels in Proto-Spanish, and of /a/ in Lena Asturian. Confronted with such a hopeless state of affairs, an unitary account of the metaphonic shifts would seem intractable.

In the face of such formal difficulties, the general strategy of serial autosegmental approaches to metaphony has been to posit a single [+high]-spreading rule, roughly along the lines of (22), followed by a set of *clean-up* (or repair) operations that takes the high vowels thus derived and turns them into upper mid ones. This is essentially the approach adopted in Kaze (1989, 1991, Calabrese 1985, 1988, 1995, Hualde 1889, 1992, Martínez-Gil 1991, 1992, Dyck 1995, 1996, and Nibert 1998, among others). The representations derived by the application of each of the [high]-spreading rules in (22), followed by the corresponding clean-up mechanisms, are shown in (23) for Proto-Spanish and (24) for Lena Asturian.

(23) Proto-Spanish:

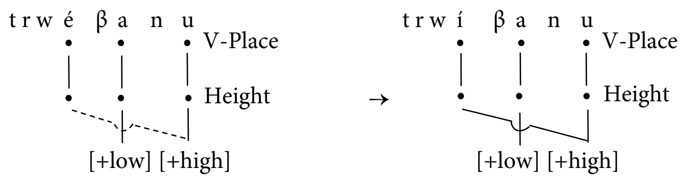


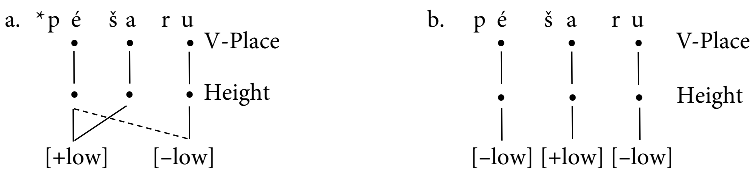
(24) Lena Asturian:



As shown, the corresponding [+high]-spreading rule turns /e, o/ into [i, u], in both Proto-Spanish (23a), and Lena Asturian (24a), as desired. However, when the target vowels are /ɛ, ɔ/ in Proto-Spanish, the [+high]-spreading rule (22a) wrongly derives lax high vowels, as shown in the first intermediate representation in (23b). Note that the raising rule cannot possibly be one that spreads [+ATR] instead of [+high], because then it would be impossible to derive upper mid-vowel raising, since the upper mid vowels are already [+ATR], as indicated earlier. At this point, the clean-up mechanism kicks in, as in (23c), correcting the illicit output representations created by the [+high]-spreading rule: first, all height features (i.e., the Height node) are delinked, followed by the assignment of the default vowel-height features (20a–c), thus resulting in upper mid vowels. In Lena Asturian, on the other hand, spreading of [+high] onto target /a/ by rule (22b) derives the universally prohibited configuration *[+high, +low], as shown in (24b) (represented here for convenience as **A*). The malformed segment is immediately submitted to the familiar clean-up mechanism (cf. (24c)): delinking of the Height node, and default application of default vowel-height rules (20a–b). Under the assumption that at this point the specification for [round] has not yet been assigned to the resulting mid vowel, the default rule (20d) would assign it the value [−round], thereby turning it into [e]. The tandem operation of the [+high]-spreading rule plus the delink-and-default repair mechanism in (23) summarizes in all relevant details the proposal by Martínez-Gil (1991, 1992) for Proto-Spanish, while (24) essentially reflects the approach taken in Hualde (1989, 1992), Kaze (1989), and Dyck (1995, 1996) for Lena Asturian.

There are two primary reasons that compel an autosegmental approach to resort to a single [+high]-spreading rule plus a repair mechanism; they can better illustrated in Lena Asturian metaphony. The first, of course, is that the alternative of positing two autosegmental-spreading rules, one that raises /e, o/ to [i, u] by spreading [+high], and a second that raises /a/ to [e] by spreading [−low], does not succeed to capture the demonstrated relatedness of the two processes, for reasons already stated. The second is that a [−low]-spreading rule is not a viable alternative to raise /a/ to [e] in one particular class of words. Recall that in forms with antepenultimate stress in Lena Asturian, such as *trwíβanu* 'beehive' (12a) (cf. *trwéβanos* 'beehives') or *péšaru* 'bird' (12b) (cf. *pášarus* 'birds'), the intervening penultimate vowel (/a/ in both cases) invariably fails to undergo metaphony. Raising of a stressed mid vowel by [+high]-spreading would proceed as intended under the assumption that the intervening /a/ is unspecified for [high] at this point (cf. (25)). However, raising of a stressed low vowel, cannot be achieved, since in order for the trigger's [−low] specification to link to the target vowel it would necessarily have to spread across a vowel associated to [+low], as illustrated in (26a), inevitably resulting in the contravention of an absolute (inviolable) well-formedness constraint in autosegmental phonology that prohibits the crossing of association lines. Note that assimilation to [−low] in *péšaru* can still be characterized autosegmentally without infringing the no line-crossing constraint as in (26b), but this option cannot possibly be achieved by autosegmental spreading. As we will see in Section 4, (26b) is precisely the structural configuration that emerges in an Optimality theoretical analysis, one that reflects partial height assimilation of /a/ in such antepenultimate-stressed forms without the need to resort to feature-spreading operations.

(25)


(26)


Returning to the spread-and-clean-up account of metaphony embodied in (18)–(24), appealing as it may seem as a mechanism for achieving stepwise vowel-raising, upon a closer inspection it shows several significant flaws that seriously undermine its feasibility, rendering it unacceptable.

A first problem concerns the creation of malformed representations in intermediate stages of a derivation. The metaphony rules in both Proto-Spanish and Lena Asturian are undoubtedly lexical, since they apply only inside words. In order to motivate the delinking rules in (23b) and (24b) proponents of the delinking-and-default repair mechanism would appeal to universal constraints, such as *Structure Preservation*, which prohibits the derivation by lexical rules of features or feature combinations absent in the underlying inventory of a language (see Kiparsky 1982, 1985, and much subsequent work). Thus in (23b) the output of metaphony produces [+high, −ATR], a feature combination disallowed lexically in Proto-Spanish at the relevant synchronic stage. In Lena Asturian, on the other hand, the combination of [+high, +low] created by [+high]-spreading in (24b) is not simply ruled out by Structure Preservation; it is excluded outright by Universal Grammar. It is hard to find a precedent in phonological theorizing where the derivation of surface forms requires a transgression of an absolute universal at *any* level of representation. The question thus immediately arises: whenever [+high]-spreading generates outputs which are prohibited, either on a language-specific basis, as in Proto-Spanish, or by absolute universal principles, as in Lena Asturian, how come they are allowed to emerge in the first place? In fact, in order for the spread-and-clean-up account to derive the raising of the lower mid vowels in Proto-Spanish, and /a/ in Lena Asturian, it is imperative that the disallowed outputs be generated by the [+high]-spreading rule. At issue here is the ambiguous role of universal markedness/well-formedness constraints in rule-based models of derivation. In some instances, such constraints have been used as triggers of repair mechanisms, as is the case in the analysis outlined in (22)–(24). In other instances, they have been called upon to motivate the application of phonological rules, as in Steriade's (1987) appeal to the Obligatory Contour Principle to motivate lateral dissimilation in the Classical Latin suffix *-alis* to *-aris*. In yet other cases, universal constraints have been utilized to block the operation of phonological rules; Structure Preservation comes to mind as an obvious example. As many critics of rule-based phonology have noted, rule-based theory fails to provide a principled basis to predict the *modus operandi* of a given constraint. In fact, it is not uncommon for one and the same constraint to be used as a trigger of phonological rules in some instances, and as a blocker in others, the OCP being a case in question (cf. McCarthy 1986).

A second argument against the spread-and-clean-up approach is based on its inability to explain the different behavior of the low vowel /a/ in Proto-Spanish and Lena Asturian. Suppose we attempt to account for the failure of /a/ to undergo metaphony in Proto-Spanish on the grounds that spreading of [+high] onto /a/ is blocked because it is specified as [+low], given the incompatibility of both features. This would not constitute a valid explanation, since the feature [+high], as we have seen, is allowed to spread in /a/-raising in Lena Asturian. In short, the failure of /a/ to undergo raising in Proto-Spanish can only be obtained by brute force as in (22a), namely, by imposing the feature [–low] as a target condition of the metaphony rule. No explanation is otherwise available as to why /a/, among all the non-low vowels, should be excluded from the metaphonic shifts in Proto-Spanish, but be a legitimate target of metaphony in Lena Asturian. Furthermore, the inclusion of [–low] in (22a), although needed to prevent [+high]-spreading onto /a/, is inconsistent with the minimally-specified Proto-Spanish vowel representations in (18b).

A third problem with the account in (22)–(24) is that it not only seems unsuitable to describe more complex cases of stepwise raising, but also makes the wrong predictions, by excluding the possibility of metaphony in languages with slightly different properties. Consider, for example, a chain shift similar to that of Proto-Spanish in which, instead of two, vowel height is raised by three steps, as in Nzɛbi (1a). Given the difficulties of providing a unified account of a two-step vowel height by means of autosegmental feature-spreading, it is hard to imagine how a three-step raising could be adequately handled. Consider, on the other hand, a language identical in all relevant respects to either Proto-Spanish or Lena Asturian, except that the default vowel is high, instead of mid. The default rules (20a–b), would assign [+high] (instead of [–high]), to the unspecified output of the delinking rule, therefore yielding complete, instead of partial, height assimilation: all non-high vowels in both instances would be raised to high. It is thus predicted that scalar raising such as that of Proto-Spanish and Lena Asturian would never occur in such language. We know of no evidence suggesting that this prediction has any empirical basis on reality. In fact, it would be immediately falsified in those Italian dialects that exhibit the two-step raising type of metaphony of either Proto-Spanish or Lena Asturian but in which the default vowel is [i], instead of [e]. Consider now a language identical in all relevant respects to Lena Asturian (i.e., exhibiting the same vowel inventory, and [e] as the default vowel), but that differs from it in that metaphony is non-structure preserving (and thus non-neutralizing). The variety spoken in the Nalón Valley, an Asturian dialect in close geographical proximity with Lena, provides an instructive example. In this dialect, non-high vowels also undergo metaphonic raising; just as in Lena Asturian, mid vowels are raised to high; interestingly, however, and unlike Lena, /a/-raising yields the round lower mid vowel [ɔ]: /blanku/ → [blɔ́ŋku] 'white-MASC.', /palu/ → [pɔ́lu] 'stick', /gatu/ → [gɔ́tu] 'cat-MASC.' (cf. the respective plural forms *blancos*, *palos*, *gatos*; Hualde 1998: 102–104, and references therein). Since the default vowel in the Nalón Valley Asturian dialect is still [e], it is unclear how the spread-and-delink analysis would derive this type of metaphony. In other words, while mid-vowel raising is easily achieved by a rule spreading of [+high]; raising of /a/ to [ɔ] cannot be accounted for by the spread-and repair mechanism; instead, this type of raising would require a rule spreading simultaneously [–low] and [+round] from the trigger, while the target vowel somehow would need to retain its lexically non-contrastive [–ATR] specification.

Finally, perhaps the most troubling aspect of the spread-and-clean-up account to metaphony is that while raising of the upper mid vowels is achieved by [+high]-spreading, raising of the lower mid vowels or /a/ is brought about by an operation that effectively wipes out the structure created by the [+high]-spreading rule, as noted by Cole (1998: 73). Because in autosegmental phonology, assimilation is expressed primarily by feature spreading, the [+high]-spreading portion of the autosegmental analysis is assimilatory by definition. However, the delink-and-default repair mechanisms in (25)–(26) evidently are not assimilatory in nature; in fact, they are the established autosegmental mechanism to express dissimilation (see, for example, Steriade 1987). In short, the spread-and-repair analysis actually entails two successive contradictory operations: first assimilation, and then dissimilation. It is thus not difficult to conclude that such an analysis can hardly make any significant claims about characterizing metaphony as a unified process of vowel height assimilation.[13]

13. Clements' theory of vowel height (Clements' 1990, 1991, Clements and Hume 1995), also couched in autosegmental theory, deserves some comment. The model is designed primarily to avoid the pitfalls of traditional vowel-height features by construing vowel height as an intrinsically scalar phonological dimension, recursively divided into autosegmental levels of representation] by the binary

4. An Optimality theoretical analysis of metaphony in Proto-Spanish and Lena Asturian

In this section we propose a unified analysis of metaphony in Proto-Spanish and Lena Asturian within the framework of Optimality Theory (*OT*) that relies exclusively on the interaction of phonological constraints, while still resorting to the traditional vowel-height features [high], [low] and [ATR], and averts the bulk of the problems associated with serial accounts. A first OT approximation to the data in terms of the standard interaction of markedness and individual faithfulness constraints, however, is shown to be inadequate to provide a unified account of scalar vowel raising in both Proto-Spanish and Lena Asturian. A simple solution is advanced that crucially appeals to the local conjunction of faithfulness constraints on vowel height. The interaction of locally conjoined constraints with an agreement constraint demanding assimilation in vowel height to the triggering high vocoid is shown to effectively limit unfaithfulness

feature [open]: [$open_1$] or primary register, [$open_2$] or secondary register, [$open_3$] or tertiary register, and so on. Articulatorily, these levels designate phonologically significant points in the movement of the tongue dorsum along the vertical axis, in direct correlation with the degree of jaw opening. At each level the binary values of [open] divide vowel height into two levels: [$open_1$] specifies a vowel system such as /a, i, u/ with two vowel heights (i.e., high vs. non-high); [$open_1$] and [$open_2$] characterize a vowel system with three heights (i.e., high vs. mid vs. low), such as Lena Asturian (1c); three levels identify a vowel system with four heights (high vs. upper mid vs. lower mid vs. low), such as Proto-Spanish (1b), and so on. In order to achieve scalar raising, Clements' model endows autosegmental rules spreading the feature [open] with the power of applying at any vowel height register, constrained only by Structure Preservation. Consider, for example, the Servigliano dialect of Italian, which exhibits both an underlying vowel inventory and a metaphony type in all relevant respects analogous to Proto-Spanish. Working within Clements' model of vowel height, Nibert (1998: 96) proposes an analysis of Servigliano metaphony in which the feature [$-open_2$] spreads autosegmentally from a word-final high vowel /i, u/ onto a stressed vowel in the preceding syllable. A direct application of this rule changes the tense mid vowels into their high counterparts (i.e., /e, o/ → [i, u]). However, because spreading [$-open_2$] onto the lax mid vowels /ɛ, ɔ/ creates segments absent in the lexical inventory of Servigliano, and thus ruled out by Structure Preservation, the rule's *modus operandi* is adjusted, and instead of [$-open_2$], the rule now spreads [$-open_3$], resulting in [e, o], as desired. Taken a face value, Clement's model of vowel height does not seem to be a significant improvement over the standard spread-and-clean-up autosegmental approach based on the traditional binary vowel height features outlined in (18)–(24), in that it also fails to provide a unified account of metaphony. In fact, from a formal point of view, it is difficult to ascertain how the analysis of Servigliano metaphony in Clement's model would differ from an alternative that postulates two distinct assimilation rules that appeal to traditional vowel height features: one that spreads [+high] (essentially equivalent to Nibert's [$-open_2$]-spreading), and a second one that spreads [+ATR] (similar to [$-open_3$]-spreading). As Cole (1998: 77) points out, the failure of this model to achieve a unitary account of metaphony derives from the fact that each raising step involves the assimilation of a different instance of the feature [open]. There are other approaches to scalar vowel raising in the literature which cannot be reviewed here in detail because of space limitations. They include Schane's (1984) theory of Particle Phonology, (see Kaze 1991 for a critical review), and Maiden's (1991) account of metaphony in Italian dialects within the framework of Dependency Phonology (reviewed in Cole 1998). Parkinson (1996) and Salting (1998, 2003) present analyses of vowel-height features that closely resembles Clement's aperture model.

to underlying forms to at most one feature, thereby resulting in stepwise raising. Finally, it is shown that this analysis can be easily extended to handle the metaphonic shifts in Nalón Valley Asturian by simply appealing to a different constraint ranking, a natural result of what in OT is known as *factorial typology*.

4.1 An OT approximation to Proto-Spanish and Lena Asturian metaphony

A central tenet of the OT program, as articulated in the seminal work of Prince and Smolensky (1993 [2004]), McCarthy and Prince (1993a), and much subsequent work, is that linguistically significant generalizations result exclusively from the interaction of universal constraints, rather than from the sequentially-ordered set of rules assumed in serial theories of phonological derivation.

The model consists of three basic formal components: (a) the generator (*GEN*), a function that relates the input (the underlying form) to a set of candidate representations (the set potential outputs); (b) the universal set of wellformedness constraints (*CON*), regarded as part of our innate knowledge of language, and whose primary role is to either require or prohibit some aspect of surface representations; and (c) the evaluator (*EVAL*), a function that for any given input compares all potential outputs from the set of candidates generated by GEN, and selects among them the *most harmonic* or *optimal* candidate, the one that best satisfies the language-particular constraint hierarchy. There are two basic ways of achieving 'best satisfaction': (a) the optimal form may violate one or more constraints that rank lower in the constraint hierarchy than those infringed by its competitor forms; and (b) when all the viable candidates tie on the higher-ranked constraints (either because they all satisfy such constraints or because they all disobey them), the selection of the most harmonic candidate rests on their performance on the lower-ranked constraints. The optimal form is the one that either violates the least number of lower-ranked constraints or violates them to a lesser extent (also known as *gradient violation*) than the competing set of candidates.

There are two primary (and often antagonistic) types of universal constraints in OT. Input-output *faithfulness* constraints demand structural identity between underlying and surface forms. *Markedness* constraints, on the other hand, require that outputs conform to a set of universal (though violable) wellformedness principles grounded on certain structural configurations known to be preferred across languages. Universal constraints are ranked on a language-particular basis; the phonology of a language essentially consists of a constraint hierarchy that specifies dominance relations among the universal constraints. Both crosslinguistic and dialectal variation result primarily from the various constraint-ranking permutations.

Faithfulness and markedness constraints are often in conflict. Phonological alternations arise when markedness constraints outrank input-output faithfulness. The satisfaction of markedness constraints in surface forms may be brought about by a variety of mechanisms that inevitably compromise faithfulness to the corresponding input, including epenthesis, deletion, assimilation, and so on. The potential interest of an OT approach to stepwise vowel raising in general, and to metaphony in particular, stems from the fact that it does not rely on a sequence of ordered rules that govern the mapping between underlying and surface forms, which, as discussed in the preceding section, has proven unsuccessful at formally capturing the unitary nature of such assimilatory phenomena. Because the OT model relies exclusively on the interaction of violable universal constraints on output forms, it provides a fresh analytical framework to the problem of scalar vowel raising.

Let us consider again the most significant details of the Proto-Spanish and Lena Asturian metaphonic shifts illustrated earlier in (7)–(8), and (12), respectively. Metaphony in Proto-Spanish involves raising assimilation of the upper mid vowels to high, and of the lower mid vowels to upper mid, before a high front vocoid in the following (word-final) syllable. Thus, for the upper mid vowels, input and output for the feature [high] ([−high] → [+high]), while raising of the lower mid vowels brings about a change in the value of [ATR] ([−ATR] → [+ATR]). In Lena Asturian, metaphony raises mid vowels to high, and /a/ to [e] in the context of the word-final singular count morpheme /-u/. Here, the input-output mappings differ with respect to [high] for mid-vowel raising ([−high] → [+high]), and to [low] for low-vowel raising ([+low] → [−low]).[14]

In OT, phonological alternations result from the domination of some markedness constraint, requiring a certain structural configuration over faithfulness constraints, demanding identity of input-output mapping. Assimilation phenomena are generally expressed in terms of the *Agreement* family of markedness constraints, which require that a segment share some phonological property with another segment (Agree, for short; see Lombardi 1999, Bakovic 2000, and much related work; also known as the *Identical Cluster* family of constraints in Pulleyblank 1997). In this paper, metaphony will be viewed as a particular manifestation of Agreement which enforces regressive assimilation by requiring that a stressed vowel agree with a following high vocoid for some vowel height feature(s). Thus, as a first OT approximation to Proto-Spanish and Lena-Asturian metaphony, suppose the we analyze metaphonic assimilation by means of an agreement constraint demanding that the vowel bearing primary stress agree with the trigger vocoid's [+high] specification, stated informally in (27).[15]

14. Two important aspects of the OT analysis proposed here should made clear at this point. First, unlike in the account outlined in (18)–(24), underlying underspecification is not an possible option in OT, due to a central hypothesis of the theory known as the *Richness of the Base*, according to which the input of phonological representations is a free combination of linguistic primitives. As McCarthy (2002a: 70) point out, in the OT model "there are no language-particular restrictions on the input…. no lexical redundancy rules, morpheme structure constraints, or similar devices. All generalizations about the inventory of elements permitted in surface structure must be derived from the markedness/faithfulness interaction, which control the faithful and unfaithful mappings that preserve or merge the potential contrasts present in the rich base." And second, although there are no rules in OT, most phonologists working within this framework do in fact assume autosegmental representations. Observe that autosegmental representations and the phonological rules that manipulate them in serial theories are two logically independent entities to begin with.

15. The constraint in (27) is used a convenient shorthand for whatever constraint(s)/constraint interaction enforce the agreement of the stressed vowel with a following yod within the dominant foot of a word; we will not be concerned with its precise formulation here.

(27) Agree-[+high]: a stressed vowel must agree with the feature [+high] of a following high vocoid

Evidently, Agree-[+high] (27) is in conflict with the faithfulness constraints that demand input-output identity of vowel height features, shown in (28) (see McCarthy and Prince 1995, 1999 for identity constraints in OT's Correspondence Theory). For obvious reasons, related to the underlying inventory, Ident-[ATR] (28c) will be relevant only for Proto-Spanish while Ident-[low] (48b) applies only to Lena Asturian; Ident-[high] (28a), on the other hand, is relevant for both.[16]

(28) a. Identity of [high] (= *Ident*-[high]):
The specification for [high] in an output vowel must be identical to its input.
b. Identity of [low] (= *Ident*-[low]):
The specification for [low] in an output vowel must be identical to its input.
c. Identity of [ATR] (= *Ident*-[ATR]):
The specification for [ATR] in an output vowel must be identical to its input.

Vowel raising can be enforced if Agree-[+high] (27) dominates the vowel-height feature identity constraints (28), as shown in the partial ranking in (29). Clearly, vowel raising cannot be accomplished by the opposite ranking, that is, one in which the Ident constraints (28) dominate their Agree counterpart (27), because then a candidate fully faithful to underlying vowel height would inevitably prevail over a competitor that satisfies Agree-[+high]. Observe that the individual identity constraints are not critically ranked with respect to each other.

(29) Constraint ranking: Agree -[+high] >> Ident-[high], Ident-[low], Ident-[ATR]

The constraints introduced in (27)–(28) do not preclude a potential raising shift in Proto-Spanish in which lower mid vowels are raised to high, while maintaining faithfulness to the feature [ATR], thus resulting in lax high vowels. The exclusion of such a potential shift can be directly attributed to the undominated markedness constraint (30), disfavoring the feature combination *[+high, −ATR] (high vowels are in the normal case [+ATR]; cf. Archangeli and Pulleyblank 1994).) Likewise, we assume that the potential generation of lax non-high vowels by metaphonic raising in Lena Asturian, both mid (as in the mapping /a/ → *[ɛ]), and high (as in the mapping such as /e, o/ → *[ɪ, ʊ]), is to be attributed the undominated rank of the markedness constraint (31), a more general version of (30) which disfavors the [−ATR] specification for all non-low vowels.

(30) *[+high,−ATR]: high vowels are [+ATR] in the unmarked case

(31) *[−low,−ATR]: non-low vowels are [+ATR] in the unmarked case

With these considerations in mind, the updated version of the constraint ranking (29) is given in (32) for Proto-Spanish, and (33) for Lena Asturian:

16. Namely, [ATR] is distinctive for mid vowels in Proto-Spanish, but non-contrastive in Lena Asturian; the feature [low], on the other hand, is irrelevant in Proto-Spanish because low vowels do not undergo metaphonic raising.

(32) Constraint ranking for Proto-Spanish:
*[+high,−ATR] >> AGREE-[+high] >> IDENT-[high], IDENT-[ATR]

(33) Constraint ranking for Lena Asturian:
*[−low,−ATR] >> AGREE-[+high] >> IDENT-[high], IDENT-[low]

Constraint evaluation under the ranking in (32) and (33) is illustrated in (34)–(35) for Proto Spanish, and (36)–(37) for Lena Asturian, where for simplicity only the most likely candidates are shown. Following Kirchner (1996), candidates are shown schematically as individual pairs of underlying-surface mappings. In addition, because metaphony does not affect the low vowel /a/ in Proto-Spanish, IDENT-[low] will not be considered in candidate evaluation; similarly, [ATR] is inactive in Lena Asturian, and therefore violations of IDENT will be restricted to the features [high] and [low]. Finally, the constraint IDENT-[low] is not violated by any of the likely candidates in Proto-Spanish, and thus has excluded in (34)–(35) and in subsequent tableaux. As is customary, domination in the constraint hierarchy is indicated by an unbroken line; a dotted line between two constraints reflects the absence of crucial ranking with respect to each other.

(34) Proto-Spanish upper mid-vowel raising:

/e, o/	*[+high, −ATR]	AGREE-[+high]	IDENT-[high]	IDENT-[ATR]
a. ☞ /e, o/ → [i, u]			*	
b. /e, o/ → [ɪ, ʊ]	*!			
c. /e, o/ → [e, o]		*!		

(35) Proto-Spanish lower mid-vowel raising:

/ɛ, ɔ/	*[+high, −ATR]	AGREE-[+high]	IDENT-[high]	IDENT-[ATR]
a. ✖ /ɛ, ɔ/ → [i, u]			*	*
b. /ɛ, ɔ/ → [ɪ, ʊ]	*!		*	
c. ☹ /ɛ, ɔ/ → [e, o]		*!		*
d. /ɛ, ɔ/ → [ɛ, ɔ]		*!		

(36) Lena Asturian mid-vowel raising:

/e, o/	*[−low, −ATR]	AGREE-[+high]	IDENT-[high]	IDENT-[low]
a. ☞ /e, o/ → [i, u]			*	
b. /e, o/ → [ɪ, ʊ]	*!			
c. /e, o/ → [e, o]		*!		

(37) Lena Asturian low vowel raising:

/a/	*[−low, −ATR]	Agree-[+high]	Ident-[high]	Ident-[low]
a. ✖ /a/ → [i]			*	*
b. /a/ → [ɪ]	*!		*	*
c. ☹ /a/ → [e]		*!		*
d. /a/ → [ɛ]	*!	*		*
e. /a/ → [a]		*!		

As shown in tableaux (34)–(35) for Proto-Spanish, candidates (34b) and (35b) are immediately ruled out because they fatally violate the undominated *[+high, −ATR] constraint, while (34c) and (35d) are also counted out because, although fully faithful to their respective input, they contravene [+high] agreement. Candidate (35a) is unfaithful to the input, but it illegitimately succeeds as the optimal output because it satisfies higher-ranked Agree-[+high] ('✖' signals the wrong candidate; the sad face '☹' points at the intended one). Finally, (35c), the correct output, loses to (35a), the completely assimilated one, because it disobeys the higher-ranked Agree-[+high], even though the latter is unfaithful to the input's height features. In a similar fashion, although mid-vowel raising in Lena Asturian is straightforward under the assumption that Agree-[+high] outranks Ident-[high], as shown in (36), such a ranking wrongly derives complete assimilation of /a/, as can be seen in (37). In particular, candidates (36b), (37b), and (37d), exhibiting lax non-low vowels, are excluded because they fatally violate undominated *[−low,−ATR]. Candidates (36c) and (37e) follow a similar fate: although entirely faithful to their respective input, they fatally violate higher-ranked Agree-[+high]. Although unfaithful to input [high], candidate (36a) is optimal, because it satisfies agreement. Finally, domination of Agree-[+high] over Ident-[high] in (37) enforces complete assimilation, wrongly favoring (37a) over the observed output form (37c), because the latter infringes higher-ranked Agree-[+high]. In sum, tableaux (34)–(37) show that scalar raising in both Proto-Spanish and Lena Asturian cannot be simply accomplished by appealing to individual constraints: domination of Agree-[+high] over Ident-[high] in Proto-Spanish accounts for raising of the upper mid-vowels to high, as desired (cf. (34), but it wrongly predicts raising of the lower mid vowels to high, and a similar result obtains in Lena Asturian in (37) for low-vowel raising. The desired stepwise raising of the lower mid vowels cannot be achieved in both instances because domination of Agree-[+high] over the identity constraints inevitably favors complete height assimilation.

Similar difficulties would arise if we adopt an alternative approach in which, instead of [+high], the Agree constraint appeals to the relevant complementary vowel-height features of the trigger vocoid, namely, [+ATR] in Proto-Spanish, and [−low] in Lena-Asturian. Namely, while the domination of Agree-[+ATR] over Ident-[ATR] would compel the desired raising of the lower mid vowels to higher mid in Proto Spanish, it would fail to raise the upper mid vowels, because they are already [+ATR], wrongly predicting that they would stay faithful to underlying vowel height. Likewise, although the postulation of an Agree-[−low] constraint over the Ident constraints in

Lena Asturian would certainly accomplish the task of raising /a/ to [e], it would have no discernible effect on the class of mid vowels, which are already [–low], thus incorrectly predicting that mid vowels would remain unaffected by metaphony. Of course, mid-vowel raising can be enforced only if the Agree constraint refers to the specification [+high], as shown earlier.

A simple solution to these problems can be advanced by assuming that instead of single height features, the Agree constraint is defined over the vowel-height node itself (cf. (21) earlier). We will refer to this constraint simply as Agree-Vowel Height, as in (38). Recall that the Height node dominates the features: [high], [low], and [ATR], and that the metaphony-triggering high vocoid in each case (i.e., /j, i/ in Proto Spanish and /i, u/ in Lena Asturian) is specified as [+high, –low, +ATR]; these are precisely the values to be checked by Agree V-Height.[17]

(38) Agree Vowel-Height (= *Agree V-Height*): a stressed vowel must agree with the features specified in the height node of a following high vocoid.

Violation of an agreement constraints that ranges over multiple features, such as (38), can be readily interpreted as subject to gradient evaluation (cf. McCarthy 2002a: 18), in the sense that each candidate will be checked for how closely the stressed vowel satisfies Agree V-Height.[18] Accordingly, violation marks are assigned to a candidate to the

17. As it is the case in Lena Asturian, metaphony in Proto-Spanish was undoubtedly a lexical process, since it applied exclusively within words. Accordingly, one might readily object to bringing the [+ATR] specification of the trigger yod into the discussion, given the fact that the feature [ATR] was lexically contrastive in Proto-Spanish *only* for the mid vowels, not their high counterparts, and is evidently noncontrastive in Lena Asturian. However, since tongue root advancement is unquestionably an attribute of the phonetic implementation of the metaphony-triggering high vocoid, from the point of view of surface representations it does not appear to be anything unnatural or unexpected that the lower mid vowels would assimilate to the surface [+ATR] specification of a high tense vocoid. Indeed, other than [+ATR] it is not obvious what other property of the trigger vocoid could be invoked in order to account for raising of the lower mid vowels in Proto-Spanish. Unlike in the theory of lexical phonology, the conflict between lexical and post-lexical considerations does not arise in OT, since in the latter surface forms are the primary domain of phonological generalizations, including the notion of "contrastive feature." For an insightful discussion of the characterization of lexical contrast in both the standard (representational) generative model and OT, see Kirchner (1997).

18. Note that from the point of view of candidate evaluation, (38) is entirely analogous to assuming individual constraints requiring agreement of the relevant single height features. From a practical point of view, (38) is also a convenient way of avoiding unnecessary cluttering of tableaux. For clarity, hereafter for each Agree V-Height violation mark, the disagreeing feature(s) are indicated in parenthesis in the corresponding cells of this constraint in each tableaux. An alternative to enforcing metaphonic raising by means of Agree-V-Height is laid out in Walker's (2004) theory of Generalized Constraint Licensing theory. In fact, Walker's primary objective is to solve the problem posed by raising across an intervening transparent vowel in Lena Asturian. Notice that instead of Agree-V-Height, one might alternatively resort to an Alignment constraint (cf. McCarthy and Prince 1993b), requiring that the stressed vowel (the head of the dominant foot) coincide with the vowel-height features of the triggering vocoid (for this type of approach to vowel harmony processes in OT, see Kirchner 1993, Pulleyblank 1993, 1996, Akinlabi 1994, 1996, Cole and Kisseberth 1994, 1995, Ringen and Vago 1998,

extent that the stressed vowel's height features disagrees with [+high, −low, +ATR], as indicated in tableaux (39)–(41) below. Significantly, however, the new formulation of the agreement constraint still fails to yield the desired results, as shown in (39)–(40) for Proto-Spanish, and in (41)–(42) for Lena Asturian. For although it correctly accounts for the raising of the upper mid vowels to high in each case (cf. (39) and (41)), it undesirably compels complete assimilation of the lower mid vowels in Proto-Spanish, as shown in (40), and of the low vowel /a/ in Lena Asturian, as can be seen in (42).

(39) Proto-Spanish upper mid-vowel raising:

/e, o/	*[+high, −ATR]	Agree V-Height	Ident-[high]	Ident-[ATR]
a. ☞ /e, o/ → [i, u]			*	
b. /e, o/ → [ɪ, ʊ]	*!	* ([−ATR])	*	*
c. /e, o/ → [e, o]		*! ([−high])		

(40) Proto-Spanish lower mid-vowel raising:

/ɛ, ɔ/	*[+high, −ATR]	Agree V-Height	Ident-[high]	Ident-[ATR]
a. ✖ /ɛ, ɔ/ → [i, u]			*	*
b. /ɛ, ɔ/ → [ɪ, ʊ]	*!	* ([−ATR])	*	
c. ☹ /ɛ, ɔ/ → [e, o]		*! ([−high])		*
d. /ɛ, ɔ/ → [ɛ, ɔ]		**! ([−high, −ATR])		

(41) Lena Asturian mid-vowel raising:

/e, o/	*[−low, −ATR]	Agree V-Height	Ident-[high]	Ident-[low]
a. ☞ /e, o/ → [i, u]			*	
b. /e, o/ → [ɪ, ʊ]	*!	* ([−ATR])		*
c. /e, o/ → [e, o]		*! ([−high])		

and Archangeli and Pulleyblank 2002, among others). Proto-Spanish metaphony could, in principle, be analyzed by an Alignment constraint; however, facts such as those in (25)–(26) make unfeasible an analysis of Lena Asturian metaphony in terms of alignment, since the optimal candidate would be one that is not aligned, and an alignment analysis predicts that the optimal candidate is one in which either the stressed vowel does not undergo metaphony, or that the intervening vowel also undergoes raising to mid, both of which are wrong.

(42) Lena Asturian low vowel raising:

/a/	*[−low, −ATR]	Agree V-Height	Ident-[high]	Ident-[low]
a. ✗ /a/ → [i]			*	*
b. /a/ → [ɪ]	*!		*	*
c. ☹ /a/ → [e]		*! ([−high])		*
d. /a/ → [ɛ]	*!	* ([−high, −ATR])		*
e. /a/ → [a]		***! ([−high, +low, −ATR])		

In sum, up to this point a constraint-based approach that appeals to agreement of vowel-height features does not fare much better than the autosegmental rule-based analysis discussed earlier. Indeed, the OT analysis just outlined presents essentially the same technical problems as the feature-spreading analysis. In Proto-Spanish, Agree-[+high] accomplishes the raising of /e, o/ to [i, u], but it also predicts complete vowel-height assimilation, by incorrectly raising the lower mid vowels to high. On the other hand, stepwise raising of the lower mid vowels must appeal to Agree-[+ATR], but this would leave the upper mid vowels unaltered, because they already [+ATR]. As we have just seen, an alternative that involves agreement to all height features of the triggering vocoid reaches an impasse essentially analogous to the option of positing Agree-[+high]: agreement to [+ATR] does not affect the upper mid vowels, which are already [+ATR], but agreement to [+high] incorrectly compels complete height assimilation of the lower mid vowels in Proto-Spanish, and of /a/ in Lena Asturian. In the following section we demonstrate that a satisfactory solution to these difficulties is readily available in OT by simply introducing the mechanism of local conjunction of faithfulness constraints on vowel-height features, while keeping the basic premises of the analysis illustrated in tableaux (39)–(42).

4.2 Towards a unified OT analysis of metaphony

As we determined in the preceding section, an analysis in terms of the interaction of Agree V-Height with individual vowel height faithfulness constraints is incapable of accomplishing scalar raising, predicting instead complete height assimilation for the lower mid-vowels (Proto-Spanish) and the low vowel (Lena Asturian). Importantly, however, the scalar raising effect can be obtained by simply adding to such an analysis an additional component: the local conjunction of vowel-height faithfulness constraints. Following ideas by Smolensky (1993, 1995), originally designed to capture phonotactic restrictions on syllabification, Kirchner (1996) proposes that local conjunction can be extended to faithfulness constraints in order to effectively restrict the degree of input-output unfaithfulness along a phonetic scale such as vowel-height. Following Kirchner, we propose a unified account of metaphony in Proto-Spanish and Lena Asturian by appealing to the local conjunction of vowel-height identity constraints involving the features [high] and [ATR] for Proto-Spanish, as in (43), and [high] and [low] for Lena Asturian, as in (44).[19]

(43) *Ident*-[high] & *Ident*-[ATR] (Proto-Spanish): The feature values for either [high] or [ATR] in an output vowel must be identical to those of its input.

(44) *Ident*-[high] & *Ident*-[low] (Lena Asturian): The feature values for either [high] or [low] in an output vowel must be identical to those of its input.

According to the conventional interpretation of constraint schema such as (43) and (44), a local conjunction is violated if, and only if, *both* members are violated within the relevant domain. Thus, for example, an output that meets Ident-[high] but contravenes *Ident*-[ATR], or vice versa, still satisfies the conjunction Ident-[high] & Ident-[ATR] (43). By prohibiting the simultaneous violation of two identity constraints, the net effect of the locally conjoined constraints in (43)–(44) is to prevent raising by two degrees, while still allowing stepwise raising, because the latter operation entails the violation of only one of the members of the conjunction.

Before we discuss the role of local constraint conjunction in providing a unified account of the Proto-Spanish and Lena Asturian metaphony shifts, we need to consider in more detail at this point the central intuition suggested at the outset of this paper that stepwise vowel-height raising arises in the balanced tension between two basic opposing forces: articulatory inertia and preservation of lexical contrast, better known in OT terminology as *markedness* and *input-output faithfulness*, respectively. Let us consider how the notion of two opposing forces in relative equilibrium can be expressed in terms of ranking within an OT approach.

As indicated earlier, a fundamental source of linguistically-significant generalizations in OT lies in the interaction of markedness and faithfulness constraints. The former favor certain unmarked types of structural configurations; the latter ensure the preservation of lexical contrasts. Quite often the two types of constraints are in conflict: compliance of a given output form with an unmarked structural property can only be achieved through unfaithfulness to its corresponding input; and conversely, an output's complete faithfulness to its corresponding input is often at odds with markedness considerations. This basic competition between markedness and faithfulness constraints is resolved on a language-specific basis in terms of their relative ranking in a constraint hierarchy. Thus, consider a phonological property P, a markedness constraint

19. For the application of local conjunction of constraints to a variety of phonological problems, see Kirchner (1996), (Alderete 1997), Smolensky (1997), Fukazawa and Miglio (1998), Itô and Mester (1998, 2003), Zoll (1998), Bakovic (1999), Lubowicz (2002, 2003a, 2003b, 20003c, 2005), Fukazawa (2001), Moreton and Smolensky (2002), Beckman (2003), and references therein. For discussion of the theoretical implications of local constraint conjunction, see Kager (1999: 392–400), and McCarthy (2002a: 17–18). Other analyses of chain shifts have been proposed within the model of Optimality Theory, including those of Gnanadesikan (1997), Lubowicz (2003a, 2003c), and Mortensen (2004), which do not resort to local constraint conjunction. However, none of these alternatives presents, in our opinion, any compelling advantages over constraint conjunction to the problem of chain shifts vowel height such as those illustrated in (1).

C_M, requiring that P conform to a certain structural configuration, and a faithfulness constraint C_F demanding input-output identity for property P. Domination of C_M over C_F, necessarily entails an unfaithful input-output mapping: in order to comply with C_M, property P will undergo some modification in surface forms, inevitably resulting in a violation of C_F. In Proto-Spanish and Lena Asturian metaphony, C_M demands that the stressed vowel agree in height features with a following high vocoid; satisfaction of Agree V-height is accomplished by raising the stressed vowel, but raising comes at the expense of sacrificing identity to the input's vowel height. If, on the other hand, C_F outranks C_M, lexical contrast may be maintained only at the cost of increased markedness. Modern standard Spanish, for example, does not require the agreement of vowel-height features observed in the Proto language; that is, C_M is subordinate to C_F in the constraint hierarchy, and therefore stressed mid vowels stay unaltered in precisely the contexts in which they underwent raising in Proto-Spanish. Hence, the input height of the stressed vowel in Modern Spanish *medio* /medjo/ 'half-MASC.' is preserved in its corresponding surface form [mé.djo] (not *[mí.djo]), but such preservation is in conflict with the inertial properties of the articulators that favor anticipatory assimilation; namely, the transition from the stressed mid vowel to the prenuclear high front glide in the following syllable requires a relatively complex adjustment in the tongue body's articulatory travel from a mid to a high position that would be eliminated if the mid vowel were to undergo raising in anticipation of the following glide.

Not all constraints in a language's particular hierarchy are related by strict domination. When a given constraint does not interact (i.e., does not conflict) with another, their relative ranking is irrelevant in the evaluation of optimal output forms. For instance, the relative ranking of Ident-[high] and Ident-[ATR] in Proto-Spanish is not critical because faithfulness to the feature [high] is never in conflict with faithfulness to [ATR]. Another logical possibility in constraint ranking that also involves the absence of strict domination is one in which two *conflicting* constraints, let us say A and B, are assigned the same (sufficiently high) rank in the hierarchy. When this situation arises, a resolution of the conflict may materialize in the two ways illustrated schematically in (45). Namely, when given a competing pair of candidates (say, *cand1* and *cand2*), either both violate or both satisfy the two equally-ranked constraints, as depicted in (45a) and (45b), respectively, the decision on the optimal form is passed onto the lower-ranked constraint C. If, on the other hand, either A or B (or both), are subject to *gradient* violation, as we proposed earlier for Agree V-Height, the candidate that incurs a lesser amount of violations will be selected as optimal. Thus, as shown in (45c), both candidates satisfy A, and both contravene B; $cand_1$ is optimal because it performs better on B than does $cand_2$: the former violates B once, while the latter violates it twice. (Of course, if both candidates were to incur the same amount of multiple violations of B, we would face a situation essentially analogous to that depicted in (45a)). Notice thus that in terms of evaluation, constraints whose rank is irrelevant due to absence of interaction are formally indistinguishable from conflicting constraints that have the same ranking.

(45) a. Both competing candidates tie in their violations of constraints A and B:

Candidates	A	B	C
a. ☞ $cand_1$	*		
b. $cand_2$		*	*!

b. Both competing candidates satisfy constraints A and B:

Candidates	A	B	C
a. ☞ $cand_1$			
b. $cand_2$			*!

c. Both competing candidates meet A, but violate B to a different degree:

Candidates	A	B	C
a. ☞ $cand_1$		*	*
b. $cand_2$		**!	

In our final analysis of Proto-Spanish and Lena Asturian metaphony presented directly below, the three possibilities in (45) summarize in all relevant details the interaction of the local conjunction of identity constraints on vowel-height features in (43)/(44) (= constraint A in (45)), Agree V-Height (38) (= constraint B), and the individual identity constraints (28a–c) (= constraint C). Stepwise raising in both metaphony types is obtained when the relevant conjoined identity constraints and Agree V-Height are assigned the same rank, but both still dominate the individual vowel-height identity constraints, which themselves are not crucially ranked, as reflected in the constraint ranking given in (46) and (47), which include all the relevant constraints considered in our final analysis.

(46) Constraint ranking in Proto-Spanish: *[+high, −ATR] >> Ident-[high] & Ident-[ATR], Agree V-Height >> Ident-[high], Ident-[ATR]

(47) Constraint ranking in Lena Asturian: *[−low, −ATR] >> Ident-[high] & Ident-[low], Agree V-Height >> Ident-[high], Ident-[low], Ident-[ATR]

Evaluation of instructive candidates is given in (48)–(49) for Proto-Spanish, and in (50)–(51) for Lena Asturian. Observe first, that candidates containing a shifted high [−ATR] vowel in Proto-Spanish (cf. (48b) and (49b)), and a shifted non-low [−ATR] vowel in Lena Asturian (cf. (50b), (51b), and (51d)), are immediately ruled out by virtue of the undominated status in both cases of *[+high, −ATR] and *[−low, −ATR], respectively. As shown in (48) and (50), raising of the (upper) mid vowels to high in each case is achieved directly by the domination of both Agree V-Height and the corresponding composite Ident constraint over the individual vowel-height identity constraints. Finally, we observe for the lower mid vowels in Proto-Spanish (49), and /a/ in Lena Asturian (51), that in both instances output candidates containing a shifted non-low[+ATR] vowel ([e] or [i]) tie on the high ranked constraints Agree-V-Height and the locally conjoined Ident constraints; the decision is then passed onto the individual identity constraints, which select the one-step raising candidate as more harmonic than its two-step counterpart.

(48) Proto-Spanish upper mid-vowel raising:

/e, o/	*[+high, −ATR]	Ident-[high] & Ident-[ATR]	Agree V-Height	Ident-[high]	Ident-[ATR]
a. ☞ /e, o/ → [i, u]				*	
b. /e, o/ → [ɪ, ʊ]	*!	*	* ([−ATR])	*	*
c. /e, o/ → [e, o]			*! ([−high])		

(49) Proto-Spanish lower mid-vowel raising:

/ɛ, ɔ/	*[+high, −ATR]	Ident-[high] & Ident-[ATR]	Agree V-Height	Ident-[high]	Ident-[ATR]
a. /ɛ, ɔ/ → [i, u]		*		*!	*
b. /ɛ, ɔ/ → [ɪ, ʊ]	*!		* ([−ATR])	*	
c. ☞ /ɛ, ɔ/ → [e, o]			* ([−high])		*
d. /ɛ, ɔ/ → [ɛ, ɔ]			**! ([−high, −ATR])		

(50) Lena Asturian mid-vowel raising:

/e, o/	*[−low, −ATR]	Ident-[high] & Ident-[low]	Agree V-Height	Ident-[high]	Ident-[low]	Ident-[ATR]
a. ☞ /e, o/ → [i, u]					*	
b. /e, o/ → [ɪ, ʊ]	*!		* ([−ATR])			*
c. /e, o/ → [e, o]			*! ([−high])			

(51) Lena Asturian low vowel raising:

/a/	*[−low, −ATR]	Ident-[high] & Ident-[low]	Agree V-Height	Ident-[high]	Ident-[low]	Ident-[ATR]
a. /a/ → [i]		*		*!	*	*
b. /a/ → [ɪ]	*!	*	* ([−ATR])	*	*	
c. ☞ /a/ → [e]			* ([−high])		*	*
d. /a/ → [ɛ]	*!		* [−high, −ATR])		*	
e. /a/ → [a]			***! ([−high, +low, −ATR])			

Let us consider tableaux (48)–(51) in more detail, starting with Proto-Spanish in (48)–(49). The analysis of upper mid-vowel raising (48) is straightforward. Candidate (48b) fails because it fatally violates undominated *[−low, −ATR]. The choice between the optimal candidate (48a) and its unshifted counterpart (48c), both of which satisfy the composite constraint Ident-[high] & Ident-[ATR], is based on agreement of height features: (48b) satisfies Agree V-Height, while (48c) disagrees for [high]. As for lower mid-vowel raising (49), candidate (49b), exhibiting a high [−ATR] vowel is rejected for the same reason as (48b) just discussed. The unshifted candidate (49d), on the other hand, is perfectly faithful to the input, but fails because it infringes vowel- height agreement on two counts: [−high], and [−ATR]. At this point, the two remaining candidates (49a) and (49c) are still tied on the higher-ranked constraints: candidate (49a), exhibiting a shifted high vowel incurs a violation of Ident-[high] & Ident-[ATR], while its competitor (49c), with a shifted upper mid vowel, exhibits disagreement with the feature [+high]. In addition, both candidates disobey the lower-ranked individual identity constraint Ident-[ATR]). The outcome is thus determined by faithfulness to the input's [−high]: the optimal candidate (49c) matches this value, while its [+high] competitor (49c) does not. It is thus evident that the local conjunction Ident-[high] & Ident-[ATR] plays a critical role in sifting out an output form (49c) that departs from the input by two features; as a result, one-step raising is favored over an alternative involving complete height assimilation.[20]

Turning now to Lena Asturian in (50)–(51), candidates (50b), (51b), and (51d) fail because they contain a non-low [−ATR] vowel, and thus fatally violate the undominated

20. Interestingly, the correct results would also obtain in Proto Spanish if Ident-[high] & Ident-[ATR] dominates Agree V-Height, as shown in (ia–b) below, corresponding to (48)–(49), respectively; here the conjoined Ident constraints critically selects candidate (ii) over its competing candidates in lower mid-vowel raising:

(i) a. Proto-Spanish upper mid-vowel raising:

/e, o/	*[+high, −ATR]	Ident-[high] & Ident-[ATR]	Agree V-Height	Ident-[high]	Ident-[ATR]
a. ☞ /e, o/ → [i, u]				*	
b. /e, o/ → [ɪ, ʊ]	*!	*	* ([−ATR])	*	*
c. /e, o/ → [e, o]			*! ([−high])		

b. Proto-Spanish lower mid-vowel raising:

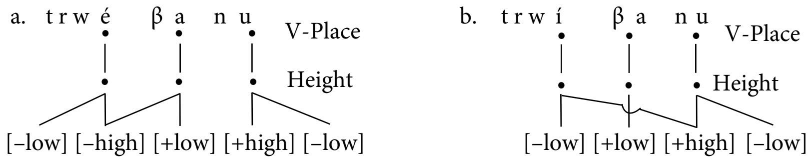
/ɛ, ɔ/	*[+high, −ATR]	Ident-[high] & Ident-[ATR]	Agree V-Height	Ident-[high]	Ident-[ATR]
a. /ɛ, ɔ/ → [i, u]		*!		*	*
b. /ɛ, ɔ/ → [ɪ, ʊ]	*!		* ([−ATR])	*	
c. ☞ /ɛ, ɔ/ → [e, o]			* ([−high])		*
d. /ɛ, ɔ/ → [ɛ, ɔ]			**! ([−high, −ATR])		

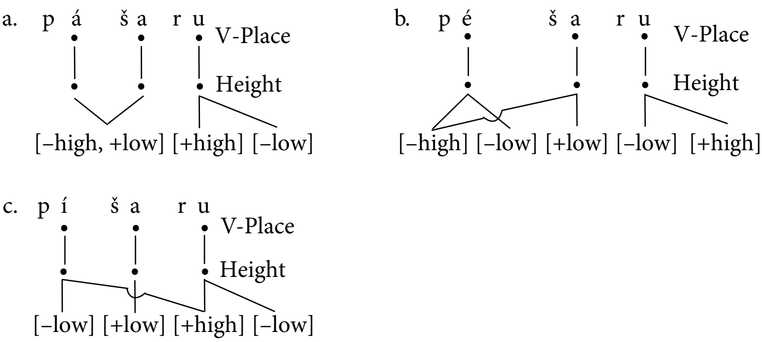
In this paper we have adopted the undominated ranking alternative in (48)–(49) because it closely reflects the balanced opposition between faithfulness vs. markedness assumed to underlie stepwise vowel raising.

markedness constraint *[–low,–ATR]. As in Proto-Spanish, raising of the mid vowels to high in (50), follows directly from the domination of Agree V-Height over faithfulness to the [–high] specification of the input; here, the local conjunction Ident-[high] & Ident-[ATR] is obviously irrelevant for this outcome. Candidate (50c) is entirely faithful to the input, but violates the high ranked Agree V-Height. Candidate (50a) satisfies agreement and thus is selected as optimal, even though it fails to satisfy Ident-[high]. As shown in (51), the complete faithfulness of an unshifted vowel, as in (51e), is rejected because it fails to meet agreement on three counts: [–high], [+low], and [–ATR]). The two remaining candidates, (51a) and (51c), tie on the higher-ranked constraints (each violates once Ident-[high] & Ident-[low] and Agree V-Height, respectively), and they also tie on the lower-ranked Ident-[low] and Ident-[ATR]. As in Proto-Spanish lax mid-vowel raising (49), here too the decision between the two-degree raising in the mapping /a/ → [i] (51a), and the one-degree raising in the mapping /a/ → [e] (51c), is left to the lower-ranked Ident-[high] constraint, which selects the latter as the optimal candidate. Crucially, then, the role of the composite identity constraint Ident-[high] & Ident-[low] in /a/-metaphony is to proscribe a candidate that fully satisfies vowel-height feature agreement because it departs from its corresponding input by two features, favoring instead the compromise solution: the winner exhibits only partial agreement, but its featural make-up for vowel height is more faithful to the input. Note that raising of /a/ to [e] infringes two identity constraints not shown in (51): Ident-[back], and Ident-[ATR]. Obviously, these two faithfulness constraints must be low enough in the hierarchy because they are freely violated in /a/-raising. As shown in Section 4.3 below, this is clearly not the case in Nalón Valley Asturian.

Our OT analysis must still account for the different behavior exhibited by the low vowel in the two metaphony types; namely, /a/ is raised to [e] in Lena Leonese, but fails to undergo raising in Proto-Spanish. Recall that the rule-based approach deals with this fact by including [–low] in the structural description of Proto-Spanish metaphony rule (cf. (22a) above). An OT analysis offers a remarkably simple and direct explanation for the divergent treatment of /a/ in the two metaphony types, one which emanates solely from constraint ranking and factorial typology. Namely, the different behavior of /a/ in Proto-Spanish is attributed to the undominated status of Ident-[low] (28b) in the constraint hierarchy; accordingly, faithfulness to this feature prevails, and /a/ remains unaffected by metaphony. By contrast, in Lena Asturian Ident-[low] is ranked lower than both Agree V-Height and Ident-[high] & Ident-[ATR]; raising of /a/ is enforced in order to satisfy the latter constraints.

A final issue to be addressed in our OT analysis of Lena Asturian. Recall that in forms with antepenultimate stress, such as *trwíβanu* 'beehive', and *péšaru* 'bird' (cf. (12) above), the intervening /a/ fails to undergo raising. We further observed that raising of /a/ to [e] poses an intractable problem for a rule-based analysis based on autosegmental spreading, in that in order for such raising to take effect, [–low] would have to spread across a vowel specified as [+low], as illustrated earlier in (26), an impossible move under the absolute universal wellformedness constraint that prohibits the crossing of association lines. In OT the problem is resolved in a straightforward manner, by naturally attributing the inviolability of such constraint to GEN; an illegitimate configuration that exhibits crossed association lines, such as (26a), would never be generated as a possible candidate to begin with.[21] Let us consider likely candidates for each of the two items in question, a stated in autosegmental form in (52) and (53), respectively, with all the relevant vowel-height specifications.

(52)


(53)


The optimal candidates, of course, are (52b) and (53b), identical, in all relevant respects to the output of (25) and to (26b) above, respectively. The problem posed by /a/-raising in such forms can be effectively resolved in an OT analysis: a crucial property of optimal candidate (53b) is that while the stressed vowel exhibits agreement with the trigger /u/ for the feature [–low], such an agreement does not entail autosegmental spreading of this feature, an operation precluded by the prohibition against crossing of association lines, as noted earlier. With this in mind, the derivation of the optimal candidates in (52)–(53), is shown in (54)–(55), respectively (where (54b) = (52b), (55b) = (53b), and (55c) = (53c); *[–low, –ATR] has been omitted from evaluation for simplicity).[22]

21. Following a commonly held assumption in OT, candidates that violate universally excluded configurations, such as one exhibiting a crossing of association lines, can never be generated by GEN. Thus, McCarthy (2002: 8) states that the potentially infinite set of candidates (the property of GEN known as *inclusivity* or *freedom of analysis*) "is limited only by primitive structural principles essential in every language". We consider the prohibition against the crossing of association lines one such primitive structural principle.

22. For convenience we have excluded from evaluation in (54)–(55) potential candidates in which the intervening vowel has been raised stepwise. Because Agree V-Height (38) restricts the agreement requirement to the stressed vowel, any vowel located between this vowel and the triggering yod falls outside the scope of this constraint; faithfulness alone, thus, dictates that the optimal candidates [trwíbanu] in (54) and [péšaru] in (55) will be favored over a potential competitors such as *[trwíbenu] or

(54) Lena Asturian mid-vowel raising in /trwébanu / → [trwíβanu] 'beehive':

/trwébanu/	Ident-[high] & Ident-[low]	Agree V-Height	Ident-[high]	Ident-[low]	Ident-[ATR]
a. trwéβanu		*! ([−high])			
b. ☞ trwíβanu			*		

(55) Lena Asturian low-vowel raising in /pašaru/ → [péšaru] 'bird':

/pášaru/	Ident-[high] & Ident-[low]	Agree V-Height	Ident-[high]	Ident-[low]	Ident-[ATR]
a. pášaru		**! ([−high, low])			
b. ☞ péšaru		* ([−high])		*	*
c. píšaru	*		*!	*	*

In (54), the faithful candidate (54a) fails to satisfy agreement for [high]; it loses to its competitor (54b), exhibiting a shifted stressed vowel, because the latter fully complies with vowel-height agreement (cf. (52b) above), although it is unfaithful to input [high]. In (55), candidates (55a) and (55c) are ruled out because they fatally violate the higher-ranked constraints Ident-[high] & Ident-[low] and Agree V-Height, respectively. The optimal candidate satisfies agreement for the feature [low] (cf. (53b) above) while successfully avoiding a structural configuration in which this feature is illicitly linked to the stressed vowel across a vowel specified as [+low], as in (26a) above.

4.3 Metaphony in Nalón Valley Asturian

At the end of Section 3.2, we briefly mentioned the case of Nalón Valley, a variety of Asturian closely related to Lena, in which non-high vowels also undergo metaphony. As in Lena, mid vowels in this dialect undergo raising to high: /e, o/ → [i, u]; unlike Lena, raising of /a/ results in the round lower-mid vowel [ɔ]. While mid-vowel raising would proceed essentially as in Lena (cf. (50) above), in order to attain the raising /a/ → [ɔ] in Nalón Valley the following assumptions need to be made: (a) instead of *[−low, −ATR], the undominated constraint now is *[+high, −ATR], prohibiting high lax vowels, but not their mid counterparts; (b) Agree V-Height must be subordinate to both Ident-[back] and Ident-[ATR]: the mapping /a/ → [ɔ], which is faithful to the input's [+back, −ATR] specifications but violates agreement twice ([−high, −ATR]), wins over candidates with an upper mid vowel [e, o], which violate agreement only once ([−high]); and (c) Ident-[back] must be ranked above Ident-[round], since the mapping /a/ → [ɔ], which is faithful to input's [+back], wins over both /a/ → [ɛ], and /a/ → [e], which are not. These observations can be factored into the constraint ranking proposed for Nalón Valley Asturian in (56). As can be seen in tableaux (57)–(58), metaphony in Nalón Valley Asturian can be derived in accordance with factorial

*[péšeru]: while in the former violations of faithfulness taken place only in the stressed vowel, in the latter they also occur in the intervening vowel.

typology by essentially reshuffling the order of the constraints we have already considered for the Lena variety.

(56) Constraint ranking in Nalón Valley:
*[+high, −ATR] >> IDENT-[back], IDENT-[ATR] >> IDENT-[high] & IDENT-[low], AGREE V-Height >> IDENT-[high], IDENT-[round]

(57) Nalón Valley Asturian mid-vowel raising:

/e, o/	*[+high −ATR]	IDENT-[back]	IDENT-[ATR]	IDENT-[high] & IDENT-[low]	AGREE V-Height	IDENT-[high]	IDENT-[round]
a.☞ /e, o/ → [i, u]						*	
c. /e, o/ → [ɪ, ʊ]	*!					*	*
d. /e, o/ → [e, o]					*! ([−high])		

(58) Nalón Valley Asturian low vowel raising:

/a/	*[+high −ATR]	IDENT-[back]	IDENT-[ATR]	IDENT-[high] & IDENT-[low]	AGREE V-HEIGHT	IDENT-[high]	IDENT-round]
a. /a/ → [i]		*!	*	*		*	
b. /a/ → [ɪ]	*!	*		*		*	
c. /a/ → [e]		*!	*		* ([−high)		
d. /a/ → [ɛ]		*!			** ([−high,−ATR]])		
e. /a/ → [o]			*!		* ([−high)		*
f. ☞ /a/ → [ɔ]					** ([−high,−ATR])		*
g. /a/ → [a]					***! ([−high,+low, −ATR])		

Finally, the fact that /a/-raising results in a unrounded mid vowel in Lena Asturian but a rounded one in Nalón Valley can also be made to follow in a straightforward manner from factorial typology. Thus, if we consider the interaction of faithfulness constraints on vowel height features and those on the features [back] and [round] in both varieties, the two different outcomes of /a/-raising are derived directly under the assumption that in Lena Asturian IDENT-[round] dominates both IDENT-[back] and IDENT-[ATR], while in Nalón Valley Asturian, both IDENT-[ATR] and IDENT-[back] outrank IDENT-[round]. With the exception of the mapping /a/ → [e] over /a/ → [ɛ] in Lena Asturian, which follows directly from the undominated status of *[−low, −ATR], the particular mid vowel that emerges as the optimal outcome in each instance is primarily a consequence of the different constraint ranking, as illustrated in (59), where all four potential mid vowels are evaluated as candidates.

(59) a. Lena Asturian selects the mapping /a/ → [e] over /a/ → [o], [ɛ], [ɔ]:

/a/	*[−low, −ATR]	IDENT-[round]	IDENT-[back]	IDENT-[ATR]
a. ☞ /a/ → [e]			*	*
b. /a/ → [o]		*!		*
c. /a/ → [ɔ]		*!		
d. /a/ → [ɛ]	*!		*	

b. Nalón Valley Asturian selects the mapping a/ → [ɔ] over /a/ → [ɛ], [e], [o]:

/a/	*[+high, −ATR]	IDENT-[ATR]	IDENT-[back]	IDENT-[round]
a. /a/ → [e]		*!	*	
b. /a/ → [o]		*!		*
c. ☞ /a/ → [ɔ]				*
d. /a/ → [ɛ]			*!	

5. Concluding remarks

In this paper we have presented a unified constraint-based account of metaphony in Proto-Spanish and Lena Asturian which has been shown to be superior to available rule-based alternatives. The analysis presented here naturally expresses a fundamental insight which is difficult to capture in serial accounts, namely, that stepwise shifts such those involved in metaphony reflect a compromise in the tension created by two antagonistic forces present in phonological phenomena: the tendency to minimize articulatory effort, resulting from the inertia of the vocal tract, and the tendency to maintain the information encoded in underlying forms. In this context, the raising created by the metaphony processes is stepwise, incurring *one* violation of faithfulness to vowel height at a time, in accordance with the empirical observation that, all other things being equal, languages disfavor phonological processes that carry out too radical a departure from underlying forms.

In concluding, it would seem appropriate to compare the account of metaphony proposed in this paper with the analysis of the three-chain raising shifts in Nzɛbi first proposed in Kirchner (1996). This author appeals to the concerted action of two local conjunctions of faithfulness constraints, in our terms, IDENT-[high] & IDENT-[ATR], and IDENT-[low] & IDENT-[ATR], both of which are unranked with respect to each other, but they crucially dominate a RAISING constraint, requiring that vowel height be maximized in verbs with certain tense and aspect of affixes, also subject to gradient violation, all of which, in turn, outrank the individual faithfulness constraints. One important difference between Kirchner's account and the present one is that, unlike in Kirchner's, in our analysis, the raising constraint and the conjunction of vowel-height feature identity constraints are assigned the same rank. In their seminal programmatic work on Correspondence Theory, McCarthy and Prince (1995, 1997) suggest that in OT phonological processes emerge (or, in their own terms, "become active") when a structural constraint crucially dominates a conflicting faithfulness constraint. For example, a vowel harmony process becomes active in a language when the requirement for the harmonic features to agree within the harmonic domain is more compelling than the identity of input-output features. While the account put forth in this paper does not go against the guidelines of this conceptual framework, Kirchner's analysis of Nzɛbi is incompatible with it, since vowel raising occurs in spite of the fact that the raising constraint is crucially dominated by (the local conjunction of) identity constraints. In this sense, the present analysis of gradient vowel raising represents an improvement of Kirchner's original proposals.

While some authors working within OT have questioned the status of local conjunction in the theory (e.g., McCarthy 2002b, Padgett 2002, Lubowicz 2003a), this mechanism is justified to the extent that it provides a way to capture certain aspects of phonological structure that cannot otherwise be expressed by individual constraint interaction. In fact, constraint conjunction remains relatively controversial in OT because, on the one hand, it greatly increases OT's descriptive power, thus possibly predicting phonological patterns unattested in human language, and, on the other, it substantially undermines the basic OT tenet of strict constraint domination. Unfortunately, however, there is no widespread agreement at present on the nature and the type of substantive limitations that should be imposed on local conjunction. Some authors have attempted to set restrictions on the kinds constraints that may be conjoined, such as the condition that they belong to the same family (Itô & Mester 1998) or, alternatively, that they share the same domain (Fukazawa and Miglio 1998, Itô and Mester 1998, 2003, Lubowicz 2005). The only condition generally agreed on is that conjoined constraints share some common property (cf. Padgett 2002). While a detailed discussion of constraint conjunction is beyond the scope of this chapter, reasonably solid motivation can be provided in support of the composite constraint used in our analysis of Proto-Spanish and Lena Asturian metaphony. First, it meets the requirement that the two members of a conjunction be phonetically conjoinable (McCarthy 1997). Second, the two conjoined constraints operate within words, thus also satisfying the general condition that the members of a conjunction share the same domain (Smolensky 1995, 1997). Finally, and perhaps most importantly, the present analysis can be justified insofar as it succeeds in expressing the unitary nature of metaphony.

References

Akinlabi, A. 1994. Alignment constraints in ATR harmony. *Studies in the Linguistic Sciences* 24:1–18.

Akinlabi, A. 1996. Featural affixation. *Journal of Linguistics* 32:239–289.

Alderete, J. 1997. Dissimilation as local conjunction. *Proceedings of NELS 27*, K. Kusumoto, 17–32. Amherst MA: GLSA.

Archangeli, D. 1984. *Underspecification in Yawelmani Phonology and Morphology.* PhD dissertation, MIT.

Archangeli, D. 1988. Aspects of underspecification theory. *Phonology* 5: 183–207.

Archangeli, D. and Pulleyblank, D. 1994. *Grounded Phonology*. Cambridge MA: The MIT Press.

Archangeli, D. and Pulleyblank, D. 2002. Kinande vowel harmony: domains, grounded conditions and one-sided alignment. *Phonology* 19: 139–188.

Bakovic, E. 1999. Assimilation to the unmarked. Ms., Pennsylvania State University (Available on Rutgers Optimality Archive).

Bakovic, E. 2000. Harmony, Dominance and Control. PhD dissertation, Rutgers University. (Available on Rutgers Optimality Archive).

Blaylock, C. 1965. Hispanic metaphony. *Romance Philology* 18: 253–271.

Beckman, J. 2003. The case for local conjunction: Evidence from Fyem. In *Proceedings of the 22nd West Coast Conference on Formal Linguistics*, G. Garding and M. Tsujimura (eds), 56–69. Somerville MA: Cascadilla.

Calabrese, A. 1985. Metaphony in Salentino. *Rivista di gramatica generativa* 9/10: 1–141.

Calabrese, A. 1988. Towards a Theory of Phonetic Alphabets. PhD dissertation, MIT.

Calabrese, A. 1995. Phonological markedness and simplification procedures. *Linguistic Inquiry* 26: 373–463.

Clements, G.N. 1990. The hierarchical representation of vowel height. Ms, Cornell University, Ithaca NY.

Clements, G.N. 1991. Vowel height assimilation in Bantu languages. In *Berkeley Linguistics Society* 17: *Proceedings of the special session on African language structures*, K. Hubbard (ed.), 25–64. Berkeley CA: Berkeley Linguistics Society.

Clements, G.N. and Hume, E. 1995. The internal organization of speech sounds. In *The Handbook of Phonological Theory*, J. Goldsmith, 245–306. Cambridge MA: Blackwell.

Cole, J. 1998. Deconstructing metaphony. *Rivista di Linguistica* 10: 69–98.

Cole, J. and Kisseberth, C. 1994. An optimal domains theory of harmony. *Studies in the Linguistics Sciences* 24:101–114.

Cole, J. and Kisseberth, C. 1995. Nasal harmony in optimal domains theory. In *Proceedings of the Western Conference on Linguistics* (*WECOL*), Vol. 7, V. Samiian and J. Schaeffer (eds), 44–58. Fresno CA: California State University at Fresno.

Contreras, H. 1969. Simplicity, descriptive adequacy, and binary features. *Language* 45:1–8.

Craddock, J. 1980. The contextual varieties of yod: An attempt to systematization. In *A Festschrift for Jacob Ornstein*, E. Blasnitt and R.V. Teschner, 61–68. Rowley MA: Newbury House.

Dyck, C.J. 1995. Constraining the Phonology-Phonetics Interface: With exemplification from Spanish and Italian dialects. PhD dissertation, University of Toronto.

Dyck, C.J. 1996. The interface between underspecified phonological representations and specified phonetic representations. In *Interfaces in Phonology*, U. Kleinhenz (ed.), 279–293. Berlin: Akademie Verlag.

Eastlack, C. 1976. The phonology of twelfth century Castilian and its relation to the phonology of Proto-Romance. *Papers in Linguistics* 9: 89–126.

Foster, D.W. 1967/68. Phonetic issues associated with the four yods of Spanish. *Filología Moderna* 29–30: 151–158.

Fukazawa, H. 2001. Local conjunction and extending sympathy theory: OCP effects in Yucatec Maya. In *Segmental Phonology in Optimality Theory: Constraints and representations,* L. Lombardi (ed.), 231–260. New York: CUP.

Fukazawa, H. and Miglio, V. 1998. Restricting conjunction to constraint families. *Proceedings of the West Coast Conference on Linguistics* 9 (*WECOL* 96), V. Samiian (ed.), 102–117. Fresno CA: Department of Linguistics, California State University.

Gnanadesikan, A.E. 1997. Phonology with Ternary Scales. PhD dissertation, University of Massachusetts, Amherst.

Guthrie, M. 1968. Notes on Nzɛbi (Gabon). *Journal of African Languages* 7: 101–129.

Harris, J.W. 1975. Diphthongization, monophthongization, metaphony revisited. In *Diachronic Studies in Romance Linguistics*, M. Saltarelli and D. Wanner, 85–97. The Hague: Mouton.

Hartman, L. 1974. An outline of Spanish historical phonology. *Papers in Linguistics* 7: 123–191.
Hualde, J.I. 1989. Autosegmental and metrical spreading in the vowel harmony systems of Northern Spain. *Linguistics* 27: 773–805.
Hualde, J.I. 1992. Metaphony and count/mass morphology in Asturian and Cantabrian dialects. *Theoretical Analyses in Romance Linguistics*, C. Laeuffer and T. Morgan (eds), 99–114. Philadelphia PA: John Benjamins.
Hualde, J.I. 1998. Asturian and Cantabrian metaphony. *Rivista di Linguistica* 10: 99–108.
Hualde J.I. and Martínez-Gil, F. 1994. Un análisis autosegmental de ciertas alternancias vocálicas en el gallego moderno. *Actas do 19 Congreso Internacional de Lingüística e Filoloxía Románicas*, 181–195. La Coruña: Fundación Pedro Barrié de la Maza.
Itô, J. and Mester, A. 1998. Markedness and word-structure: OCP effects in Japanese. Ms., University of California, Santa Cruz (Available on Rutgers Optimality Archive).
Itô, J. and Mester, A. 2003. On the sources of opacity in OT. *The Syllable in Phonological Theory,* C. Féry and R. van de Vijver (ed.), 271–303. New York NY: CUP.
Kager, R. 1999. *Optimality Theory*. New York NY: CUP.
Kaze, J. 1989. Metaphony in Italian and Spanish Dialects Revisited. PhD dissertation, University of Illinois at Urbana-Champaign.
Kaze, J. 1991. Metaphony and two models for the description of vowel systems. *Phonology* 8: 163–170.
Kenstowicz, Michael, and Charles Kisseberth. 1979. *Generative Phonology*. New York: Academic Press.
Kiparsky, P. 1982. Lexical phonology and morphology. *Linguistics in the Morning Calm,* I.S. Yang (ed.), Vol. II, 3–91. Seoul: Hanshin.
Kiparsky, P. 1985. Some consequences of lexical phonology. *Phonology* 2: 85–138.
Kirchner, R. 1993. Turkish vowel harmony and disharmony: An optimality theoretic account. Paper presented at *Rutgers Optimality Workshop*–1. Rutgers University (Available on Rutgers Optimality Archive).
Kirchner, R. 1996. Synchronic chain-shifts in optimality theory. *Linguistic Inquiry* 27: 341–350.
Kirchner, R. 1997. Contrastiveness and faithfulness. *Phonology* 14: 83–111.
Krepinski, M. 1962. *La inflexión de las vocales en español*. Madrid: C.S.I.C.
Ladefoged, P. 1989. Representing phonetic structure. *UCLA Working Papers in Phonetics* 73. Los Angeles CA: UCLA.
Leonard, C. 1978. *Umlaut in Romance. An essay in linguistic archeology*. Grossen-Linden: Hoffmann Verlag.
Lindau, M. 1978. Vowel features. *Language* 54: 541–563.
Lombardi, L. 1999. Positional faithfulness and voicing assimilation in optimality theory. *Natural Language and Linguistic Theory* 17: 267–302.
Lloyd, P.M. 1987. *From Latin to Spanish.* Philadelphia PA: American Philosophical Society.
Lubowicz, A. 2002. Derived environment effects in optimality theory. *Lingua* 112: 243–280.
Lubowicz, A. 2003a. Contrast Preservation in Phonological Mappings. PhD Dissertation, University of Massachusetts, Amherst.
Lubowicz, A. 2003b. Local conjunction and comparative markedness. *Theoretical Linguistics* 29: 101–112 (special volume on comparative markedness, Scott Myers (ed.).
Lubowicz, A. 2003c. Counterfeeding opacity as a chain-shift effect. In *Proceedings of the 22nd West Coast Conference on Formal Linguistics*, G. Garding and M. Tsujimura (eds), 315–327. Somerville MA: Cascadilla.
Lubowicz, A. 2005. Locality of conjunction. Ms., University of Southern California (Available on Rutgers Optimality Archive).
Maiden, M. 1987. New perspectives on the genesis of Italian metaphony. *Transactions of the Philological Society* 85: 38–73.

Maiden, M. 1991. *Interactive Morphonology: Metaphony in Italian*. New York NY: Routledge.

Malkiel, Y. 1966. Diphthongization, monophthongization, metaphony: Studies in their interaction in the paradigm of Old Spanish *-ir* verbs. *Language* 42: 430–4472.

Martínez-Gil, F. 1991. The insert/delete parameter, redundancy rules, and neutralization processes in Spanish. In *Current Studies in Spanish Linguistics*, H. Campos and F. Martínez-Gil, 495–571. Washington DC: Georgetown University Press.

Martínez-Gil, F. 1992. Metafonía vocálica en proto-español. Paper presented at the *Second Colloquium on Generative Grammar*. Universidad del País Vasco, Vitoria-Gasteiz, Spain.

Martinet, A. 1952. Celtic lenition and Western Romance consonants. *Language* 28: 192–217.

Martinet, A. 1955. *Economie des changements phonétiques*. Paris: Francke.

McCarthy, J. 1986. OCP effects: Gemination and antigemination. *Linguistic Inquiry* 17: 207–264.

McCarthy, J. 1987. Process-specific constraints in optimality Theory. *Linguistic Inquiry* 28: 231–251.

McCarthy, J. 2002a. *A Thematic Guide to Optimality Theory.* New York NY: CUP.

McCarthy, J. 2002b. Comparative markedness. Ms., University of Massachusetts at Amherst. (Available on Rutgers Optimality Archive).

McCarthy, J and Prince, A.S. 1993a. Prosodic Phonology 1: Constraint interaction and satisfaction. Ms., University of Massachusetts at Amherst, and Rutgers University. (Available on Rutgers Optimality Archive).

McCarthy, J. and Prince, A.S. 1993b. Generalized alignment. In *Yearbook of Morphology* 1993, G. Booij and J.van Marle (eds), 79–153. Dordrecht: Kluwer.

McCarthy, J. and Prince, A.S. 1995. Faithfulness and reduplicative identity. In *University of Massachusetts Occasional Papers in Linguistics* 18: *Papers in optimality theory*, J.N. Beckman, L. Walsh Dickey and S. Urbanczyk, 249–384. Amherst MA: Graduate Linguistic Student Association, University of Massachusetts, Amherst.

McCarthy, J. and Prince, A.S. 1999. Faithfulness and identity in prosodic morphology. In *The Prosody-Morphology Interface*, R. Kager, H. van der Hulst and W. Zonneveld (eds), 218–309. New York NY: CUP.

Menéndez Pidal, R. 1906/1990. *El dialecto leonés*. León: Breviarios de la Calle del Pez.

Menéndez Pidal, R. 1964. *Orígenes del español: Estado lingístico de la Península Ibérica hasta el siglo XI* (5th ed.). Madrid: Espasa Calpe.

Menéndez Pidal, R. 1980. *Manual de gramática histórica española* (16th ed.). Madrid: Espasa Calpe.

Moreton, E. and Smolensky, P. 2002. Typological consequences of local constraint conjunction. Ms., Johns Hopkins University (Available on Rutgers Optimality Archive).

Mortensen, D. 2004. Abstract Scales in Phonology. Ms., University of California, Berkeley (Available on Rutgers Optimality Archive).

Neira Martínez, J. 1955. *El habla de Lena*. Oviedo: Diputación de Oviedo.

Nibert, H. 1998. Processes of vowel harmony in the Servigliano dialect of Italian: A comparison of two non-linear proposals for the representation of vowel height. *Probus* 10: 67–101.

Odden, D. 1991. Feature geometry. *Phonology* 8: 261–189.

Padgett, J. 2002. Constraint conjunction versus grounded constraint subhierarchies in optimality theory. Ms., University of California, Santa Cruz. (Available on Rutgers Optimality Archive).

Parkinson, F.B. 1996. The Representation of Vowel Height in Phonology. PHD dissertation, The Ohio State University.

Penny, R. 1991. *A History of the Spanish Language*. New York NY: CUP.

Penny, R. 2002. *A History of the Spanish Language* (2nd ed.). New York NY: CUP.

Pensado Ruíz, C. 1984. *Cronología relativa del castellano*. Salamanca: Ediciones Universidad de Salamanca.

Poser, W.J. 1982. Phonological representations and action-at-a-distance. In *The Structure of Phonological Representations*, Vol. 2, H. van der Hulst and N. Smith (eds), 121–158. Dordrecht: Foris.

Prince, A and Smolensky, P. 1993 [2004] *Optimality Theory: Constraint interaction in generative grammar*. Cambridge MA: Blackwell.
Pulleyblank, D. 1993. Vowel harmony and optimality theory. In *Proceedings of the Workshop on Phonology*, 1–18. Universidade de Coimbra: Associação Portuguesa de Linguística.
Pulleyblank, D. 1996. Neutral vowels in optimality theory: A comparison of Yoruba and Wolof. *Canadian Journal of Linguistics/Revue Canadienne de Linguistique* 4: 295–347.
Pulleyblank, D. 1997. Optimality theory and features. In *Optimality Theory: An overvie*w, D. Archangeli and D.T. Langendoen, 59–101. Oxford: Blackwell.
Ringen, C.O. and R.M. Vago. 1988. Hungarian vowel harmony in optimality theory. *Phonology* 5: 393–416.
Rivas, A.M. 1977. Hierarchical classes of features in binary-feature phonology. In *Proceedings of NELS* 8. Amherst MA: Graduate Linguistic Student Association, University of Massachusetts, Amherst.
Rohlfs, G. 1966. *Gramatica storica della lingua italiana y dei suoi dialetti*: *Fonetica*. Torino: Einaudi.
Salting, D. 1998. Vowel height: Reconsidering distinctive features. In *Proceedings of the 24th Annual Meeting of the Berkeley Linguistics Society*, B.K. Bergen, M.C. Plauché, and A.C. Bailey, 391–402. Berkeley CA: Berkeley Linguistics Society.
Salting, D. 2003. Toward a typology of vowel height features. In *Proceedings of the Western Conference on Linguistics (WECOL),* Vol. 15, B. Agbayani, V. Samiian, and B. Tucker, 255–269. Fresno CA: California State University.
Saltarelli, M. 1968. Marsian vocalism. *Orbis* 17: 88–96.
Saltarelli, M. 1973. Orthogonality, naturalness, and the binary feature framework. In *Issues in Linguistics: Papers in honor of Henry and Renée Kahane*, B.B. Kachru, R.B. Lees, Y. Malkiel, A. Pietrangeli and S. Saporta, 798–807. Urbana-Champaign IL: University of Illinois Press.
Schane, S. 1984. Fundamentals of particle phonology. *Phonology Yearbook* 1: 129–155.
Schürr, F. 1936. Umlaut und Diphthongierung in der Romania. *Romanische Forschungen* 50: 275–316.
Schürr, F 1964. La inflexión y la diptongación en español en comparación con las otras lenguas románicas. *Presente y Futuro de la Lengua Española: Actas de la Asamblea de Filología del I Congreso de Instituciones Hispánicas*. Madrid: C.S.I.C.
Schürr, F. 1970. *La diphtongaison romane.* Tübingen: Tübingen Beiträge zur Linguistik.
Smith, N.V. 1970/1971. Bedik and binarity. *African Language Review* 9: 90–98.
Smolensky, P. 1993. Harmony, markedness and phonological activity. (Available on Rutgers Optimality Archive).
Smolensky, P. 1995. On the internal structure of the constraint component *Con* of UG. (Available on Rutgers Optimality Archive).
Smolensky, P. 1997. Constraint interaction in generative grammar II: Local conjunction. Ms., University of Colorado. (Available on Rutgers Optimality Archive).
Steriade, D. 1987. Redundant values. In *Papers from the 23rd Annual Meeting of the Chicago Linguistic Society,* Part II: *Parassesion on autosegmental and metrical phonology*, A. Bosch, B. Need and E. Schiller, 339–362. Chicago IL: Chicago Linguistics Society.
Walker, R. 2004. Vowel feature licensing at a distance: Evidence from northern Spanish language varieties. In *Proceedings of the 23rd West Coast Conference on Formal Linguistics*, V. Chand, A. Kelleher, A.J. Rodriguez and B. Schmeiser (eds). 773–786. Somerville MA: Cascadilla.
Wang, W. 1968. Vowel features, paired variables, and the English vowel shift. *Language* 44: 695–708.
Williams, E.B. 1962. *From Latin to Portuguese* (2nd ed.). Philadelphia PA: University of Pennsylvania Press.
Williamson, K. 1977. Multivalued features for consonants. *Language* 53: 843–871.
Zamora Vicente, A. 1996. *Dialectología española* (2nd ed.). Madid: Gredos.
Zoll, C. 1998. Positional asymmetries and licensing. Ms., MIT. Cambridge MA. (Available on Rutgers Optimality Archive).

The phonology of nasal consonants in five Spanish dialects*

Carlos-Eduardo Piñeros
University of Iowa

The processes of nasal place assimilation, neutralization, velarization and absorption are analyzed in terms of three independent markedness constraints: Agree(Place), Place Hierarchy, and Align-C(Nasal), which despite being concerned with different aspects of the structure of output forms, conspire to undermine the place features of nasal consonants in the syllable coda. Data from five different Spanish dialects support the view that coronal is the unmarked place for consonants, and that the tendency of syllable-final nasals to become velar is not a consequence of assigning them an unmarked place articulator but of assimilating them to the preceding vowel. From this standpoint, velarization is only an intermediate step in a larger-scale process, whereby the nasal consonant is incorporated into the structure of the nuclear segment for the sake of segment-to-syllable alignment.

Keywords: velar nasal, nasal absorption, place assimilation, neutralization, alignment

0. Introduction

The common assumption that coronal is the unmarked place of articulation seems to be contradicted by the tendency of syllable-final nasals to velarize (e.g. Caribbean Spanish [ˈpãŋ] < /pan/ 'bread'). To cope with this unexpected pattern, some linguists have proposed that coronal is the unmarked place in the syllable onset, but velar is the unmarked place in the coda (Trigo 1988). An alternative proposal is that specific grammars may select coronal or velar as the default place (Harris 1984). Others defend the view that final nasals become velar by sharing place features with the preceding vowel (Paradis and Prunet 1990, 1993). Yet another interpretation has been to assume

* I am grateful to three anonymous reviewers who provided me with insightful comments to improve this paper. Discussion with Maria Rosa LLoret at the 35th Linguistic Symposium on Romance languages, where this paper was presented, also helped me improve the analysis. Thanks are also due to my colleague Paula Kempchinsky, who took the time to read the manuscript and suggest stylistic changes.

that the derived velar nasals are actually not velar (Bakovic 2000). The patterns exhibited by final nasals in Spanish dialects are pertinent to this debate because both coronal and velar place behave as though they were the unmarked specification for nasal consonants in the coda.

In this paper, the processes of nasal place assimilation, neutralization, velarization and absorption are analyzed in terms of three independent markedness constraints: Agree(Place), Place Hierarchy, and Align-C(Nasal), which despite being concerned with different aspects of the structure of output forms, conspire to undermine the place features of nasal consonants in the syllable coda. Data from five different Spanish dialects support the view that coronal is the unmarked place for consonants (even in the coda), and that the tendency of syllable-final nasals to become velar is not a consequence of assigning them an unmarked place articulator but of assimilating them to the preceding vowel. From this standpoint, velarization is only an intermediate step in a larger-scale process, whereby the nasal consonant is incorporated into the structure of the nuclear segment for the sake of segment-to-syllable alignment.

1. The data

So-called 'conservative' Spanish dialects are characterized by their tendency to retain syllable-final consonants (e.g. [ˈt̪ak.si] < /t̪aksi/ 'taxi', [ˈkas.pa] < /kaspa/ 'dandruff', [bo.ˈt̪on] < /bot̪on/ 'button', [ˈkul.pa] < /kulpa/ 'guilt', [ˈkaɾ.t̪a] < /kaɾt̪a/ 'letter'). This property of 'conservative' dialects opposes them to 'radical' dialects, which have a tendency to lose or weaken consonants assigned to the syllable coda (Guitart 1996). Processes such as deletion (e.g. [ˈt̪a.si]), debuccalization (e.g. [ˈkah.pa]), nasal velarization/absorption (e.g. [bo.ˈt̪õŋ]/[bo.ˈt̪õ]), vocalization (e.g. [ˈkui̯.pa], [ˈkai̯.t̪a]), among various others, manifest an aversion against consonants in syllable-final position.

A facet of this phenomenon that has been fairly well documented is the weakening of syllable-final nasals. In this regard, a 'conservative' dialect such as Mexico City Spanish contrasts sharply with a 'radical' dialect such as Panama City Spanish, as illustrated in (1) and (2) below.

The data in (1a–b) show that, in Mexico City Spanish, nasals adopt the place features of a following obstruent consonant (stop, affricate, or fricative). While it is possible for nasals to disagree in place of articulation with a following sonorant consonant, this only happens when that consonant is another nasal (1c–e). Moreover, we see that in the absence of a following consonant, (1f–g), syllable-final nasals surface as [n], which suggests that coronal is the unmarked place of articulation.

(1) Syllable-final nasals in Mexico City Spanish (From Harris 1969)[1]

Nasal C before	*Bilabial*	*Labio-dental*	*Dental*	*Alveolar*	*Palato-alveolar*	*Velar*
a. *Stop/Affricate*	ca[m]po ca[m]bio		cua[n̪]to cua[n̪]do		ra[n̠]cho	a[ŋ]ca ga[ŋ]ga
b. *Fricative*		triu[ɱ]fo		ca[n]so		aje[ŋ]jo
c. *Nasal*	i[n]menso			i[n]nato colu[m]na		
d. *Lateral*				e[n]lace		
e. *Rhotic*				ho[n]ra		
f. *# Vowel*				esta[n] allá		
g. *# Pause*				desdé[n]		

Although the nasal allophones that occur in the dialect of Mexico City also occur in that of Panama City, the latter variety differs in that it allows more than one realization for any nasal consonant that is assigned to the syllable coda.

1. Glosses are as follows:

a. *Stop/Affricate*	'countryside' 'change'		'how much' 'when'		'ranch'	'haunch' 'bargain'
b. *Fricative*		'triumph'		'tired'		'absinth'
c. *Nasal*	'immense'			'innate' 'column'		
d. *Lateral*				'link'		
e. *Rhotic*				'honor'		
f. *# Vowel*				'they are there'		
g. *# Pause*				'disdain'		

(2) Syllable-final nasals in Panama City Spanish (From Cedergren and Sankoff 1975)[2]

Nasal C before	*Bilabial*	*Labio-dental*	*Dental*	*Alveolar*	*Palato-alveolar*	*Velar*
a. *Stop/Affricate*	ca[m]po c[ã]po		ca[n̪]to c[ã]to			ci[ŋ]co c[ĩ]co
	ca[m]bio c[ã]bio		cua[n̪]do cu[ã]do			co[ŋ]ga c[õ]ga
b. *Fricative*		triu[ɱ]fo triu[ŋ]fo tri[ũ]fo		ca[n]so ca[ŋ]so c[ã]so	ra[n̠ʃ]o[3] ra[ŋʃ]o r[ãʃ]o	aje[ŋ]jo aj[ẽ]jo
c. *Nasal*	i[n]menso i[ŋ]menso [ĩ]menso			hi[m]no hi[ŋ]no h[ĩ]no		
d. *Lateral*				e[n]lace e[ŋ]lace [ẽ]lace		
e. *Rhotic*				ho[n]rado ho[ŋ]rado h[õ]rado		
f. *# vowel*				está[n] allá está[ŋ] allá est[ã] allá		
g. *# pause*				desdé[n] desdé[ŋ] desd[ẽ]		

The data in (2) show that, besides assimilating in place of articulation to a following obstruent consonant, syllable-final nasals may become velar, or absorbed by the preceding vowel, regardless of what follows them (2a–f).[4] In this regard, Cedergren and Sankoff (1975:71) point out that although place assimilation before obstruents

2. Glosses are as follows:

a.	*Stop/Affricate*	'countryside'		'song'			'five'
		'change'		'when'			'Cuban dance'
b.	*Fricative*		'triumph'		'tired'	'ranch'	'absinth'
c.	*Nasal*	'immense'			'anthem'		
d.	*Lateral*				'link'		
e.	*Rhotic*				'honest'		
f.	*# Vowel*				'they are there'		
g.	*# Pause*				'disdain'		

3. In Panama City Spanish, the affricate /tʃ/, which in Spanish orthography is represented as 'ch', undergoes deaffrication to [ʃ].

4. Although, word-internally, syllable-final nasals do not have a velar alternant before stops, this option does occur across a word boundary (e.g. co[m] padre ~ co[ŋ] padre ~ c[õ] padre 'with father').

does occur in Panama City Spanish, its frequency is so low (only 2%) that it cannot be regarded as a productive phonological process. By contrast, the productivity of velarization and absorption is unquestionable from the frequency rates presented in (3). The statistics show that in all contexts where final nasals may occur, their predominant realization is as nasalization on the preceding vowel, (3c), whereas the velar nasal is the second most frequent allophone, (3b).

(3) Distribution of final nasal variants in Panama City Spanish (From Cedergren and Sankoff 1975:72)

Variants	___ #C	___ #V	___ #‖
a. Assimilated or alveolar nasal	2% 89/4460	1% 28/2759	1% 9/919
b. Velarized nasal	24% 1070/4460	41% 1131/2759	34% 312/919
c. Absorbed nasal	74% 3300/4460	58% 1600/2759	69% 634/919

It is important to emphasize that the processes of nasal velarization and absorption are not categorical, but variable and gradient (Terrell 1975, D'Introno and Sosa 1988). Several social variables such as age, sex, socio-economic status, and urban vs. rural origin have been identified as factors that condition the probability with which these two processes occur (Cedergren and Sankoff 1975, López Morales 1980).

Regarding the gradient nature of these changes, it has been observed that, as the nasal consonant shifts to the velar place of articulation, there is increasing nasalization of the preceding vowel, with the highest degree of nasalization occurring when the consonant is completely absorbed. That is to say that there are increasing degrees of coarticulation between the members of the $\mathrm{VN}]_\sigma$ sequence. The fusion of the two segments into a single one, [Ṽ], is the stage at which coarticulation is maximal, but we will see in Section 4 that there are also stages of partial coarticulation, which gives rise to several other allophones. Further evidence that these sound changes are gradient is provided by the fact that the velar nasal is not always [ŋ]. The constriction of the velar nasal may be formed so weakly that sometimes there is no linguo-velar contact (i.e. [ɣ̃]), and other times there are no perceptible place features at all (i.e. the anusvara, represented here as [ɴ]).

In addition to Panama City Spanish, the weakening of syllable-final nasals has also been thoroughly documented for the dialects of Havana (Terrell 1975), San Juan (López Morales 1980), and Caracas (D'Introno and Sosa 1988).

Consider next the case of the dialect spoken in San Juan. As the frequency rates in (4) show, a place-assimilated nasal in the context ___ #C and an alveolar nasal in the context ___ #V are the predominant variants of final nasals in this dialect (4a). We find, nonetheless, that despite the high occurrence of place-assimilated and alveolar nasals in final position, the attrition of final nasals is already underway, as it is evinced by the fact that both velarization and absorption occur, even if it is only as the second and third most frequent variants (4b, c). The effects of consonant weakening are most noticeable in the context ___ #‖, where the frequency of velarization triples the number of coronal realizations and absorption becomes more significant.

(4) Distribution of final nasal variants in San Juan Spanish (From López Morales 1980:209)

Variants	___ #C	___ #V	___ #‖
a. Assimilated or alveolar nasal	80.6% 3006/3725	65.8% 1458/2214	22.4% 280/1246
b. Velarized nasal	13% 485/3725	26.6% 590/2214	69.3% 864/1246
c. Absorbed nasal	6.2% 234/3725	7.4% 166/2214	8.1% 102/1246

For Havana, Terrell (1975) found that place assimilation and velarization are in complementary distribution. In preconsonantal position, the predominant variant is a place-assimilated nasal with a frequency rate of 60%, while in prevocalic and prepausal positions it is the velar allophone that predominates at comparable frequency rates (59% and 54%, respectively). If we compare the numbers reported for San Juan, (4), with those reported for Havana, (5), we see that in the latter dialect both velarization and absorption continue to gain generality at the expense of assimilated and alveolar allophones. It is remarkable that in Havana Spanish the number of absorbed nasals jumps up to 38–39% in all contexts.

(5) Distribution of final nasal variants in Havana Spanish (From Terrell 1975:263)

Variants	___ #C	___ #V	___ #‖
a. Assimilated or alveolar nasal	60% 1140/1898	3% 30/983	8% 42/560
b. Velarized nasal	1% 29/1898	59% 582/983	54% 303/560
c. Absorbed nasal	39% 730/1898	38% 371/983	38% 215/560

In their study of the same phenomenon in Caracas, D'Introno and Sosa (1988) found that place-assimilation has dramatically lost ground to velarization, (6). The statistics in (6) show that in the context of a following consonant, nasals assimilate in only 7.8% of the cases, whereas velarization occurs at a frequency rate of 76.5%. In the absence of a following consonant, final nasals also surface most frequently as velar (94.6% before a vowel, and 92.1% before a pause), while the alveolar articulation has a very low frequency rate (3.8% before a vowel, and 4.6% before a pause). In addition to the overwhelming percentages of velarization, the occurrence of nasal absorption at rates that, although small, are not negligible indicates that the tendency of final nasals to be coarticulated with the preceding vowel is gaining strength.[5]

5. D'Introno and Sosa (1980) is the only study that counts the instances of total absorption separately from those in which the nasal consonant remains in the coda but has no perceptible place features (e.g. [ɴ]). Since they note that researchers tend to assign [ɴ] to the category of absorbed nasals (p. 29),

(6) Distribution of final nasal variants in Caracas Spanish (From D'Introno and Sosa 1988:26–27)

Variants	___ #C	___ #V	___ #‖
a. Assimilated or alveolar nasal	7.8% 59/761	3.8% 17/443	4.6% 24/522
b. Velarized nasal	76.5% 582/761	94.6% 419/443	92.1% 481/522
c. Absorbed nasal	15.7% 120/761	1.6% 7/443	3.3% 17/522

To summarize, all four 'radical' dialects discussed above exhibit a tendency to undermine nasal consonants in syllable-final position, not just through place assimilation and neutralization, but also through velarization and absorption. Quantitative studies have found that in San Juan and Havana, the processes of nasal velarization and absorption are still incipient to moderate, whereas in Caracas and Panama City they have become highly productive. Panama City Spanish seems to be the dialect where the tendency to weaken syllable-final nasals is most advanced, but even in that system, nasals are not completely barred from the syllable coda. To the best of my knowledge, there is still no variety of Spanish where the process of nasal absorption has become categorical, which would have given rise to a new system of nasal vowel phonemes, as occurred in the history of French and Portuguese.

2. Nasal place assimilation

It is well known that in 'conservative' Spanish dialects, both word-internal and word-final nasals are subject to place assimilation in the context of a following obstruent consonant provided that speech is connected (Navarro Tomás 1967, Harris 1969). The fact that nasals in such dialects are subject to place assimilation but show no signs of velarization or absorption indicates that the factor responsible for the attrition of syllable-final nasals is independent of the force that drives assimilation. Following much work in Optimality Theory, I assume that assimilation is caused by a constraint that requires sharing of features (Agree), whose satisfaction may be obtained at the expense of the identity between input and output forms. On this view, place assimilation arises when Agree(Place) takes precedence over two faithfulness constraints: one that prohibits the loss of underlying place features, (8), and another one that bans multiple linkage, (9). Tableau (10) shows how the ranking Agree(Place) >> {Max(Place), Uniformity} induces place assimilation.

(7) Agree(Place): The members of a consonant cluster must agree in place features. (cf. Lombardi's 1999 Agree(Laryngeal))

I have combined the instances of [ɴ] with those of [Ṽ] in order to put their results into categories that are comparable with those used by the other studies.

(8) Max(Place): The place features of input segments must be preserved in the output. (cf. Lombardi's 2001 Max(Laryngeal))

(9) Uniformity: Input and the output elements must stand in a one-to-one correspondence relationship with each other. (Lamontagne and Rice 1995, McCarthy and Prince 1995)

(10) The members of a consonant cluster are forced to become homorganic

Input: /enfoke/ 'approach'	Agree (Place)	Max (Place)	Uniformity
a. [en.fo.ke]	*!		
☞ b. [e**ɱ**.fo.ke]		*	*

When examining the tableaux, please note that bolding is used to signal those elements of output candidates that are in multiple correspondence with input structure. In tableau (10), candidate (10b) is favored over (10a) because its two flaws (failure to preserve the place features of the underlying nasal and the generation of a linked structure between the segments [**ɱ.f**]) are justified by the overriding need to satisfy the dominant constraint Agree(Place).

Following Beckman (1999), I attribute the role of determining the directionality of assimilation to a positional faithfulness constraint requiring the preservation of the place features of onset segments, (11). This approach grants greater faithfulness to onset segments on the assumption that the syllable onset is a prominent linguistic position. According to this, the preservation of underlying place features may be broken down into a positional and a general faithfulness constraint: Max^{Ons}(Place) and Max(Place). The universal ranking Max^{Ons}(Place) >> Max(Place) guarantees that the preservation of the place features of onset segments will take precedence over the preservation of the place features of segments parsed elsewhere.

(11) Max^{Ons}(Place): Onset segments must preserve the place features of their input correspondents (after Beckman 1999 and Lombardi 2001)

While domination of Agree(Place) over both Max(Place) and Uniformity induces assimilation, the higher rank of Max^{Ons}(Place) prevents assimilation from working to the detriment of onset consonants. As a result of this, assimilation must be regressive. Tableau (12) shows that if place assimilation were progressive, (12c), a fatal violation of Max^{Ons}(Place) would ensue; whereas if assimilation is regressive, (12b), both Max^{Ons}(Place) and Agree(Place) may be satisfied.

(12) Nasal place assimilation must be regressive

Input: /enfoke/ 'approach'	Max^{Ons} (Place)	Agree (Place)	Max (Place)	Uniformity
a. [en.fo.ke]		*!		
☞ b. [e**ɱ**.fo.ke]			*	*
c. [e**n**.**s**o.ke]	*!		*	*

Another issue that must be addressed is why nasals are so prone to assimilate to obstruents. This fact can also be captured in terms of prominence-based faithfulness constraints, as suggested by Padgett (1996b). Under the ranking MAX^{Obstr}(Place) >> MAX(Place), the place features of obstruent consonants are prioritized. Support for this approach is provided by the observation that the phonetic cues that signal place in obstruents are more salient than those that signal place in nasals and other consonant classes (Ohala and Ohala 1993, Henton et al 1992). As tableau (13) shows, the rank of MAX^{Obstr}(Place) above AGREE(Place) has the effect of exempting obstruents from place assimilation, (13c).

(13) Nasals fall prey to assimilation, but not obstruents

Input: /infekt̪a/ '(s)he infects'	MAX^{Obstr} (Place)	MAX^{Ons} (Place)	AGREE (Place)	MAX (Place)	UNIFORMITY
a. [in.fek.t̪a]			**!		
b. [i**n**.**s**ek.t̪a]		*!	*	*	*
c. [i**ɱ**.fe**t̪**.**t̪**a]	*!			**	**
☞ d. [i**ɱ**.fek.t̪a]			*	*	*

Because higher priority is granted to the preservation of the place features of obstruent and onset segments, the only cases where the demands of AGREE(Place) can be met are those where one of the consonants of the cluster is both sonorant and syllabified as a coda, (13d). Given Spanish phonotactics, this analysis predicts that aside from NC clusters, the only other clusters where AGREE(Place) can be obeyed are those where the first member is a liquid consonant. This prediction is borne out, as it is indeed the case that liquid consonants also undergo place assimilation in Mexico City Spanish and other 'conservative' dialects (e.g. [fal̪.d̪a] < /fald̪a/ 'skirt', [al̟.θaɾ] < /alθaɾ/ 'to raise', [kol̠.tʃa] < /koltʃa/ 'blanket'). As it can be seen in (14), none of the dominant constraints can rescue the place features of a syllable-final liquid, (14b).

(14) Liquids are also subject to place assimilation

Input: /fald̪a/ 'skirt'	MAX^{Obstr} (Place)	MAX^{Ons} (Place)	AGREE (Place)	MAX (Place)	UNIFORMITY
a. [fal.d̪a]			*!		
☞ b. [fa**l̪**.**d̪**a]				*	*
c. [fa**l**.**d**a]	*!	*		*	*

Despite their common origin, the processes of nasal and liquid place assimilation differ substantially. Whereas nasals assimilate to obstruents at all places of articulation, liquids only do so within the coronal region. I hypothesize that the reason for this asymmetry is that segments with a lateral or rhotic manner of articulation are more difficult to produce by the tongue dorsum or lips than by the tongue tip (cf. Ladefoged and Maddieson 1996).[6] As a matter of fact, even within the coronal area, dental and interdental rhotics are highly marked segments. This would suggest that the limited productivity of liquid place assimilation is an effect of additional markedness constraints; however, I leave this issue for future research because it falls beyond the scope of this paper.

Turning now to NN clusters, which in 'conservative' dialects may be heterorganic (1b), Harris (1984) has pointed out that [mm] and [ɲɲ] are impossible clusters both inside and across morpheme boundaries. Harris also notes that morpheme-internal clusters consisting of two alveolar nasals are extremely rare. In fact, *pere*[n.n]*e* is the only common word that contains an [nn] sequence within the same morpheme. Except for a handful of uncommon words (e.g. *pi*[n.n]*ado* 'pinnate', *pi*[n.n]*ípedo* 'pinniped' and *esta*[n.n]*ífero* 'stanniferous'), all other [nn] clusters occur across morpheme boundaries (e.g. [in.no.βle] < /in+noble/ 'ennoble', [in.ne.se.sa.ɾi̯o] < /in+nesesario/ 'unnecessary', etc.). Moreover, there is a strong tendency to reduce such clusters to a single consonant in casual speech (Quilis 1996). These observations point to the generalization that homorganic NN clusters are prohibited, at least within morphemes. With the addition of a positional markedness constraint against morpheme internal geminates, (15), the possibility that the members of an NN cluster differ in place features is granted, (16a). That is to say that the reason why heterorganic NN clusters are tolerated is to avoid forming a geminate consonant, (16b).

(15) *Gem(Morph): Morpheme internal geminates are prohibited.

(16) Morpheme-internal NN clusters are allowed to be heterorganic

Input: /kolumna/ 'column'	*Gem (Morph)	Max^{Obstr} (Place)	Max^{Ons} (Place)	Agree (Place)	Max (Place)	Uniform
☞ a. [ko.lum.na]				*		
b. [ko.lu**n**.**n**a]	*!				*	*
c. [ko.lu**m**.**m**a]	*!		*		*	*

3. Nasal place neutralization

Besides place assimilation, 'conservative' Spanish dialects such as the one spoken in Mexico City exhibit neutralization to the unmarked place of articulation (i.e. [coronal]). This is clearly observable when the nasal consonant is word final and not under the influence of a following consonant (1f–g). In such a context, one would expect that the three-way contrast that exists in initial position (e.g. [ma.t̪a] '(s)he kills' ~ [na.t̪a]

6. Labial laterals are impossible because lateral airflow requires the participation of the tongue in order to create lateral passages. As to velar laterals, Ladefoged and Maddieson (1996) report that languages such as Melpa and Mid-Waghi use [ʟ], but this sound is crosslinguistically rare. With regard to rhotics, trills may be articulated with the participation of the lips, [ʙ], or the tongue dorsum, [ʀ], but they are also far less common than coronal rhotics.

'cream' ~ [ɲa.t̪a] 'flat nosed') would be able to emerge. Yet, contrary to that expectation, there are no patrimonial words ending in [m] or [ɲ], and whenever foreign words such as *album*, *boom*, *tang, ring,* etc. are nativized, they are turned into [al.bun], [bun], [tan], [rin]. The fact that /m/ and /ɲ/ neutralize to [n] in the syllable coda is corroborated by alternations such as [a.ˈðan] 'Adam' vs. [a.ða.ˈmi.t̪a] 'adamite' and [d̪ez.ˈðen] 'disdain' vs. [d̪ez.ˈðe.ɲa] '(s)he disdains', as Harris (1984) first noted.

Following Prince and Smolensky (1993/2002) and De Lacy (2002), I attribute this limitation on the place of articulation of final nasals to a family of markedness constraints that prohibits place features, (17). These place markedness constraints are organized in a fixed hierarchy, according to which Dorsal is the most marked place articulator, whereas Coronal is the least marked. In direct conflict with the place markedness constraints is a principle requiring segments to bear place features (18). Tableau (19) demonstrates that, under the ranking HavePlace >> *Dor >> *Lab >> *Cor >> Max(Place), the only place of articulation that a final nasal may have, in case of not being place-linked to a following consonant, is coronal.

(17) Place Hierarchy: *Dorsal >> *Labial >> *Coronal

(18) Have Place: All segments must have place features.

(19) Coronals are the least costly place-specified consonants

Input: /ad̪am/ 'Adam'	Have Place	Place Hierarchy			Max (Place)
		*D	*L	*C	
a. [a.ðam]			*!	*	
b. [a.ðaɲ]		*!		**	*
☞ c. [a.ðan]				**	*
d. [a.ðaɴ]	*!			*	*

Note that although the best way to comply with the Place Hierarchy would be to leave the nasal consonant deprived of place features, (e.g. [ɴ]), this option is ruled out by the dominant constraint Have Place, (19d). When the decision is passed on to the Place Hierarchy, an alveolar nasal is selected as the optimal allophone because it violates the lowest of the place markedness constraints, (19c). It is worth highlighting that the palatal nasal incurs two violations of the Place Hierarchy due to the fact that the articulation of palatal sounds engages both the front and back parts of the tongue (Keating 1988). Also, keep in mind that the only violations of *Place that are being counted in the tableaus are those incurred by consonants.

In partial summary, the proposed analysis takes the stance that nasal place assimilation and neutralization are triggered by separate constraints (Agree(Place) and the Place Hierarchy), both of which outrank the faithfulness constraint Max(Place). The application of assimilation is restricted by the prominence-based faithfulness constraints Max^{Ons}(Place) and Max^{Obstr}(Place), which outrank Agree(Place), and thereby exempt onset and obstruent consonants from undergoing assimilation. Furthermore, the outcome of neutralization may not be a placeless nasal because the markedness constraint Have Place takes precedence over the members of the Place Hierarchy.

The interplay between the two processes is illustrated in (20) with the English borrowing *ping-pong*, which the grammar of 'conservative' Spanish dialects turns into [pim.pon]. Not being crucial for this example, the constraint Max$^{\text{Obstr}}$(Place) has been left out for lack of tableau space.

(20) Both place assimilation and neutralization affect nasal consonants in the coda

Input: /piŋpoŋ/[7] 'ping pong'	Max$^{\text{Ons}}$ (Place)	Agree (Place)	Have Place	Place Hierarchy *D	*L	*C	Max (Place)	Unif
a. [piŋ.poŋ]		*!		**	**			
b. [pi**m**.poŋ]				*!	**		*	*
☞ c. [pi**m**.po**n**]					**	*	**	*
d. [pi**m**.po**N**]			*!		**		**	*
e. [piŋ.**g**on]	*!			*	*	*	**	*

4. Nasal velarization and absorption

Let us turn now to the analysis of final nasals in 'radical' dialects. Nasal velarization cannot be caused by the same constraint that triggers place assimilation, Agree(Place), for two reasons. First, the members of the NC cluster often disagree in place features (e.g. *co*[ŋp]*adre* 'with father', *ra*[ŋʃ]*o* 'ranch', *triu*[ŋf]*ar* 'to triumph', *hi*[ŋn]*o* 'anthem', *e*[ŋl]*ace* 'link', etc.), and second, the nasal consonant may become velar even when it is not in contact with another consonant (e.g. *pa*[ŋ] 'bread', *corazó*[ŋ] 'heart'). The Place Hierarchy is not likely to be the trigger of velarization either, because the segment that is created is articulated precisely with the most costly of the three place articulators.

I propose that the processes of nasal velarization and absorption have a common cause; namely, the markedness constraint known as the Coda Condition. But rather than viewing it as a negative constraint, I follow Itô and Mester (1994, 1999) in their proposal to reformulate the Coda Condition as a positive constraint by resorting to the notion of segment-to-syllable alignment. Within this approach, the constraint Align-C(Nasal) is the principle that governs the distribution of nasal consonants within the syllable, (21). The adoption of this alignment constraint obviates the need to invoke one constraint to force the nasal consonant to give up its place features (i.e. Coda Condition) and another constraint to trigger the absorption of the entire nasal segment (i.e. *Coda). In the analysis proposed below, the degree to which the nasal consonant is weakened will depend on the interaction between Align-C(Nasal) and the members of the Max(Feature) constraint family.

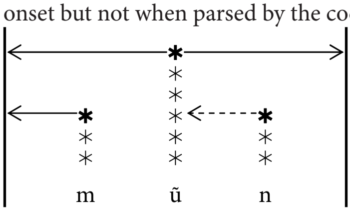
7. Note that regardless of the place of articulation that we posit for the nasal consonants in the input form (e.g. /pi**m**po**m**/, /pi**ɲ**po**ɲ**/ or /pi**n**po**n**/), the proposed grammar will select [pi**m**.po**n**] as the optimal output form.

(21) ALIGN-C(Nasal): Every nasal consonant must be aligned with the left edge of a syllable. (Itô and Mester 1994, 1999, Piñeros 2001, 2004)[8]

(22) MAX(Feature): The features of input segments must be preserved in the output.

Nasal consonants in the syllable coda are challenged by ALIGN-C(Nasal) because they cannot be aligned with the left edge of the syllable that parses them. This is illustrated in (23) with the final syllable of the word *común* [ko.mũn] 'common'.[9] In this syllable, the first nasal consonant is aligned, but the second one is misaligned. To indicate proper alignment, an arrow with a continuous line is used, whereas the arrow with a broken line indicates failure to obtain such alignment.

(23) Consonants can be aligned with the left edge of their syllable when parsed by the onset but not when parsed by the coda



Following Itô and Mester (1999), segment-to-syllable alignment is assessed in terms of a sonority grid, which is constructed according to the sonority value of each segment. In (23), for example, the high vowel [ũ] is assigned three more marks than each one of the nasal consonants that flank it. This is because laterals, rhotics, and high vowels are increasingly more sonorous than nasals. Given that the organization of segments within the syllable is such that less sonorous segments appear towards the margins, the sonority grid tends to have the shape of a hill. In syllables with an onset and a coda as in (23), there is an incline from the left margin to the nucleus, and also a decline from the nucleus to the right margin.

What is crucial for segment alignment is the highest mark on the sonority column of each segment because it is at this level that alignment is checked. It follows from this that the first nasal consonant in (23) is in compliance with ALIGN-C(Nasal) because nothing intervenes between its highest mark and the left syllable margin. By contrast, the second nasal consonant in (23) is in violation of ALIGN-C(Nasal) because the sonority column of the nuclear segment (e.g. the vowel [ũ]) blocks its alignment. Note that, being the peak of sonority within the syllable, the nuclear segment is able to align itself with both syllable margins. As a consequence of this, postnuclear consonants

8. ALIGN-C(Nasal) belongs to a family of consonant-alignment constraints (i.e. ALIGN-C(Stop), ALIGN-C(Fricative), ALIGN-C(Lateral), ALIGN-C(Rhotic)), which requires all consonants to be aligned with the left edge of a syllable. Phonetic grounding for this constraint family is provided by the fact that the left syllable margin guarantees that a consonant in that position will be released into a segment of greater sonority. This has the positive effect of enhancing the perceptibility of the consonant because the release provides a greater number of phonetic cues that signal properties such as place of articulation and laryngeal state.

9. A vowel flanked by nasal consonants is regularly nasalized in Spanish.

are at a disadvantage because they cannot get past the sonority column of the nuclear segment. In other words, the nuclear segment acts as an insurmountable barrier that stands between postnuclear consonants and the left edge of their syllable.[10]

Considering that not even in 'radical' dialects are final nasals completely wiped out, the constraint Max(Seg) must take precedence over Align-C(Nasal).[11] According to this, final nasals do not undergo deletion but rather coalescence, as is evinced by the fact that the consonant is never removed without there being heavy nasalization of the preceding vowel (Cedergren and Sankoff 1975:70, Terrell 1975:261, López Morales 1980:212, D'Introno and Sosa 1988:25). Yet, as the members of the VN]$_{\sigma}$ sequence fuse into a single segment, loss of most of the features of the nasal consonant is unavoidable. The ranking Max(seg) >> Align-C(Nasal) >> {Max(Feature), Uniformity} accounts for the process of nasal absorption, (25).

(24) Max(Seg): Every segment in the input must have a correspondent in the output. (McCarthy and Prince 1995)

(25) Syllable-final nasals are subject to coalescence rather than deletion

Input: /konfunden̪/ 'they confuse'	Max (seg)	Align-C (Nasal)	Max (Feature)	Uniformity
a. [kon.fun.d̪en]		*!**		
b. [koɱ.fun̪.d̪en]		*!**		**
☞ c. [kõ.fũ.d̪ẽ]			***	***
d. [ko.fu.ðe]	*!**		***	

The problem with candidate (25a) is that it contains a total of three nasal consonants that cannot be aligned with the left edge of a syllable because they are in postnuclear position. Neither place assimilation nor neutralization helps remedy this situation because even if a nasal adopts the place features of another consonant or uses the least costly articulator, it continues to be a consonantal segment in postnuclear position

10. The alternative of transferring the nasal in syllable-final position to the onset of the following syllable (e.g. [mũ.n̪d̪o] instead of [mũn̪.d̪o] 'world') is precluded by the Sonority Sequencing Generalization (Selkirk 1984). Note that this would create an illformed structure because there would be more than one sonority peak within the syllable.

11. The study conducted by D'Introno and Sosa (1988) is the only one that reports cases of loss of final nasals without concomitant nasalization of the preceding vowel. The authors clarify, however, that out of a total of 1726 final nasals, there were only 8 instances of deletion (0.46%), which can all be explained as an effect of grammatical factors. In this regard, it is significant that all 8 cases of deletion occurred in verbs. For some of them, the omission of the final nasal may be the result of a failure to express subject-verb agreement given that the plurality signaled by the nasal consonant is redundant (e.g. *Me fascina(n) todas las cosas vivas* 'I like all live things'). The remaining cases can be explained as a change from [+count] to [−count] that affects the head of certain noun phrases as in the sentence *Ahí vive mucho estudiante* 'A lot of students live there', where it is clear that *mucho estudiante* has a collective meaning. According to D'Introno and Sossa (1988:30), this semantic change is quite common in the Spanish of Caracas.

(25b). By contrast, the fusion of a nasal consonant with the preceding vowel effectively removes the offending segment from the right syllable margin, (25c). This solution comes at the cost of violating the faithfulness constraints Max(Feature) and Uniformity, but given their dominated status, the mismatch between input and output forms is inescapable. The more drastic solution of deleting not only some of the features, but all of the structure of the misaligned consonants (25d), is ruled out by Max(seg), which still holds strong above Align-C(Place).

It was shown in Section 1, however, that the behavior of final nasals is more complicated than this. One must also take into account that even in highly 'radical' dialects such as Panama City Spanish, syllable-final nasals are not always totally absorbed, (3). The most detailed phonetic studies have found that the absorption of final nasals exhibits a spectrum of realizations (D'Introno and Sosa 1988). The following are the five more distinct variants.

The weakest case of absorption is when the nasality of the consonant starts to migrate to the preceding vowel causing light nasalization on that segment, but with the nasal still retaining a full oral closure that is not limited to the velar place of articulation (e.g. [k**õɱ**.fu̯e.ɣo] < /kon fuego/ 'with fire'). Greater cohesion between the members of the VN]$_σ$ sequence occurs when, in addition to spreading its nasality to the vowel, the constriction of the nasal consonant shifts to the velar place of articulation (e.g. [k**õŋ**.fu̯e.ɣo]). As the nasalization of the vowel increases, the velar constriction of the nasal consonant gives in. The result of this is that the complete closure between the tongue dorsum and the velum is lost (e.g. [k**õɣ̃**.fu̯e.ɣo]), and ultimately there is no constriction at all but merely a nasal transition from the nasalized vowel to the postnasal consonant (e.g. [k**õɴ**.fu̯e.ɣo]). Lastly, total absorption is obtained when the vowel becomes maximally nasalized and no traces of velar constriction or nasal transition remain (e.g. [k**õ**.fu̯e.ɣo]). These allophones, connected in a chain-like fashion, are the main steps in the evolution from Vn]$_σ$ to Ṽ]$_σ$.

(26) Spectrum of VN]$_σ$ allophones

Vn]$_σ$	>	Ṽn]$_σ$	>	Ṽŋ]$_σ$	>	Ṽɣ̃]$_σ$	>	Ṽɴ]$_σ$	>	Ṽ]$_σ$
a.		b.		c.		d.		e.		f.

Part of the difficulty in unraveling this phenomenon has been that the differences among these allophones are subtle, and not all of the studies on final nasals observe such fine distinctions. The allophones (26a, b), for example, are normally regarded as the same one (e.g. a place-assimilated or alveolar nasal), despite the light change in nasal quality on the preceding vowel. Similarly, (26c, d) are both classified as velar nasals regardless of the degree of constriction, and (25e, f) tend to be grouped as instances of absorption, which is often incorrectly referred to as deletion.

When we look at these phonetic variants not in isolation, but as part of the spectrum depicted in (26), it becomes clear that what we are witnessing is a change in progress whereby a VN]$_σ$ sequence merges into a single segment through the incorporation of the consonant into the structure of the vowel. The variation that we observe in 'radical' Spanish dialects such as those of San Juan, Havana, Caracas, and Panama City is the result of the progression of this change.

To capture this progression, I propose that in the grammar of 'radical' Spanish dialects the markedness constraint Align-C(Nasal) is gradually gaining precedence over the cluster of faithfulness constraints represented by Max(Feature). Hence, when it is only Uniformity and a few members of Max(Feature) that surrender to Align-C(Nasal), absorption of the nasal consonant by the precedent vowel is incipient; but when, in addition to Uniformity, most members of Max(Feature) succumb to Align-C(Nasal), absorption is heavy or complete.

The implementation of this proposal also relies on Feature Class Theory (Padgett 1996a, b), which holds that features are organized according to class membership and that constraints may refer to such classes. The feature classes that are relevant for capturing the attrition of final nasals are Major (e.g. [consonantal, sonorant, etc.]), Stricture (e.g. [continuant, high, low, etc.], Place (e.g. [labial, coronal, dorsal, etc.]), and Nasality (e.g. [nasal]). The breakdown of Max(Feature) according to these features classes gives rise to a set of more specific feature faithfulness constraints: Max(Major), Max(Stricture), Max(Place), and Max(Nasality).

The initial stage of absorption, in which coarticulation only causes light nasalization of the preceding vowel (26b), arises when Uniformity is the only faithfulness constraint that surrenders to Align-C(Nasal). This is illustrated in tableau (27). When examining this and subsequent tableaus, please note that the hyphens that appear in the cells underneath Align-C(Nasal) are used to indicate gradient satisfaction of this constraint.

(27) Vowel nasalization

Input: /enlase/ 'link'	Max (seg)	Max (Nasal)	Max (Major)	Max (Strict)	Max (Place)	Align-C (Nasal)	Unif
a. [en.la.se]						*	
☞ b. [ẽ̆**n**.la.se]						---	*
c. [e.la.se]	*!	*	*	*	*		

In this evaluation, it is quite obvious that candidate (27a) violates Align-C(Nasal), whereas candidate (27c) abides by it. This is in contrast with the scenario illustrated by candidate (27b), where the assessment of what constitutes a violation of Align-C(Nasal) is not as transparent. While it is undisputable that candidate (27b) has a nasal consonant in the coda, it may be argued that this consonant is not completely misaligned. To develop this argument, it is crucial to observe that, in candidate (27b), nasality is not a feature that belongs exclusively to the syllable-final consonant, but also to the nuclear vowel.

Recall that by virtue of being the peak of sonority within the syllable, the nuclear vowel is the only segment within the syllable that is able to align itself with both syllable edges (23). Hence, while candidate (27b) is not in perfect compliance with Align-C(Nasal), it is superior to candidate (27a) because at least the [nasal] feature of the offending consonant is aligned with the left edge of the syllable via the nuclear vowel. It is true that there remain features of the nasal consonant (e.g. Major, Stricture, and Place) that are not properly aligned in candidate (27b), but one cannot deem a candidate that has made no effort to avoid consonant misalignment, (27a), to be in the same standing as a candidate that has taken a step towards achieving proper alignment. In other words, acknowledging that languages can assess violations of Align-C(Nasal) gradiently enables us to capture the fact that some of the strategies used to 'fix' the misalignment of final nasals are more effective than others.

In accord with this view, candidate (27b) does not receive an asterisk from Align-C(Nasal), but rather three hyphens, one for each of the feature classes that remain misaligned in the nasal consonant that occupies the syllable coda. Certainly, candidate (27c) does not contain any misaligned consonants; however, at this stage of the grammar, where most faithfulness constraints remain dominant, deletion is not sanctioned as a licit means to avoid consonant misalignment.

Consider now the evaluation in (28), which illustrates how the proposed system of constraints accounts for cases of nasal velarization (26c). When the next faithfulness constraint to be surpassed by Align-C(Nasal) is Max(Place), the grammar favors candidate (28c). The difference between (28c) and (28b) is that the structure of the nasal consonant is linked to that of the preceding vowel not only in terms of nasality but also in terms of place features. The idea behind this is that the nasal consonant does not become velar through the addition of a [dorsal] feature (feature insertion), but through feature sharing (assimilation). More specifically, I follow Paradis and Prunet (1990, 1993) in viewing velarization as an effect of progressive place assimilation, whereby the main place articulator of the nuclear vowel is extended to the nasal consonant that occupies the coda of the same syllable. Since the [dorsal] feature that causes the final nasal to become velar is not its own, but that of the vowel that precedes it, it follows that the place feature of the nasal is also aligned with the left edge of the syllable via the nuclear vowel. Candidate (28c), therefore, receives only two hyphens from Align-C(Nasal) since Stricture and Major are the only feature classes of the nasal consonant that remain misaligned.

(28) Nasal velarization

Input: /enlase/ 'link'	Max (seg)	Max (Nasal)	Max (Major)	Max (Strict)	Align-C (Nasal)	Max (Place)	Unif
a. [en.la.se]					*!		
b. [ẽ**n**.la.se]					---!		*
☞ c. [ẽ**ŋ**.la.se]					---	*	*
d. [e.la.se]	*!	*	*	*		*	

The assumption that the derived velar nasal shares its nasal and place features with the preceding vowel suggests that this kind of segment has an ambivalent structure: it is a consonant, but it bears some vocalic features. There are several phonetic arguments that indicate that velar nasals are vowel-like. Based on acoustic primitives, Ohala and Ohala (1993:234–235) conclude that the farther back a nasal consonant is articulated the less consonantal it becomes. This is due to the fact that as the oral constriction of the nasal is moved backwards, its oral antiresonances are weakened. As a consequence of this, the spectrum that remains is dominated by the resonances of the pharyngealnasal airway, which makes the nasal consonant sound very similar to a nasalized vowel. Another factor that undermines the consonantality of all back consonants is the presence of longer and slower transitions, which is an inevitable consequence of being produced by a massive articulator such as the tongue dorsum. Due to the quality of their transitions, the property that is considered to be the defining trait of a good consonant (an abrupt change in amplitude and spectrum with respect to neighboring vowels) is considerably diminished in back consonants (Ohala and Ohala 1993, Stevens 1989). These acoustic properties lead us to conclude that although [ŋ] is certainly a consonant; it is not a particularly good one.

Proceeding to the next stage (26d), the implementation of implosive nasals as [ɣ̃] is favored when the constraint Align-C(Nasal) continues to ascend in the hierarchy by defeating Max(Stricture). This is illustrated in tableau (29) below. In terms of alignment, the improvement made by candidate (29d) consists in obtaining proper alignment for an additional feature class. By giving up its full oral closure and taking on the continuancy of the preceding vowel, the nasal consonant that occupies the syllable coda now manages to align its Stricture class features with the left edge of the syllable via the nuclear vowel. The upshot of this is that the only features of the nasal consonant that remain misaligned are those that belong to the Major class, for which candidate (29d) is assigned a single hyphen by Align-C(Nasal).

(29) Loss of full oral closure with place assimilation

Input: /enlase/ 'link'	Max (seg)	Max (Nasal)	Max (Major)	Align-C (Nasal)	Max (Strict)	Max (Place)	Unif
a. [en.la.se]				*!			
b. [ẽ**n**.la.se]				--!-			*
c. [ẽ**ŋ**.la.se]				--!		*	*
☞ d. [ẽ**ɣ̃**.la.se]				-	*	*	*
e. [e.la.se]	*!	*	*		*	*	

At this same stage of the grammar, the anusvara (26e), which represents the alternative of ridding the nasal consonant of all Place and Stricture features, is also possible. As tableau (30) shows, the constraint ranking in (29) leads to the selection of two winners (30d, e). The difference between these two attested forms is that, whereas the nasal consonant in (30d) uses the preceding vowel to align its Place and Stricture features, the nasal consonant in (30e) omits such features to obviate the need that they be left aligned. Either way, the result is equivalent: Major features are the only component of the nasal consonant that is not properly aligned.

(30) Loss of full oral closure with or without place assimilation

Input: /enlase/ 'link'	Max (seg)	Max (Nasal)	Max (Major)	Align-C (Nasal)	Max (Strict)	Max (Place)	Unif
a. [en.la.se]				*!			
b. [ẽ**n**.la.se]				--!-			*
c. [ẽ**ŋ**.la.se]				--!		*	*
☞ d. [ẽ**ɣ̃**.la.se]				-	*	*	*
☞ e. [ẽ**ɴ**.la.se]				-	*	*	*
e. [e.la.se]	*!	*	*		*	*	

Whether the VN sequence will surface as [Ṽɣ̃] or [Ṽɴ] depends on the ranking between the markedness constraints Have Place and Place Hierarchy. The ranking Have Place >> Place Hierarchy favors the place assimilated variant (31a), whereas the reversal of this ranking favors the placeless allophone (32b).

The issue that this raises is why the ranking between certain constraints should be reversed. This kind of constraint mobility may be understood as a consequence of the fact that the transition from a grammar that tolerates misaligned nasals to one that disallows them does not take place in an abrupt, but gradual fashion. Within Stochastic Optimality Theory, this phenomenon may be captured by assigning each constraint a ranking value along a continuous scale (Boersma 1997, Boersma and Hayes 2001). When the ranking value of a given constraint is far above the ranking value of a conflicting constraint, it is unlikely that their rankings will ever be reversed. In the case at hand, this situation would correspond to the relationship between the constraints Max(seg) and Align-C(Nasal), which in the 'radical dialects' examined here are consistently obeyed in that order.

By contrast, when the ranking values of two conflicting constraints are close, there is a chance that their orders be reversed. This is because a noise value is temporarily added to the ranking of every constraint during each evaluation. The noise value may then bring the ranking value of a constraint above the ranking value of a slightly higher constraint. The relationship between Align-C(Nasal) and the constraints grouped under Max(Feature) would correspond to such scenario. Likewise, a minor difference in the ranking values of the constraints Have Place and Place Hierarchy would allow for the selection of (31a) or (32b) as optimal, depending on which of these constraints is favored by the addition of noise.

(31) Place sharing complies with Have Place

Input: /enlase/ 'link'	Have Place	Place Hierarchy		
		*Dor	*Lab	*Cor
☞ a. [ẽ**ɣ̃**.la.se]		*		
b. [ẽ**ɴ**.la.se]	*!			

(32) The anusvara abides by the Place Hierarchy

Input: /enlase/ 'link'	Place Hierarchy			Have Place
	*Dor	*Lab	*Cor	
a. [ẽɣ̃.la.se]	*!			
☞ b. [ẽɴ.la.se]				*

Moving on to the last stage (26f), total absorption comes about when the constraint Align-C(Nasal) surpasses Max(Major), and thereby subdues the entire cluster of Max(Feature) constraints. This is illustrated in tableau (33) below. Candidate (33f) achieves categorical satisfaction of the constraint Align-C(Nasal) by deleting all features of the underlying nasal consonant, except for its nasality. The reason why [nasal] is the only feature that survives may be found in its ability to combine with the features of vowels.

Unlike the Place, Stricture, and Major feature classes, whose values are decisive to determine the identity of segments as consonants or vowels, the presence of Nasality does not ascribe segments to either one of these two categories. This is because, being unable to form a constriction in the vocal tract, the role of the velum during articulation is limited to that of a valve that controls one of the two openings of the airway. If in accord with this observation, we assume that Nasality is the least involved feature class in signaling consonantality, the ability of the feature [nasal] to appear in both consonants and vowels seems only natural.

It also follows from this reasoning that when the feature [nasal] of a consonant is properly aligned through the nuclear vowel, the constraint Align-C(Nasal) cannot force its deletion, because there is nothing in the structure of a nasalized vowel that clashes with the demands of Align-C(Nasal). This provides a plausible explanation for the fact that the attrition of stop, fricative, lateral, and rhotic consonants in syllable-final position usually culminates in deletion (e.g. ['t̪a.si] < /t̪aksi/ 'taxi', ['ka.pa] < /kaspa/ 'dandruff', ['ku.pa] < /kulpa/ 'guilt', ['ka.t̪a] < /kaɾt̪a/ 'letter'); but the attrition of syllable-final nasals most often ends at the stage of absorption (e.g. [bo.'t̪õ] < /bot̪on/ 'button').

(33) Total absorption

Input: /enlase/ 'link'	Max (seg)	Max (Nasal)	Align-C (Nasal)	Max (Major)	Max (Strict)	Max (Place)	Unif
a. [en.la.se]			*!				
b. [ẽ**n**.la.se]			-!--				*
c. [ẽ**ŋ**.la.se]			-!-			*	*
d. [ẽ**ɣ̃**.la.se]			-!		*	*	*
e. [ẽ**ɴ**.la.se]			-!		*	*	*
☞ f. [ẽ.la.se]				*	*	*	*
g. [e.la.se]	*!	*		*	*	*	

To sum up, the tendency of 'radical' Spanish dialects to velarize and absorb syllable-final nasals follows from the gradual ascension of the constraint Align-C(Nasal) above feature faithfulness constraints. Given that Align-C(Nasal) militates against syllable-final nasals regardless of their place features, neither place assimilation nor neutralization is an effective strategy to avoid misaligned consonants. Under the mounting pressure that they be aligned with the left edge of a syllable, syllable-final nasals opt to give up some of their structure and share features with the preceding vowel. While this weakens them as consonants and makes them more similar to vowels, it helps them improve their alignment gradually, until they eventually obtain categorical satisfaction of Align-C(Nasal) without having to give up the entire segment.

5. Remaining issues

One aspect in which the processes of place assimilation, neutralization, velarization and absorption are related is that they all contribute to simplify the structure of syllable-final nasals. The output that emerges from applying any one of these processes is structurally less costly because some of the features of the underlying nasal consonant are lost. This common effect makes one wonder if all four processes could receive a unified account by relying on a single markedness constraint.

The stance I take in this regard is that the constraints Agree(Place), Place Hierarchy and Align-C(Nasal) are indeed related, for they all fall under the ultimate markedness constraint: *Structure. But if we are to account for the various ways in which the structure of nasal consonants may be simplified, the independence of these related but distinct markedness constraints must be acknowledged.

Both place assimilation and neutralization yield a reduction in the number of place specifications; however, the different conditions under which these changes operate lead us to conclude that they are governed by different principles. Place assimilation responds to a drive to reduce the complexity of consonant clusters, whereas place neutralization seeks to reduce the cost of place features regardless of their involvement in consonant clusters. The autonomy of these processes is confirmed by the fact that languages may have a process of nasal place assimilation without having a process of nasal place neutralization (e.g. English).

Continuing along this line, it is clear that the process of progressive place assimilation (which creates velar nasals) and the process of regressive place assimilation (which creates homorganic NC clusters) reduce the number of place specifications by creating a structure where two segments rely on a single set of place features. Nevertheless, while the linked structure that results from progressive place assimilation involves a consonant and a vowel (e.g. VN), the linkage created through regressive place assimilation is between two consonants (e.g. NC). An even more significant difference is that feature sharing in the latter structure is limited to place features, whereas the former structure always involves sharing of features other than place.

Considering that this diversity of structures reflects various forms of markedness, it is only appropriate that the proposed analysis relies on three independent markedness constraints: Agree(Place), Place Hierarchy and Align-C(Nasal). Without all three of them, it does not seem possible to account for the behavior of Spanish syllable-final nasals in a principled manner.

Another issue that merits some discussion is that, despite being extendable to all syllable-final nasals, the process of nasal velarization usually starts in word-final position. One way to account for this pattern is through the use of context-sensitive faithfulness constraints.

(34) Contiguity(IO): Internal elements in the input must have a correspondent in the output. (After McCarthy and Prince 1995)

(35) Anchor(IO)R: The final element in the input must have a correspondent in the output. (After McCarthy and Prince 1995)

(36) Only word-final nasals velarize

Input: /sinrason/ 'arbitrary action'	Contiguity (IO)	Align-C (Nasal)	Anchor (IO)R
a. [sin.ra.son]		**!	
☞ b. [sin.ra.sõŋ]		* _	*
c. [sĩŋ.ra.sõŋ]	*!	_ _	*

(37) Velarization affects all syllable-final nasals

Input: /sinrason/ 'arbitrary action'	Align-C (Nasal)	Contiguity (IO)	Anchor (IO)R
a. [sin.ra.son]	**!		
b. [sin.ra.sõŋ]	*! _		*
☞ c. [sĩŋ.ra.sõŋ]	_ _	*	*

The ranking Contiguity(IO) >> Align-C(Nasal) >> Anchor(IO)R corresponds to a stage of velarization where only word-final nasals are permitted to improve their alignment by losing some of their features (36b). However, once Align-C(Nasal) overtakes both Contiguity(IO) and Anchor(IO)R, the position within the word becomes a moot factor (37c).

Lastly, a question that remains, with regard to variation, is whether the frequency rates reported for the allophones of final nasals can be replicated using Stochastic Optimality Theory. In this paper, I have only sketched how variation is tackled within this framework, but the actual ranking values of the constraints have not been determined.

6. Comparison with previous accounts

The analysis proposed above views nasal velarization as an intermediate step in a larger-scale process: the fusion of the nasal consonant with the preceding vowel in order to improve consonant alignment. From this point of view, it is quite natural that the members of the $VN]_\sigma$ sequence are produced with various degrees of coarticulation.

Since the features of the nasal consonant are aligned via the nuclear vowel, the more structure these segments share, the better the alignment. Previous analyses, on the other hand, have overlooked the significance of coarticulation. Failure to establish the connection that exists between velarization and concomitant changes (nasalization of the preceding vowel, lack of linguo-velar contact, and total absorption of the nasal consonant) has led to serious shortcomings in the past.

Harris (1984), for example, has to stipulate that in 'non-velarizing' dialects the unmarked place of articulation is coronal, whereas in 'velarizing' dialects it is velar. Harris' analysis is problematic not only because of positing two different unmarked places of articulation, but also because it fails to capture important facts. Velarization never occurs without there being nasalization of the preceding vowel; and in all dialects where velarization has been attested, there are also instances of nasal absorption. Rather than negligible detail, these are key elements to understand why syllable-final nasals have a tendency to become velar.

Although Trigo (1988) recognizes the close relationship that exists between velarization and absorption, she also assumes that there are two choices for the unmarked place of articulation: coronal in the onset, velar in the coda. As it turns out, this view is incompatible with the process of nasal place neutralization that occurs in 'conservative' dialects such as Mexico City Spanish. If velar were the unmarked place of articulation in the coda, we would expect that the loss of contrast between /m/, /ɲ/ and /n/ that we find in word-final position would produce velar rather than coronal nasals. It is [n], however, that emerges.

Bakovic (2000) adheres to the common view that coronal is the only unmarked place of articulation, but in order to explain why in non-standard Spanish dialects syllable-final nasals tend to velarize, he is forced to make a questionable reinterpretation of the data. He claims that velar nasals are actually not velar, but placeless consonants. Contrary to this assumption, the studies conducted by Cedergren and Sankoff (1975), Terrell (1975), López Morales (1980), and D'Introno and Sosa (1988) unambiguously state that the attested velar nasals are velar, not placeless. D'Introno and Sosa, for example, found that although placeless nasals do arise in the Spanish of Caracas (6.5%), a nasal consonant with a complete velar closure is by and large the most common realization of implosive nasals (76.5%).

More compatible with the attested behavior of syllable-final nasals is the proposal that they become velar through the application of a spreading rule that links them to the place features of the preceding vowel (Paradis and Prunet 1990, 1993). The problem with such a rule is that it has to stipulate that spreading is to take place from left to right. But why should assimilation be progressive rather than regressive? Why should the nasal consonant share place features with the preceding vowel rather than with the following consonant? The analysis I propose has a principled explanation. Assimilation is progressive because it allows the nasal consonant to improve its alignment with the left edge of the syllable via the nuclear vowel.

7. Conclusion

This paper has presented an analysis of four processes that target syllable-final nasals in Spanish dialects. In addition to place assimilation and neutralization, which are highly productive in 'conservative' dialects, there are two processes of increasing productivity in 'radical' dialects: velarization and absorption. Three markedness constraints have been identified as the propellers of these changes. Assimilation is caused by Agree(Place), neutralization is induced by the Place Hierarchy, and velarization and absorption are the workings of Align-C(Nasal).

In 'conservative' dialects, where Align-C(Nasal) is bottom ranking, nasal consonants are free to appear in the syllable coda, where Agree(Place) and the Place Hierarchy can force a reduction in the number of place contrasts through place assimilation and neutralization. These two markedness constraints never threaten the preservation of final nasals because their demands do not conflict with consonants per se, but with the kind of place features they bear. On the other hand, when Align-C(Nasal) ascends in the ranking, it can not only eclipse the processes of place assimilation and neutralization by forcing final nasals to become velar, but also compromises their preservation because the only way to obtain categorical satisfaction of this constraint is if the offending consonant is completely removed from the syllable coda.

Based on data from four different Spanish dialects, which show that the removal of the nasal consonant from the syllable coda is a gradual process, I proposed that grammars may assess violations of Align-C(Nasal) gradiently. On this view, nasal velarization is only one step in a larger-scale change intended to improve the alignment of the nasal consonant through its gradual incorporation into the structure of the preceding vowel. Not surprisingly, we find that between the stage where the $VN]_\sigma$ sequence is implemented as two separate segments and the stage where it surfaces as a single segment, there are several intermediate steps where the unwanted nasal has become a less efficient consonant.

According to this analysis, when the priority of the grammar is to use the least costly place of articulation, coronal nasals are optimal in the syllable coda. However, velar nasals are preferred in this position when the grammar is more concerned with producing the least consonantal nasal.

References

Baković, E. 2000. Nasal place neutralization in Spanish. Available through the *Rutgers Optimality Archive* at http://roa.rutgers.edu/index.php3.

Beckman, J.N. 1999. *Positional Faithfulness*. New York NY: Garland.

Boersma, P. 1997. How we learn variation, optionality and probability. *Proceedings of the Institute of Phonetic Sciences* 21: 43–58. (University of Amsterdam).

Boersma, P. and Hayes, B. 2001. Empirical tests of the gradual learning algorithm. *Linguistic Inquiry* 32: 45–86.

Cedergren, H. and Sankoff, D. 1975. Nasals: A sociolinguistic study of change in progress. In *Papers from a Symposium on Nasals and Nasalization*, C. Ferguson, L. Hyman and J. Ohala (eds), 67–80. Stanford CA: Stanford University.

De Lacy, P. 2002. The Formal Expression of Markedness. PhD dissertation, University of Massachusetts, Amherst.

D'Introno, F. and Sosa, J.M. 1988. Elisió de nasal o nasalizaciõ de vocal eŋ caraqueño. In *Studies in Caribbean Spanish Dialectology*, R. Hammond and M. Resnick (eds), 24–34. Washington DC: Georgetown University Press.

Guitart, J. 1996. Spanish in contact with itself and the phonological characterization of conservative and radical styles. In *Spanish in Contact: Issues in Bilingualism*, A. Roca and J. Jensen (eds), 151–157. Sommerville MA: Cascadilla.

Harris, J.W. 1969. *Spanish Phonology*. Cambridge MA: The MIT Press.

Harris, J.W. 1984. Autosegmental phonology, lexical phonology, and Spanish nasals. In *Language Sound Change*, M. Aronoff and R. Oehrle (eds), 67–82. Cambridge MA: The MIT Press.

Henton, C., Ladefoged, P. and Maddieson, I. 1992. Stops in the world's languages. *Phonetica* 49: 65–101.

Itô, J. and Mester, A. 1999. Realignment. In *The Prosody Morphology Interface*, R. Kager, H. van der Hulst and W. Zonneveld (eds), 88–217. Cambridge: CUP.

Itô, J. and Mester, M. 1994. Reflections on codacond and alignment. In *Phonology at Santa Cruz* III, J. Merchant, J. Padgett and R. Walker (eds), 27–46. Santa Cruz CA: University of Santa Cruz.

Keating, P. 1988. Palatals as complex segments: X-ray evidence. *University of California Working Papers in Phonetics* 69: 77–91.

Ladefoged, P. and Maddieson, I. 1996. *The Sounds of the World's Languages*. Oxford: Blackwell.

Lamontagne, G. and Rice, K. 1995. A correspondence account of coalescence. In *University of Massachusetts Occasional Papers* 18, J. Beckman, L. Walsh Dickey and S. Urbanczyk (eds), 211–224. Amherst MA: GLSA.

Lombardi, L. 1999. Why place and voice are different: Constraint-specific alternations in optimality theory. In *Segmental Phonology in Optimality Theory: Constraints and Representations*, L. Lombardi (ed.), 13–45. Cambridge: CUP.

Lombardi, L. 2001. Positional faithfulness and voicing assimilation in optimality theory. *Natural Language and Linguistic Theory* 17: 267–302.

López Morales, H. 1980. Velarización de /n/ en el español de Puerto Rico. *Lingüística Española Actual* 2: 203–217.

McCarthy, J. and Prince, A. 1995. Faithfulness and reduplicative identity. In *University of Massachusetts Occasional Papers* 18, J. Beckman, L. Walsh Dickey and S. Urbanczyk (eds), 249–384. Amherst MA: GLSA.

Navarro Tomás, T. 1967. *Manual de pronunciación española*. Madrid: Consejo Superior de Investigaciones Científicas.

Ohala, J. and Ohala, M. 1993. The phonetics of nasal phonology: Theorems and data. In *Nasals, Nasalization, and the Velum*, M. Huffman and R. Krakow (eds), 225–249. San Diego CA: Academic Press.

Padgett, J. 1996a. Feature classes. Available through the *Rutgers Optimality Archive* at http://roa.rutgers.edu/index.php3.

Padgett, J. 1996b. Partial class behavior and nasal place assimilation. Available through the *Rutgers Optimality Archive* at http://roa.rutgers.edu/index.php3.

Paradis, C. and Prunet, J-F. 1990. The coronal vs. velar placeless controversy. *McGill Working Papers in Linguistics* 6(2): 192–228.

Paradis, C. and Prunet, J-F. 1993. A note on velar nasals: The case of Uradhi. *Canadian Journal of Linguistics/Revue canadienne de linguistique* 38(4): 425–439.

Piñeros, C-E. 2001. Segment-to-syllable alignment and vocalization in Chilean Spanish. *Lingua* 111(3): 163–188.
Piñeros, C-E. 2004. Explicación para el surgimiento de la s apical en un dialecto de español del Caribe. *Bulletin of Hispanic Studies* 81: 275–301.
Prince, A. and Smolensky, P. 1993. Optimality theory: Constraint Interaction in Generative Grammar. Technical Report TR–2, Rutgers Center for Cognitive Science, Rutgers University, New Brunswick NJ. Also posted in 2002 on the *Rutgers Optimality Archive*.
Quilis, A. 1996. *Curso de fonética y fonología españolas*. Madrid: Consejo Superior de Investigaciones Científicas.
Selkirk, E. 1984. On the major class features and syllable theory. In *Language Sound Structure: Studies in Phonology*, M. Aronoff and R. Oehrle (eds), 107–136. Cambridge MA: MIT Press.
Stevens, K. 1989. On the quantal nature of speech. *Journal of Phonetics* 17: 3–45.
Terrell, T. 1975. La nasal implosiva y final en el español de Cuba. *Anuario de Letras* 13: 257–271.
Trigo, R. L. 1988. On the Phonological Derivation and Behavior of Nasal Glides. PhD dissertation, Massachusetts Institute of Technology.

Optimality-theoretic advances in our understanding of Spanish syllable structure*

Sonia Colina
The University of Arizona

This article offers an optimality-theoretic account of Spanish syllable structure that integrates all areas covered by traditional analyses of syllabification: syllable types, phonotactic restrictions, syllabification algorithms, domain of syllabification, and repair strategies. The article aims to highlight the advantages of an optimality theoretic approach to syllabification in order to support the claim that OT has brought about significant improvement in syllabic theory. Among these advantages are the replacement of language-specific rules with universal constraints; the resolution of rule conspiracies; and the elimination of stipulatory statements (quality of epenthetic vowels) and adhoc conditions on rule application. The descriptive facts are explained through the general mechanism of interaction of universal markedness and faithfulness constraints. Cross-dialectal and intra-speaker variation are obtained through variation in the ranking of the constraints. By resorting to universal constraints and language-specific ranking, variation is shown to result from the implementation of various ways of obtaining the same goal (e.g., elimination of coda consonants: complete deletion, voice neutralization, stricture neutralization, vocalization, etc.). Processes that were presented as separate in a derivational model (i.e., Spanish diphthongization, resyllabification and onset strengthening) are shown to respond the same motivation (avoid onsetless syllables). The article aims to be an updated optimality-theoretic alternative to general accounts of syllabification such as Harris (1989) and Hualde (1991).

Keywords: syllabification, diphthong, hiatus, syllable, syllable structure, Optimality Theory, phonotactics

0. Introduction. The role of the syllable in phonological theory

Since its introduction as a unit of phonological organization in the late seventies (Hooper 1976, Kahn 1976), the syllable has played an increasingly important role in

* I would like to thank Stuart Davis, Fernando Martínez-Gil and two reviewers for comments and discussion; all inadequacies remain mine.

phonological theory. The syllable allows the analyst to formulate generalizations that could not be easily expressed without it. For instance, consider some well-known processes of Spanish phonology, such as nasal velarization (e.g. [pãŋ] ← /pan/ 'bread'), /s/ aspiration (e.g. [doh] ← /dos/ 'two'), /s/ voicing assimilation (e.g. [mizmo] ← /mismo/ 'same'), liquid gliding (e.g. /papel/ [papei̯] ← /papel/ 'paper'), and nasal assimilation (e.g. [kambio] ← /kanbio/ 'change'). Without referring to the syllable, the analyst would fail to grasp the common underlying motivation for those processes: the neutralization of contrasts in a weak syllabic position (coda). Similarly, phenomena like onset strengthening, in which a high vocoid is realized as a palatal obstruent in onset position (e.g., /kom-iendo/ [ko.mi̯en̪.do] 'eat-gerund' vs. /kre-iendo/ [kre.yen̪.do] 'believe-gerund') can be seen as the result of the onset preference for strong, less sonorous segments, an insight that would be entirely lost in a model of phonology without syllables.

The syllable is also relevant with respect to non-segmental aspects of the phonology. For instance, many stress generalizations cannot not be formulated without it. In Spanish it is well-known that lexical stress cannot be placed further to the left than the antepenultimate syllable (*3-syllable window*, Harris 1983 and many others after him), *teléfono *télefono* 'telephone', or further than the penultimate when the latter has a branching rhyme (*branching condition*, Harris 1983), *Venezúela *Venézuela*. Phonotactic restrictions also hold over syllables and syllabic components with regard to the type and number of segments. For example, the illformedness of hypothetical **muersto* can only be explained as the result of an excessive number of segments in the rhyme (three being the maximum), given that /ue/ and /rs/ sequences are by themselves licit strings.[1]

The importance of the role played by the syllable in modern phonological theory increased exponentially with the advent of Optimality Theory (OT). The syllable is possibly the area of phonological inquiry that has attracted the most interest amongst OT-practitioners and, as a result, it constitutes the focus of a significant body of OT research. All of the early OT studies contain large sections devoted to syllabification issues (cf. Prince and Smolensky 1993, McCarthy and Prince 1993a &b). In Spanish too the first dissertations published within an OT framework were studies of syllabification and syllabification-related processes (Morales Front 1994, Colina 1995). The volume of syllable-related OT research does not come as a surprise if one considers the ease with which syllable types illustrate optimality accounts of factorial typologies and how the syllable serves to exemplify the interaction of segments, moras, sonority, edges, and stress in OT.

In addition to contributing to the development of OT, the syllable has benefited from advances in OT, in particular, OT has helped to improve our understanding of the syllable and syllable structure. In general terms, three areas of the theory have proven useful for syllabic theory:

(a) In OT language-specific rules are replaced by universal constraints and language-specific constraint ranking. Consequently, *syllable structure is the result of*

1. *St-* is not an acceptable onset cluster in Spanish.

conflicting universal requirements on syllable structure prioritized differently across languages. An important consequence of this is that OT can formalize and account for the similarity of syllabification mechanisms in various languages in a much more principled way than the numerous language-specific syllabification rules of serial phonology. For example, most languages seem to have an *Onset Rule* that attaches one or more consonantal segments to the left of the nucleus. Yet, in order to capture the universal nature of this rule, a derivational model, consisting of language-specific rules, has to stipulate that the *Onset Rule* is universal. In OT, however, the universal preference for V.CV is the effect of a universal constraint, ONSET, that requires that all syllables have an onset, in combination with a universal dislike/constraint for codas, *CODA. Another important contribution of OT to the understanding of syllable structure is that constraints are violable under domination from a more highly ranked constraint. Hence not all languages and all syllables will have onsets — some languages will have onsetless syllables. The prioritizing of conflicting, violable, universal constraints in multiple rankings produces variation in syllable structure and syllabification.

(b) In OT constraints are of two types: those that require preservation of underlying contrasts (faithfulness constraints) and those that favor unmarked structure. Thus, syllable structure (i.e., the output of syllabification/a syllabified output) is *the result of the interaction of universal faithfulness and markedness constraints*. ONSET, for example, is a markedness constraint that states that the preferred syllable type is CV. If all syllable markedness constraints were always dominant across languages, languages would exhibit no marked syllable structure and the only syllable type would be CV. However, this is not so, because in order to be useful communication tools, languages need to express a large number of contrasts. In response to this functional need, faithfulness constraints require preservation of input form. Hence, inputs may consist of syllables without onsets. If the corresponding faithfulness constraint (DEP-IO — no epenthesis — or MAX-IO-no deletion) is ranked above markedness, the output and the language will permit onsetless syllables. If markedness is ranked above faithfulness (DEP-IO or MAX-IO), all syllables will have onsets. An important observation brought to light by OT is that when the faithfulness constraint(s) forcing violation of markedness is/are no longer relevant, unmarked structures will surface ("the emergence of the unmarked", McCarthy and Prince 1994). This has been shown to be true in adult phonology as well as in child and second language phonology. In Spanish hypochoristics, for instance, faithfulness to the underlying representation is no longer at stake because hypochoristic formation implies deletion by definition. CVC or CG(glide)V syllables, usually tolerated because of the domination of faithfulness over markedness constraints (*CODA, *COMPLEX-NUCLEUS), are truncated to CV when faithfulness is no longer dominant, e.g. *Constantino* > *Consta*, [dan̯i̯el] > *Dáni* 'Daniel' (Colina 1996, Piñeros 2000).

(c) OT can satisfactorily explain *conspiracies*. Languages often have several rules that work towards a common goal. For instance, Spanish has a rule of diphthongization (i.e., syllable merger) of high vowels when preceded or followed by another vowel, *mi amigo* [mi̯a.mi.ɣo] 'my friend'.

(1) $$\begin{pmatrix} -\text{cons} \\ +\text{ high} \end{pmatrix} \rightarrow [-\text{syllabic}] \; / \; \begin{Bmatrix} \text{V } (\#)\_\_\_\_ \\ \_\_\_\_(\#)\text{ V} \end{Bmatrix}$$

It also has a rule that resyllabifies a word-final consonant to the onset position of a vowel initial word, *tus amigos* [tu.sa.mi.ɣos] 'your friends'.

(2) $$\begin{array}{lcl} +\text{cons} & \rightarrow & +\text{cons} \; / \; \_\_\_ \; \# \text{ V} \\ | & & | \\ \text{coda} & & \text{onset} \end{array}$$

(Harris 1983: 43–44)

Although not apparent from the format of the rules, (1) and (2) have as a common goal the elimination of onsetless syllables. Serial rules and derivational formalisms have been known to hide the real purpose behind rules, in what is usually referred to as "the conspiracy of rules" (Kenstowicz and Kisseberth 1979). OT, on the other hand, naturally and elegantly captures this "purpose" by means of interacting universal constraints. In the examples in (1,2), it is the domination of Onset over other relevant constraints (e.g, Align-L, Max-IOμ,) that drives both resyllabification and syllable merger in the outputs: Onset satisfaction is obtained by misaligning word and syllable boundaries (Align-L violation) and by underparsing a mora (Max-IOμ, violation), respectively. Our understanding of syllabic structure has improved as the result of OT's ability to bring forth the shared motivation behind many rules of syllabification.

In sum, while syllable structure has been crucial in the development of modern phonology and in particular of OT, OT has in turn and, perhaps even to a greater extent, contributed to advancing our understanding of syllable structure. Within this context, the purpose of the current chapter is to review and highlight recent developments and advances brought about by OT with regard to the syllable structure of Spanish. The goal is not to compare fine details of analyses of Spanish syllable structure, but to show in general terms the greater explanatory power of OT with respect to Spanish syllabification. Hence many matters of detail will not be covered. A second goal of this paper is to offer a comprehensive overview of syllable structure in Spanish that is inclusive of the fifteen years of work since the publication of similar studies (Harris 1989a, Hualde 1991) and that examines optimality theoretic progress in this realm. This chapter also provides a general overview of syllable types, syllabification algorithms and other syllable-related phonological phenomena within an OT framework.

The present article is organized as follows: the section just concluded is an introduction dealing with the role of the syllable in phonological theory and more specifically, its role within OT. Using Spanish data as examples, the introduction highlights improvements in our understanding of syllable structure derived directly from OT. Section 1 offers an OT account of general syllable types and phonotactic generalizations derived from the parsing of segments into syllabic constituents. For purposes of comparison, Section 2 presents a review of syllabification rules in a serial model. It also provides an optimality theoretic model of resyllabification. Finally, Sections 3 and 4 complete the picture by examining the interaction with morphology (in serial models, domain of syllabification) and syllable repair mechanisms. The chapter concludes with some conclusions and a general overview of serial vs. constraint-based accounts of syllable structure.

1. Syllable types and phonotactics in Spanish

1.1 Basic syllable types

In purely descriptive terms, most dialects of Spanish have the syllable types in (3):

(3) Syllable types in Spanish (in italics in the examples)

V	*a*.la	'wing'
CV	*co*.lor	'color'
CVC	*pan*	'bread'
VC	*un*	'one'
CCV	*flo*.tar	'float'
CCVC	*tren*	'train'
VCC	*ins*.truir	'instruct'
CVCC	*pers*.pec.tiva	'perspective'
CCVCC	*trans*.por.te	'transportation'

For purposes of presentation, I do not include glides (G) in the typology at this time.

In OT, the possible syllable types of Spanish are the result of the interaction of universal violable constraints (markedness and faithfulness). The universal nature of such constraints makes the account superior to the purely descriptive list given in (3). That these syllable types constitute a limited inventory from which all languages draw their syllable templates finds an explanation in the existence of a limited number of constraints present in all languages. Given these assumptions about the universal nature of constraints, the analyst must demonstrate that the relevant constraints are truly universal (see Kager 1999 for detailed justification). Briefly, a universal of syllable typology is that all languages prefer syllables that start with a consonant (onset) and end in a vowel, CV being thus the preferred, unmarked syllable type. While some languages allow codas, none require them; similarly, some languages allow onsetless syllables, but none forbid onsets. In sum, there are no languages that require codas and forbid onsets. Thus, OT argues for two universal markedness constraints:

(4) Onset: No vowel-initial syllables
*Coda: Syllables cannot end in a coda[2]

2. Itô and Mester (1994) propose reformulating syllable well-formedness constraints as alignment conditions Align-L(σ, C) and Align-R(σ, V). Piñeros (2001) does this for Spanish. The interested reader is referred to Piñeros (2001) and Piñeros (this volume) for details. Generally, the Onset and Coda markedness hierarchies in (21) and (22) correspond to the alignment hierarchy Align-L(Obstruent,σ) >> Align-L(Nasal,σ) >> Align-L(Liquid,σ) >> Align-L(Glide,σ) in Piñeros (2001). A comparison of the two formalisms is beyond the scope of this paper. The non-alignment format was chosen here for its greater presentational simplicity and for its wider use within OT.

In addition, complex syllabic constituents are universally more marked than singletons: there is no language that has complex onsets/codas/nuclei and lacks single segment onsets, codas and nuclei. The reverse, however, is true. There exist languages that ban complex subsyllabic components but allow singletons. The following universal constraints are therefore proposed by OT:

(5) *Complex Onset: No more than one segment in the onset
*Complex Coda: No more than one segment in the coda
*Complex Nucleus: No more than one segment in the nucleus

Spanish allows onsetless syllables as well as syllable codas

(6) Basic segmental faithfulness constraints
Max-IO: Every segment present in the input must have a correspondent in the output (anti deletion constraint).
Dep-IO: Every segment present in the output must have a correspondent in the input (anti epenthesis constraint).
Faith: (cover term for all faithfulness constraints)

Therefore, Onset and *Coda must be dominated by faithfulness constraints: Faith >> Onset, *Coda.

(7) /ala/ [a.la]

	Faith	Onset	*Coda
a. ☞ a.la		*	
b. Ta.la	*!		
c. al.a		**!	*
d. la	*!		

(8) /poner/ [poner]

	Faith	Onset	*Coda
a. ☞ po.ner			*
b. po.ne.re	*!		
c. pon.er		*!	*
d. po.ne	*!		

In (7) candidates with epenthesis and deletion violate the top-ranked Faith because they alter the input representation either by inserting an element not present in the input (epenthesis of T, [7b]) or deleting an input phone (7d). (7a) and (7c) incur Onset violations on account of one and two onsetless syllables, respectively. By syllabifying the intervocalic consonant with the second vowel, candidate (7a) incurs only one Onset violation, while at the same time avoids a contravention of *Coda and is thus more optimal than (7c). Therefore, although not perfect, (7a), with only one Onset violation, is the optimal candidate and the output.

Evaluation proceeds similarly in (8). [poner] (8a) is the optimal candidate because (8b) [ponere], an attempt to get rid of the coda consonant through epenthesis, violates the more-highly ranked Faith. (8d) encounters the same fate given that there is deletion of the final consonant (a consonant present in the input is absent in the output). (8c) incurs an unnecessary violation of Onset and is therefore eliminated. It could be argued that word-initial onsetless syllables (*a.la*) are not the result of faithfulness, but the effect of an alignment constraint that bans insertion in word-initial position (McCarthy and Prince 1993 a&b; Kager 1999: 111).

(9) Align-L: The left edge of the grammatical word coincides with the left edge of the prosodic word

However, the existence of word-internal onsetless syllables serves to discard this hypothetical ranking, *ma.re.a* 'tide', *ve.o* 'I see'.

As mentioned above, Spanish also allows complex onset and codas, which suggests that Faith dominates the markedness constraints prohibiting onset and coda clusters *Complex Onset, *Complex Coda.

(10) Faith >> *Complex Onset, *Complex Coda.

(11) /broma/ [bro.ma] 'joke'

	Faith	*Complex Onset
a. ☞ bro.ma		*
b. ro.ma	*!	
c. be.ro.ma	*!	

(12) /insto/ [ins.to] 'I urge'

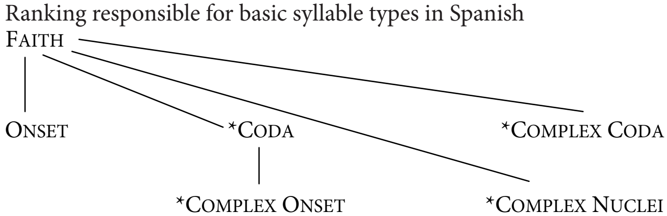
	Faith	*Complex Coda
a. ☞ ins.to		*
b. in.to, is.to	*!	
c. is.to	*!	
d. i.nes.to	*!	
e. in.se.to	*!	

*Coda in turn must dominate *Complex Onset given that word-internal onset clusters are preferred to the parsing of the consonants in the coda and the onset of two adjacent syllables (13) (cf. *onset maximization* in derivational approaches). *Complex Nuclei is violated by diphthongs, /pierde/ → [pi̯érðe]. I return to them in 1.2.1.

(13) /potro/ [po.tro] 'young horse'

	*Coda	*Complex Onset
a. ☞ po.tro		*
b. pot.ro	*!	

(14) Ranking responsible for basic syllable types in Spanish



1.2 Segments and the syllable

Despite its general explanatory adequacy, careful consideration reveals that the general ranking in (14) is not sufficient to account for all the facts. Not all consonant clusters in VCCV sequences are parsed in the same syllable, *par.te* * *pa.rte* 'part'; similarly, although Spanish allows consonants in the coda, not all codas are acceptable in all dialects, *club* [*klub] 'club'. It is apparent that syllabic constraints that refer to subsyllabic components and number of segments are not sufficient. Minimally, generalizations about the specific segments parsed in each of those positions must be accounted for as well as the sequence (order) of segments within the syllable. In broad terms, two areas need to be addressed: sonority (1.2.1) and the parsing of segment types in subsyllabic constituents (1.2.2).

1.2.1 *The sonority contour*

Syllables exhibit a contour based on the universal sonority scale in (15) according to which the syllable rises in sonority towards the nucleus (the most sonorous point) and then decreases towards the coda (Sonority Sequencing Principle, Clements 1990). Segments are ranked according to sonority in the universal sonority scale, which coincides with the one proposed for Spanish in Harris (1989b):

(15) Obstruents < Nasal < Liquid < Glide < Vowel

For Spanish, Martínez-Gil (1996, 1997) has proposed a subset of distinctions that separates obstruents into stops and fricatives.

(16) Stops < Fricatives < Nasal < Liquid < Glide < Vowel

In most dialects of Spanish, stops, fricatives, and nasals are possible onsets, but not glides or vowels. Only vowels are possible nuclei (glides are well-formed in prevocalic position). All segment types can be parsed in the coda except for vowels.

Pre-OT models of phonology express these facts in the form of descriptive generalizations, language-specific rules ('mark vowels as syllable heads') or restrictions on the application of the rule (Harris 1983, 1989a; Hualde 1991, Hualde 1999a). Additional rules are required to express repair mechanisms. Sonority could not be formalized in a direct way without resorting to special conditions stipulating that a rule would apply only if certain sonority conditions were met (for proposals and discussion on the formalization of sonority within a derivational model, see Selkirk 1984, Clements 1990, Rice 1992). On the other hand, an optimality-theoretic framework captures the generalizations that relate syllabic positions with sonority classes in a straightforward manner by means of universal scales and constraint hierarchies. The syllable-position prominence scale (Nucleus > Coda> Onset >) can be easily combined with the sonority scale (via harmonic alignment) to produce a constraint hierarchy (McCarthy 2002: 21). The most prominent syllable position (Nucleus) is aligned with the most sonorous segment (Vowel) and viceversa, so that the most highly ranked constraint is the one that penalizes parsing the most sonorous segment in the least prominent position.

(17) Harmonic Alignment of Prominence Scales (sonority and syllabic prominence)
Nucleus > …… > Onset
| |
Vowel > …… > Obstruent

(18) Constraint Hierarchy
*Nuc/obstruent >> …… >> *Nuc/vowel
*Onset/vowel >> …… >> *Onset/obstruent

The ranking of faithfulness constraints with regard to the sonority scale (hierarchy of markedness constraints) determines whether violations can be forced through domination and explains language variation (language-specific ranking) in an otherwise universally fixed hierarchy. Thus, in Spanish, the fact that only vowels can be nuclei is the result of the ranking in (19). Since the constraints against parsing non-vocalic segments in the nucleus are undominated, only vocalic nuclei are possible.

(19) Segment types in the nucleus
*Nuc/obstruent >> *Nuc/nasal >> *Nuc/liquid >> Faith, *Nuc/vowel

This is not the case in languages, such as English, that allow syllabic liquids and nasals. In English a liquid or nasal can serve as a syllable nucleus if no vowel is available. The domination of Faith over *Nuc/Nasal >> *Nuc/liquid guarantees the parsing of a nasal or liquid in the nucleus rather than deletion or vowel epenthesis.

(20) *Nuc/obstruent, Faith >> *Nuc/nasal >> *Nuc/liquid >> *Nuc/vowel

With respect to the onset position, Spanish sonorants and obstruents can appear in the onset, but obstruents are preferred.[3] Vowels cannot be in the onset and therefore *Onset/vowel must be undominated. This is reflected in the ranking in (21).

(21) Segment types in the onset
*Onset/vowel >> Faith >> *Onset/ liquid >> *Onset/ nasal >> *Onset/obstruent

In the coda, as sonority decreases from the nucleus, the more sonorous sonorants are preferred to the obstruents as shown in (22). Vowels are not possible codas as indicated by the undominated status of *Coda /vowel.

(22) Segment types in the coda
*Coda/vowel >> Faith >> *Coda/obstruent >> *Coda/nasal >> *Coda/liquid >> *Coda /glide

Glides have been purposefully omitted from the sonority scales in (19–21). In Spanish prevocalic glides are generally part of the nucleus and postvocalic glides are parsed in the coda (see Harris 1983, Hualde 1991 and Núñez-Cedeño and Morales Front [1999: 174–175] for arguments). In addition to *Nuc/glide, prevocalic glides incur a *Complex Nucleus violation (24a). This is done in order to avoid violating the more-highly ranked Onset (24b & d).

3. Evidence for this can be found in child language acquisition. In early acquisition children often avoid liquid and nasal onsets (Barlow and Gierut 1999, Ohala 1999, Gnanadesikan 2004).

(23) *Onset/glide, Onset >> *Complex Nucleus, *Nuc/glide

(24) /pierde/[pi̯érðe] 'he looses'

	*Onset/glide	Onset	*Complex Nucleus	*Nuc/glide
a. ☞ pi̯ér.ðe			*	*
b. pi.ér.ðe		*!		
c. pjér.ðe	*!			
d. pj.ér.ðe	*!			

That the glide is not parsed in the onset is guaranteed by the undominated constraint *Onset/glide (24c).[4] [j] is used in (24c) and in the rest of this paper to represent an onset glide, thus graphically distinguishing it from a nuclear glide, as in (24a).

The careful reader will have noticed that the tableaux in (24) is not quite complete. In order for an underlying vowel to be parsed as part of a complex nucleus and also satisfy Onset, its input mora must not be present in the output, thus incurring a violation of Faith, more specifically Max-IOμ (a mora present in the input must have a correspondent in the output).

(25) Diphthongization
*Onset/glide, Onset >> *Complex Nucleus, *Nuc/glide, Max-IOμ

Glides cannot be the sole segment in the nucleus. However, no additional constraint is necessary at this point, since, in order to avoid a violation of the highly-ranked Onset, glides are parsed in a complex nucleus, thus effectively avoiding sole nuclear membership, as seen in (24a) vs (24d).[5,6]

Given the undominated status of *Onset/glide, glides can never be parsed in the onset. However, an underlying vocoid can be forced into the onset (thus satisfying Onset) through faithfulness violations — Max-IOμ and Ident (son), e.g., /kom-iendo/ [ko.mi̯én̪.do] 'eat-gerund' vs. /kre-iendo/ [kre.yen̪.do] 'believe-gerund'.

(26) Ident (son): The specification for the feature [sonorant] present in the input must match the one in the output.

4. For falling diphthongs, *peine* [pei̯.ne]'comb', evaluation proceeds in the same fashion, except for the replacement of *Nuc/glide (trivially satisfied) with *Coda/glide, *Coda.

5. Despite this, an argument could be made for an undominated constraint requiring all nuclei to be moraic. (24d) would violate this constraint.

6. An issue not addressed in this paper is that of the reported contrast between diphthongs and hiatuses in some varieties of Spanish, *Luí.sa* vs. *Su.í.za* 'Switzerland' (Hualde 1997, Hualde 1999b, Colina 1999, Hualde and Prieto 2002). In a limited number of examples in Spanish, a hiatus is found instead of the expected diphthong, thus giving rise to a few near minimal contrasts like the one above. Many of these forms can be explained by means of analogy (Ident constraints, Colina 1999), but a few remain unexplained. Given the very limited number of these contrasts in the phonology, I adhere to the position that they are exceptional and that the diphthongs hiatus distinction is generally predictable (Hualde 1997, Hualde and Prieto 2002).

(27) Onset strengthening
*Onset/glide, Onset >> Max-IOμ, Ident (son)

(28) /kre-iendo/ [kre.yen̪.do]

	*Onset/glide	Onset	Max-IOμ	Ident (son)
a. ☞ kre.yen̪.do			*	*
b. kre.i̯én̪.do		*!	*	
c. kre.jén̪.do	*!		*	
d. kre.i.en̪.do		**!		

(28) shows that the process traditionally known as 'onset strengthening' is simply the result of trying to satisfy Onset while also avoiding violations of the high-ranked markedness constraint against glides in the onset (*Onset/glide). Faithfulness violations are preferred in this case. Parsing the glide in the onset (28c) or in the nucleus (28b) incurs violations of top-ranked *Onset/glide and Onset. A candidate like (28d), in which /i/ is a vowel, is ruled out because of two Onset violations. The fricative in (28a) is a better option since, by changing its stricture and underparsing a mora, (28a) only violates the low-ranked faithfulness constraints Ident (son) and Max-IOμ. An OT analysis of this kind solves the problems of causality faced by serial models in which it is not possible to ascertain whether a glide becomes an obstruent after it has moved into the onset position, or whether the glide moves to the onset after it has become an obstruent and therefore is no longer acceptable in the nucleus (Hualde 1991). Similarly, a derivational framework offers at least two equally plausible analyses of onset strengthening: (a) the high vowel is initially parsed as a glide, and then it moves from the nucleus to the onset by means of rule that modifies the relevant autosegmental associations; and b) alternatively, the high vowel is parsed as part of the nucleus if it is postconsonantal, but as part of the onset if it is (absolute) syllable-initial, thereby feeding glide strengthening. In contrast, OT offers one single, more straightforward and less stipulative account of the phenomenon, as shown in (28).

As seen above (24–25, 27–28), moraic structure interacts with syllabic constituency and the sonority hierarchy ranking. Nuclei are always moraic, onsets always non-moraic and codas can be moraic or non-moraic. Faithfulness violations with regard to moraic structure (DEP-IOμ and Max-IOμ — insertion or deletion of moras) can be incurred under pressure from more highly ranked constraints (e.g., Onset). In Spanish, high vocoids become fricatives and complex nuclei and codas (vowel + glide, glide+ vowel) are allowed to avoid onset violations (e.g, diphthongization, *diario* [di̯a.ri̯o] 'diary'; onset strengthening, [28]). A complete account of these processes, however, also needs to explain the selection of the vocoid that loses its mora (i.e., incurs a Max-IOμ violation). While derivational models simply referred to the degree of sonority ('the least sonorous vocoid is the one that becomes a glide' or, in other words, those voicoids that are the least likely to be associated with a mora), an OT analysis can elegantly formalize this generalization by means of a constraint hierarchy based on the universal sonority scale.

(29) *ONSET/glide, ONSET >> *COMPLEX NUCLEUS, * MAX-IOμ
*ONSET/glide, ONSET >> * IDENT (son), * MAX-IOμ
*hi/μ>> *mid vowel/μ>> *low/μ

The high vowels are the ones that are more likely to lose their mora since their moraicity incurs a higher violation than mid vowels and low vowels; mid glides are better than low glides because their moraicity incurs a higher violation that low vowels.

Before concluding this section, a few words must be said about the sonority of non-nuclear clusters. Onset and coda clusters must obey the sonority sequencing principle (SSP) and therefore onset clusters that do not increase in sonority or coda clusters that do not decrease in sonority are not allowed; in other words, SSP is undominated, **part.e, *pa.rte*. 'part'. In addition, the two segments of an onset cluster cannot be too close in sonority, **fu.tbol* 'soccer': one of the members must be an obstruent or /f/ and the other a liquid.[7] In pre-OT models, this generalization was expressed as a condition on the application of a Complex Onset rule that attached a second consonant to the left of an already existing onset. A number reflecting the distance on the sonority scale between the two members of the cluster (stops and liquids) was used to capture the sonority distance required. In OT the onset cluster generalization is captured by a sonority distance constraint (Maximum Sonority Distance [MSD]) that requires that the first member of the cluster be drawn from the set of the least sonorous permissible onsets and the second from that of the most sonorous permissible onsets, thus maximizing the sonority distance between the two; in other words, the MSD constraint requires that there exist the maximum sonority distance between possible onset segments. Which segments are possible onsets is captured by the independently needed sonority constraint hierarchy in (21) repeated here as (30).

(30) *ONSET/vowel, *ONSET/glide >> FAITH >> *ONSET/ liquid >> *ONSET/nasal >> *ONSET/obstruent

The class of obstruents needs to be divided in two sonority classes, that of stops and /f/, and that of fricatives; the common property between stops and /f/ that allows them to belong to the same sonority class is that they are "the class of obstruents that lack the specification [+continuant] (Martínez-Gil 2001: 217).

MSD is undominated.[8] It in turn dominates the faithfulness constraint against epenthesis — DEP-IO — (33), given that [eslaβo] is preferred to [slaβo] as the output of /slabo/. More specifically, the ranking MSD >> DEP -IO accounts for the well-known cases of initial epenthesis, *Yugoslavo* ~ *eslavo* 'Yugoslavian' ~ 'Slavian'.

7. In addition, /dl/, and /tl/ in some dialects, are not possible onset clusters. These segments incur OCP violations regarding the sharing of voiced and place features.

8. In fact, MSD is dominated. The constraint(s) responsible for the fricative must dominate MSD in at least one possible analysis. Although the non-stop allophones of voiced obstruents have traditionally been considered fricatives (Hualde 1991), recent phonetic and phonological evidence points at their approximant nature. In this paper, I have adopted the more traditional fricative view for reasons of consistency with the research referred to. Replacing [β, ð, ɣ] with [β̞, ð̞, ɰ] has no consequences for the arguments/analysis presented here.

1.2.2 *Segments and syllabic positions*

Sonority, subsyllabic constituency and moraic structure cannot explain all the descriptive facts of Spanish syllabification. Harris (1989a:155) says that the sonority scale "must be supplemented by language-particular restrictions of some kind." In this paper I show that there is no need for language-particular restrictions or descriptive conditions on permissible phonemes; instead, those generalizations can be captured by the language-specific ranking of conflicting universal markedness and faithfulness constraints. Since no additional constraints or rankings are necessary to account for onset and nucleus segments, other than those in 1.2.1, I focus on coda segments.

1.2.2.1 Segments in the syllable coda

1.2.2.1.1 *Word-medial codas.* Serial analyses of Spanish syllabification contain descriptive statements that list the consonants that are well-formed in the coda. Although a descriptive generalization of the data is always a good starting point, the problem with that type of analysis is that it does not move beyond the level of description. As indicated above with regard to onset clusters, derivational models of syllabification must tack these generalizations onto syllabification rules, e.g., Coda Rule: "adjoin a coda to the right of the nucleus. *Possible codas are*…. " I show here that in OT these conditions are simply the result of the interaction of universal markedness and faithfulness. The list of licit coda segments can thus be obtained through constraint interaction. I start by stating the generalizations to then show how OT formalizes them.

Word-internally in coda position most Spanish dialects allow nasals with the same point of articulation as the following consonant, *cambio* 'change'; /l/ or /r/ (neutralized in Caribbean dialects) *malta* 'malt', *marca* 'mark'; /s/ *pista* 'clue'; and /θ/ *pi*[θ]*ca* 'pinch' (in dialects with /θ/ in their inventories). Coda stops, lost at one point in the history of the language, have been recovered in some dialects, in formal registers and under the influence of spelling. In these cases, however, [voice] and [continuant] are neutralized, hence there is no difference between the coda obstruents in *concepción* 'conception' and *obsesión* 'obsession', *étnico* 'ethnic' and *administrar* 'to administer'; *técnica* 'technique' and *dogmático* 'dogmatic' (Hualde 1989a).

Since Spanish has codas, *Coda must be dominated. I focus on obstruents first to later return to the sonorants. According to the sonority hierarchy (31), obstruents make the worst codas. This is in agreement with the descriptive facts for Spanish.

(31) *Coda /obstruent >> *Coda /nasal >> *Coda /liquid >> *Coda /glide[9]

Many dialects of Spanish do not allow coda obstruents at all. Many of these dialects avoid them through deletion, indicating that the ranking must be:

(32) *Coda /obstruent, Dep-IO >> Max-IO

---

9. In an alignment format (Piñeros 2001): Align-L(Obstruent,σ) >> Align-L(Nasal,σ) >> Align-L (Liquid,σ) >> Align-L(Glide,σ).

(33) Max-IO: Every segment present in the input must have a correspondent in the output
Dep-IO: Every segment present in the output must have a correspondent in the input

(34) /obsoleto/ [osoleto]

	*Coda /obstruent	Dep-IO	Max-IO
a. ☞ o.so.le.to			*
b. ob.so.le.to	*!		
c. o.be.so.le.to		*!	

As seen in (34), candidates that either preserve (34b) or avoid the coda obstruent through epenthesis (34c) are ruled out because they incur violations of the top-ranked constraints *Coda/obstruent and Dep-IO.

Formal varieties of Spanish (Hualde 1991) that retain coda obstruents exhibit the ranking in (35), thus selecting [ob.so.le.to] as the output (*Coda /obstruent violation) in (36):

(35) Dep-IO, Max-IO >> *Coda /obstruent

(36) /obsoleto/ [obsoleto]

	Max-IO	Dep-IO	*Coda/obstruent
a. o.so.le.to	*!		
b. ☞ ob.so.le.to			*
c. o.be.so.le.to		*!	

Despite the preservation of the obstruent, these dialects exhibit featural neutralizations in voice and continuancy (Hualde 1989a).[10] In other words, the featural specification of the obstruent is altered with regard to the features [voice] and [continuant], incurring one or more faithfulness violations. The relevant faithfulness constraint is Ident [feature] and its more specific versions Ident(voice) and Ident(continuant).

10. There is a significant amount of cross-dialectal variation regarding the [continuant] and [voice] specifications of coda obstruents that cannot be properly addressed within the confines of this paper. For instance, in the dialect of Northern and Northwestern Spain (colloquial, fast speech) described by Fernando Martínez Gil (2003) coda obstruents are always [+continuant], except for those cases in which an underlying voiceless stop is followed by a voiceless sop, e.g. *apto* [apto] 'apt'; but *hipnosis* [iβnósis] 'hypnosis'; *abdicar* [aβðikár] 'abdicate'; *absurdo* [aβsúrðo] 'absurd'. This suggests that Agree (voice) (Voicing assimilation, in Martínez Gil [2003)]), is highly ranked. Martínez Gil also argues for a highly ranked Spir constraint that says that voiced stops are disallowed after continuant segments (i.e., voiced stops are realized as spirants). Spir is therefore a more restricted version of Agree (continuant). Although the goal here is not to propose an alternative analysis, I suspect that the spirantization effects can be obtained from more basic constraints, such as, for instance, a restriction on the combination of the features [−continuant] and [+voice]. Agree (continuant) would be low ranked in this dialect, since voiceless stops are not disallowed before continuant segments, e.g., *excepción* [eksθepθion] 'exception'.

(37) IDENT(feature): A segment's input specification for a specific feature must match that of the output.
IDENT(voice): A segment's input specification for [voice] must match that of the output.
IDENT(continuant): A segment's input specification for [continuant] must match that of the output.

For voicing neutralization, the output may reveal obstruent devoicing (/digno/ [dikno]) or assimilation (/futbol/ [fuðβol]). Since sonorants are not affected by devoicing, especially because voiceless sonorants are phonetically and typologically marked,[11] a markedness constraint against voiceless sonorants — *SONORANT [−voice] — must be undominated. However, for non-sonorants, the unmarked voice specification for the coda position is voiceless — *CODA [+voice] (voiceless codas are unmarked). *CODA [+voice] must dominate the relevant faithfulness constraint — IDENT(voice) —, so that it is possible to change input voice specifications, if necessary, to obtain a voiceless obstruent in the output. In sum, the relevant ranking for obstruent devoicing is:

(38) Obstruent devoicing in coda position
* SONORANT [−voice] >> *CODA [+voice] >> IDENT (voice)

(39) Obstruent devoicing in coda position
/digno/ [dikno]

	*CODA [+voice]	IDENT (voice)
a. ☞ dik.no		*
b. dig.no	*!	

As seen in (39) the candidate with a voiced obstruent (39b), although faithful to the input, fails because it incurs a violation of the more highly ranked constraint against voiced obstruents in the coda.

Voice assimilation of coda obstruents responds to the domination of the constraint that requires adjacent segments to agree with respect to voice — AGREE (voice) — above IDENT (voice).

(40) AGREE (voice): adjacent segments share the same specification for the feature (voice) (Lombardi 1999)
AGREE (voice) >> IDENT (voice)

(41) Regressive voice assimilation of coda obstruents
/futbol/ [fuðβol]

	AGREE (voice)	IDENT(voice)
a. ☞ fuðβol		*
b. futβol	*!	

(41a) is a better candidate than (41b) because it satisfies the dominating constraint AGREE [voice] by adopting the [+voice] specification of the following consonant.

11. Many languages that have voiced sonorants do not have voiceless ones. Those with voiceless sonorants, however, also have voiced ones.

Hualde (1989a) reports the presence of variation, even within speakers, between obstruent devoicing and voice assimilation, e.g. /futbol/ [fuðβol] ~ [futβol]. This suggests that the ranking of Agree (voice) and *Coda [+voice] with respect to each other is not fixed. When Agree (voice) and *Coda [+voice] are in conflict, the speaker must rank them, but, since the ranking is not fixed, sometimes Agree (voice) will be ranked higher, whereas other times *Coda [+voice] will come out on top.

(42) Different outcomes of voice neutralization in coda obstruents: Coda devoicing
/futbol/ [fuðβol]

	*Coda [+voice]	Agree (voice)	Ident (voice)
a. fuðβol	*!		*
b. ☞ futβol		*	

In (42) the output (42b) exhibits coda devoicing because *Coda [+voice] is more highly ranked than Agree (voice). A violation of *Coda [+voice] eliminates the candidate with voice assimilation (42a).

(43) Different outcomes of voice neutralization in coda obstruents: Voice assimilation
/futbol/ [futβol]

	Agree (voice)	*Coda [+voice]	Ident(voice)
a. ☞ fuðβol		*	*
b. futβol	*!		

(43) reveals the opposite situation to that in (42). The need to agree in voicing is more important than having a voiceless coda and therefore the candidate with assimilation, the one whose highest-ranked violation is *Coda [+voice], is the winner and the output (43a).

(44) /fuDbol/ [futβol] (assuming [+ voice] in the input UR)[12]

	Agree (voice)	*Coda [+voice]	Ident(voice)
a. ☞ fuðβol		*	
b. futβol	*!		*

(44) is included to show that the results of evaluation would be the same regardless of the voice specification of the input. Voicing assimilation only affects coda obstruents, thus an obstruent in an onset cluster does not assimilate in voicing to the following sonorant, *apretar* [a.pre.tar] *[a.bre.tar] 'to tighten'. This suggests that a more specific Ident(voice) constraint — $\text{Ident}^{\text{Onset}}$(voice) — dominates Agree (voice).

When the demands of Agree (voice) and *Coda [+voice] are not in conflict, that is, when the onset consonant following the coda is voiceless and therefore voice assimilation would produce result in a voiceless consonant, there is rarely any alternation, as predicted: "*las sordas resultan prácticamente obligatorias si la consonante siguiente es una oclusiva sorda*" 'voiceless segments are practically required if the following consonant is a voiceless stop' (Hualde 1991, 33, translation mine)". This is demonstrated in

12. D=voiced obstruent.

(45) and (46), where the output is invariantly [opsoleto], regardless of the ranking of AGREE (voice) and *CODA [+voice].

(45) /obsoleto/ [opsoleto]

	AGREE (voice)	*CODA [+voice]	IDENT(voice)
a. ☞ opsoleto			*
b. obsoleto, oβsoleto	*!	*	

(46) /obsoleto/ [opsoleto]

	*CODA [+voice]	AGREE (voice)	IDENT(voice)
a. ☞ opsoleto			*
b. obsoleto, oβsoleto	*!	*	

(38–46) focus on voicing, abstracting away from continuancy. Coda obstruents in this dialect of Spanish also show neutralization in continuancy, surfacing as either stops or fricatives. An OT explanation for the alternation lies in the fact that, by ranking markedness over faithfulness (IDENT(continuant)), preservation of a contrast is no longer important and the default, unmarked structure is preferred. On the basis of the sonority hierarchy (16), a coda fricative is less marked than a stop, /futbol/ [fuðβol].

(47) Markedness >> IDENT(continuant)
*CODA/ stop>> *CODA/ fricative, IDENT(continuant)

However, in positions of prominence (stressed syllable, emphatic position, etc.) a stop is preferred for phonetic reasons. I use the cover term PROMINENCE [–cont] to refer to the default status of stops in prominent positions. PROMINENCE [–cont] dominates *CODA fricative, so that in a position of prominence a stop will be selected over a fricative, [futβol]

(48) PROMINENCE [–cont], *CODA/ stop >> *CODA/ fricative >> IDENT(continuant)

To recapitulate: an OT analysis makes the prediction that, under the general ranking Markedness >> Faithfulness, there will be various ways to satisfy *CODA/ obstruent, since there are various types of faithfulness constraints that could be violated (whole segment, featural identity, etc.). Such prediction is borne out by cross-dialectal Spanish data. In addition to the deletion of coda obstruents, and the voice and continuancy neutralizations seen here, other Spanish dialects avoid marked codas by incurring other faithfulness constraint violations: some, for instance, eliminate the supralaryngeal node of /s/ (MAX-IO(SL)), [meh] > /mes/ 'month'; others vocalize obstruents (IDENT(Stricture)) (Piñeros 2001), /adkirir/ [ai̯kirir] 'acquire'. I will not present an OT analysis of all those processes because of space considerations. Such accounts go beyond the current goal of providing a comprenhensive view of syllabification in Spanish in an OT framework highlighting OT's advances. Obstruent coda deletion and voice and continuancy neutralizations are sufficient to show that an OT account can uncover the 'hidden motivation' behind all these processes (to eliminate a marked structure, a coda obstruent) in a way not possible under a serial analysis.

Before concluding the account of obstruents in coda position, it is important to bring to the reader's attention one last generalization with regard to the place features of coda obstruents (see Piñeros, this volume, for a complete account of place features in the coda). Unlike sonorants, which are usually coronal, obstruents in coda position retain their point of articulation, /fuDbol/~ [fuðβol] ~ [futβol] *[fupβol] *[fuββol]; /oBsoleto/ [opsoleto] ~ [oβsoleto] *[oðsoleto] ~ *[otsoleto]. This suggests the high-ranking of a constraint that requires preservation of place features in obstruents regardless of syllabic affiliation and of the well-known tendency of codas to neutralize place contrasts.

(49) IDENT^OBSTR(place): The place features of an obstruent in the input must match that of the output.
CODA COND: A coda cannot license place features
IDENT^OBSTR(place)>> CODA COND

(50) /obsoleto/ [opsoleto]

	IDENT^OBSTR(place)	CODA COND	IDENT(place)
a. ☞opsoleto		*	
b. otsoleto	*!	*	*

Coda sonorants in Spanish tend to be realized as coronals (dorsals, in some dialects, cf. Piñeros, this volume, for an account that involves reducing consonantal features) or, in the case of nasals, to assimilate to the point of articulation of the following consonant. Hence it can be concluded that faithfulness to place features is not as important for sonorants as it is for obstruents. Ranking the more specific IDENT^OBSTR(place) over the general IDENT(place) will suffice to obtain this effect without having to propose an additional constraint that refers to sonorants (IDENT(place) is independently justified). However, despite the restrictions on point of articulation in the coda (CODA COND), segments need place features; therefore HAVE PLACE must dominate CODA COND.

(51) HAVE PLACE: all segments must have place features
HAVE PLACE >> CODA COND

In the case of sonorants, given that IDENT(place) is low-ranked, HAVE PLACE will be satisfied by selecting the place features ranked lowest in the place hierarchy (the least marked features), i.e. coronal (52a).

(52) a. Place Hierarchy: *DOR >> *LABIAL >> *CORONAL
b. HAVE PLACE >> *DOR >> *LABIAL >> *CORONAL >> IDENT(place)

Nasals and laterals take their place features from the following C through assimilation, thus satisfying CODA COND and HAVE PLACE simultaneously (place features are obtained and licensed through the onset) (see Piñeros, this volume, for a complete account).

(53) /tango/ [taŋgo]

	IDENT^OBSTR(place)	HAVE PLACE	CODA COND	IDENT(place)
a. ☞ taŋgo				*
b. tango			*!	
c. tamgo			*!	*

For ease of presentation an underlyingly specified coronal point of articulation is assumed in (53). This assumption has no bearing on the results of candidate evaluation; different assumptions about the nature of the underlying representation result in the selection of the same optimal candidate (53a) (Richness of the Base, McCarthy 2002).

1.2.2.1.2 *Word-final codas.* In word-final position only coronal consonants are possible: the sonorants /-l/, /n/, and /-r/ (*papel*, *camión*, *amor*) and the obstruents /-s/ and /θ/ (*mes*, *pez*), and /d/ (virtud).[13] /d/ can be realized as [ð], [θ], [t] or be deleted. Other consonants appear in unassimilated borrowings, *club, frac, bulldog, album, chef* (Hualde 1999a). Except for the behavior of obstruents, these facts are generally in agreement with the account of word-medial codas in *1.2.2.1.* Although word-medial stops and fricatives are acceptable in some dialects, as shown above, word-final obstruents are less common and even rare in some dialects.

Non-coronal word-final obstruents tend to appear in borrowings. The absence of word-final obstruents in the native lexicon is related to the fact that those segments were repaired at one point in the history of the language through epenthesis, so many of these forms are [e] final today. At the point that epenthesis was operative, the ranking would have been *CODA/ obstruent, MAX-IO >> DEP-IO. I argue, however, that the present ranking for many dialects, is *CODA/ obstruent, DEP-IO >> MAX-IO, as demonstrated by the outputs of foreign words, *club* [klú], *frac* [fra]. More specifically, since only non-coronal obstruents are affected (coronal obstruents are well-formed), the ranking must be:[14]

(54) Non-coronal coda obstruents are deleted (rather altering place features). Coronal coda obstruents are retained
*CODA/obstruent, DEP-IO >> MAX-IO
IDENT^OBSTR(place), HAVE PLACE >> *DOR >> *LABIAL >> MAX-IO>> *CORONAL, IDENT(place)

That some varieties of Spanish preserve word-medial non-coronal coda obstruents can be explained by restricting the relevant ranking to Latinate words (nativized forms, part of the Spanish lexicon) in formal contexts.

13. Exceptionally, /-x/, *reloj*, and /-t/, *cénit*, can appear in final codas (Hualde 1999a, Harris 1983 disagrees)

14. Although deletion of word-final obstruents is a common phenomenon, some dialects exhibit retention and neutralization (in voice, and/or continuancy) as in word-medial position. Such dialects exhibit the rankings for word-medial obstruents in (35), (38), (47). Neutralization of place features would respond to the ranking: HAVE PLACE, MAX-IO, DEP-IO >> *DOR >> *LABIAL >> *CORONAL, IDENT(place), IDENT^OBSTR(place).

(55) Preservation of the place features of word-internal non-coronal coda obstruents in latinate words (formal context)
Ident^{Obstr}(place), Have place, Max-IO, Dep-IO >> *Dor >> *Labial >> *Coronal, Ident(place) (latinate words)

1.2.2.1.3 *Complex codas.* Spanish has coda clusters and therefore *Complex Coda must be dominated by faithfulness constraints. Nonetheless, since not all coda clusters are possible, additional constraints must be involved. Most coda clusters contain a coda consonant or glide + /s/. /s/ is well known to have special a status cross-linguistically that allows its adjunction to other segments, even in violation of sonority (*stop*, *abstract*). I will therefore not delve into this topic and will simply treat these clusters as exceptional. Codas consisting of a glide + /s/, *dais* 'you give', or a glide + coronal sonorant, *veinte* 'twenty', *aunque* 'although', conform to the sonority contour and to the coda markedness hierarchy that prefers coronal sonorants. Only /s/ is allowed after another consonant in a coda cluster (Hualde 1999a: 17), *biceps* 'biceps', *torax* 'thorax', *transporte* 'transport'. In fast speech, these clusters are usually simplified to [bises], [toras], [trasporte], suggesting the ranking:

(56) *Complex Coda >> Max-IO

Yet (56) alone is not sufficient, as it does not say anything about which consonant in the cluster will deleted. In an OT account, the universal sonority constraint hierarchy will select the correct output, deleting always the least sonorous consonant.

(57) *Complex Coda >> Max-IO, *Coda/obstruent >> *Coda /nasal >> *Coda /liquid >> *Coda/glide

A serial analysis, however, faces a serious obstacle in trying to account for the same facts. It cannot satisfactorily explain the selection of the segment targeted for deletion. Harris (1983) argues that in *esculp-ir* 'to scultp', *esculp-tor* 'sculptor' [p] is deleted in [escultor] because it cannot be syllabified in the coda or in the onset. Yet, this mechanism will not work for /ekspresidente/ [espresiðente] *[ekpresiðente] because both [k] and [s] are syllabifiable in the coda (through R1 and R3 in Harris 1983). An additional deletion rule targeting [k] would be necessary to derive [espresiðente]. Similarly, in Hualde (1991) a rule of /s/-Adjuntion ('Adjoin /s/ under N') must be followed by another rule that deletes a stop in a stop + /s/ cluster. In sum, to obtain the correct outputs, serial models must resort to adhoc rules that miss an important generalization — the target of deletion is the segment that makes the worst coda. In an OT account, this is a direct consequence of the universal sonority constraint hierarchy.

2. Syllabification rules. Resyllabification

In Section 1 I provided a general OT account of Spanish syllable types and phonotactics. I showed that the basic descriptive facts and syllabification mechanisms can be accounted for by means of the interaction of universal markedness and faithfulness constraints ranked in language/dialect-specific fashion. For comparison purposes it is now pertinent to briefly review how a derivational approach would account for the same facts. Based on the ruled-based approach to syllabification of Steriade (1982) and the formalism of Levin (1985), Hualde (1991) proposes that syllabification in Spanish is the result of the application of the following set of ordered rules:

1. Node projection: Mark vowels as syllable-heads, create N nodes, and project N' and N" nodes.
2. Complex Nucleus: Adjoin a prevocalic glide under the N node.
3. CV rule: Adjoin a consonant to the left of the nucleus under the N" node.
4. Complex onset: Adjoin a second consonant under the N" node if the result would be a permissible onset cluster (stop or /f/ + liquid, except */dl/ and (*) /tl/).
5. Coda rule: Adjoin a segment to the right of the nucleus under N'.
6. Complex coda: Adjoin a consonant to the right of a glide under N'.
   /s/-Adjunction: Adjoin /s/ under N'.

Figure 1. Spanish syllabification rules (Hualde 1991)

The CV rule has a second, structure-changing application. As mentioned above, an additional rule simplifying CsC clusters is also necessary (deletes a stop in a stop + /s/ cluster).

An account of syllabification like the one in *Figure 1* and *Figure 2* has the disadvantage of relying on language-specific rules. It also requires language-specific, extrinsic rule-ordering. Furthermore, although many of the generalizations expressed by the rules are common cross-linguistically, such as for instance, the fact that most languages seem to have an Onset Rule, this is only coincidental in a model of phonology where rules are language-specific. On the other hand, an OT analysis like the one presented in this paper can account for the cross-linguistic preferences present in the rules, in addition to replacing language specific rules with universal constraints. For instance, the preference for CV syllables is a consequence of a markedness constraint that penalizes onsetless syllables (or requires Onset). Such constraint is phonetically grounded as it provides for a better sonority contour for the syllable. Similarly, *Coda is motivated by the universal dislike for codas and by the linguistic implicational that, although many languages do not allow codas, no language requires them. An additional inadequacy of the serial model is that the syllabification algorithm requires descriptive generalizations/conditions on rule application indicating what types of segments constitute well-formed onset, codas and nuclei, e.g., "4. Complex onset: Adjoin a second consonant under the N" node *if the result would be a permissible onset cluster (stop or /f/ + liquid, except */dl/ and (*) /tl/).*" In OT all of this is obtained directly through the general mechanism of constraint interaction. Finally, one particular aspect of syllabification that reveals the superiority of an OT analysis is the process traditionally known as *resyllabification* — in Spanish a word final consonant is generally resyllabified as the onset of the following vowel-initial word.

(58)	los amigos [lo.sa.mi.ɣos]	'the friends'
	más osos [má.so.sos]	'more bears'
	reloj azul [re.lo.xa.sul]	'blue watch'

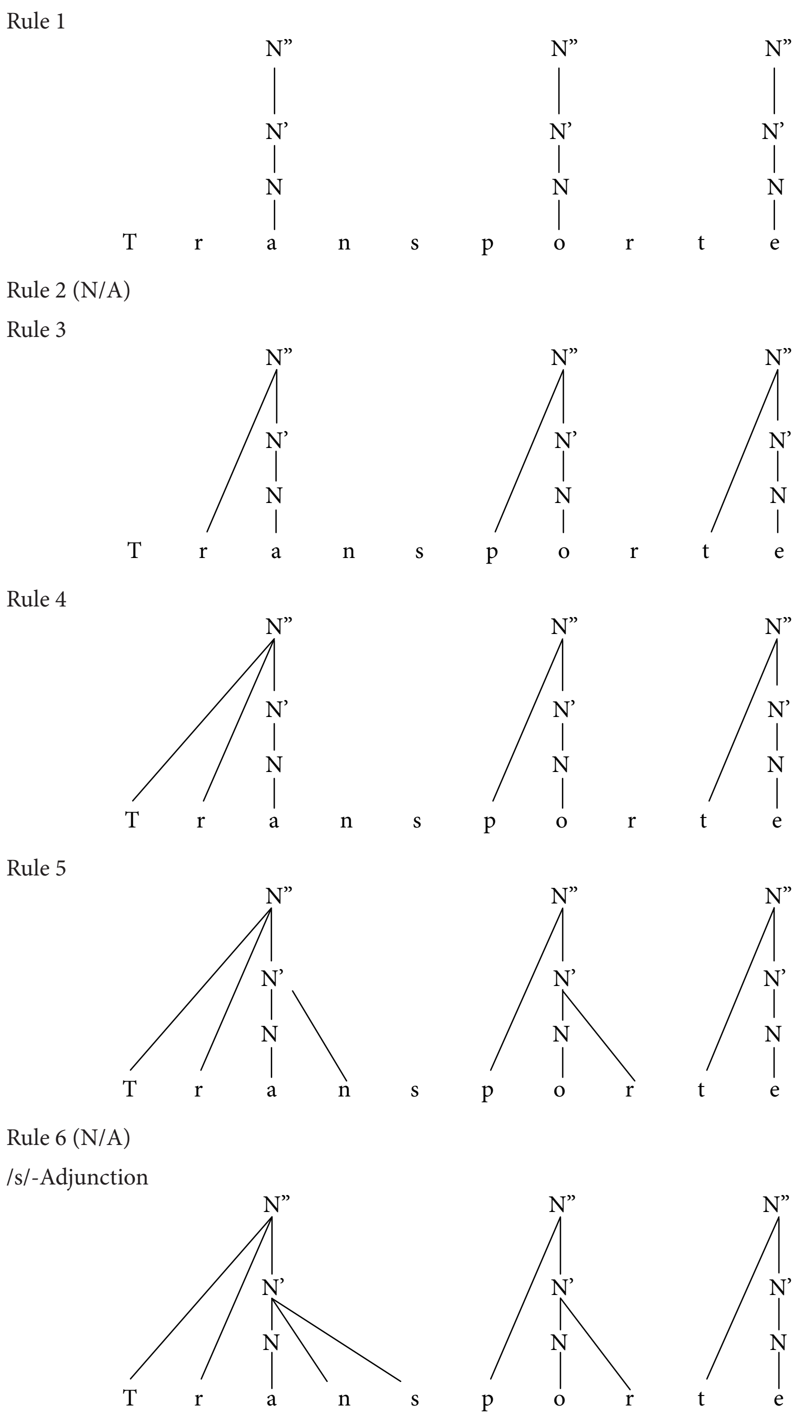


Figure 2. Application of Spanish syllabification rules *(Hualde 1991)*

Harris (1983) proposes the rule in (59):

(59) Resyllabification: [+cons] → [+cons] / ____#V
| |
coda onset

Hualde (1991) offers a superior analysis by eliminating a separate resyllabification rule and proposing instead a second postlexical application of the independently necessary CV rule.

(60)	Syllabification (including CV rule)	[mas] [o.sos]
	Postlexical component	[mas.o.sos]
	Postlexical application of CV rule	[ma.so.sos]

Nevertheless, one piece of the puzzle is still missing. In Spanish resyllabification is limited to one consonant. Although consonant clusters are preferred to two heterosyllabic consonants word internally, this is not so across words.

(61) Hablamos [a.βla.mos] *[aβ.la.mos] 'we talk'

(62) Club lindo [kluβ.lin.do] *[klu.βlin.do] 'pretty club'[15]

Hualde accounts for the data in (61–62) by proposing that the application of the Complex Onset rule is limited to the lexical domain. In other words, while the Onset rule applies lexically and postlexically, the Complex Onset rule only has a lexical application. Although Hualde's solution is descriptively adequate, its explanatory value is limited — why is the Complex Onset rule restricted to the lexical domain? In contrast, an OT analysis (Colina 1995, 1997), easily accounts for the different behavior of single consonants and consonant clusters: while resyllabification of a single consonant across words is necessary to satisfy Onset, this is not the case with the second consonant of a cluster. Resyllabifying consonants (or vowels) across words incurs a violation of an alignment constraint that requires the left edge of a syllable to be aligned with the left edge of the stem.

(63) Align (Stem, L, Syllable, L) (Align-LSt): Align the left edge of the syllable with the left edge of the stem

[ma.s | o.sos], for instance, misaligns the stem (|) and the syllable (.). Nonetheless, this is possible under Onset domination.

(64) Onset >> Align (Stem, L, Syllable, L)

(65) /masosos/ [ma.so.sos]

	Onset	Align-LSt
a. ☞ ma.s |o.sos		*
b. mas. |o.sos	*!	

15. In dialects that preserve final obstruents.

In [kluβ.lin.do] ONSET satisfaction is no longer at stake. Therefore ALIGN-LST selects [kluβ.lin.do] over misaligned [klu.β|lin.do]. *CODA must be ranked below ALIGN-LST given that a coda consonant (*CODA violation) is preferred to misalignment (ALIGN-LST violation).

(66) ONSET >> ALIGN (Stem, L, Syllable, L) >> *CODA

(67) /klublindo/ [kluβ.lin.do]

	ONSET	ALIGN-LST	*CODA
a. ☞ kluβ. | lin.do			*
b. klu.β | lin.do		*!	

Diphthogization applies across words in Spanish (i.e., syllable merger), *mi amigo* [mi̯a.mi.ɣo] 'my friend' where it is also the result of the domination of ONSET over ALIGN-LST and MAX-IOμ.

(68) ONSET >> ALIGN-LST, MAX-IOμ.

(69) /miamigo/ [mi̯a.mi.ɣo]

	ONSET	ALIGN-LST	MAX-IOμ
a. ☞ mi̯a.mi.ɫo		*	*
b. mi.| a.mi.ɫo	*!		*

As seen in (69), (a) is the optimal candidate because (b) contains a violation of the top-ranked constraint, ONSET. (for a more in-depth OT analysis of syllable merger in Chicano Spanish see Bakovic, this volume, and Martínez-Gil 2004; other recent analysis of the phenomenon are Roca 1991, Hualde 1994, Martínez-Gil 2000).

3. Domain of syllabification. Interaction with morphology

Since rules apply in a certain domain, rule-based models of syllabification need to specify the domain of syllabification. On the basis of resyllabification, aspiration, and onset strengthening data, Hualde (1989b, 1991) convincingly argues that the domain of syllabification in Spanish is a unit smaller than the word, as syllabification seems to apply before the adjunction of prefixes and before compounding (after affixation).

In an OT analysis the issue of domain can be obtained directly from the general mechanisms, independently needed in the theory, that capture the interaction between morphology and syllabification/phonology. More specifically, this type of interaction is formalized through alignment constraints that refer to morphological and prosodic constituents (see Kager 1999:117–120 for the general format of alignment constraints). In Spanish the constraint responsible for word-level syllabification (before affixation and compounding) is ALIGN-LST (63).

As seen in (70), a candidate like (70b) [de.si̯e.lo] that avoids onset strengthening through resyllabification of the final consonant of the prefix as an onset is not possible because it would misalign the syllable and the stem (ALIGN-LST violation).

It is preferable to create an acceptable onset by underparsing a mora and changing the specification of the feature sonorant (Max-IOμ and Ident (son) violations). This indicates that Align-LSt dominates Max-IOμ and Ident (cont). It has already been shown that Onset >> Align-LSt (64).

(70) / des+ ielo / [desyelo]

	Align-LSt
a. ☞ des. | yelo	
b. de. s |i̯e.lo	*!

(71) /des+ ielo/ [desyelo]

	*Onset/glide	Onset	Align-LSt	Max-IOμ	Ident (son)
a. ☞ des. | yelo				*	*
b. de. s | i̯e.lo			*!	*	
c. des. | jelo	*!			*	

Align-LSt also selects the right candidate in forms like /sublunar/ [suβ.lunar].

(72) /sublunar/ [suβ.lunar]

	Onset	Align-LSt	*Coda
a. ☞ suβ. | lu.nar			*
b. su.β | lu.nar		*!	

That syllabification applies after suffixation shows the effects of Align -R (73).

(73) Align (Word, R, Syllable, R) (Align -R): The right edge of a morphological word coincides with the right edge of a syllable.

Due to space limitations I will not present an account of the interaction between aspiration and syllabification in Spanish. The reader is referred to Hualde (1989b, 1991) for a derivational account and to Colina (2002) and Wiltshire (this volume) for optimality-theoretic approaches. I will, however, stress that in forms like *des-hacer* [de.ha.ser] 'to undo' the issue at stake is not one of alignment, given that prefixes are not morphological words[16], but one of allomorph uniformity. In aspirating dialects of Spanish the final /s/ in /des/ will be realized as [h] when /des/ is attached to a consonant-initial stem, /des+kontrol/ [deh.kon.trol]. Some of these dialects also show aspiration when the prefix precedes a vowel initial stem, despite resyllabification of final /s/ to the onset position. The motivation behind this is the need to reduce allomorphy in /des/. The relevant constraint, Ident (PrWd) (Colina 2002), requires identity amongst realizations of prosodic words. In some dialects, Ident (PrWd) dominates faithfulness, and therefore the output contains aspiration, [de.ha.ser]. In others, however, the output is [de.sa.ser], which is the result of the opposite ranking Ident -IO >> Ident (PrWd) (see also Wiltshire, this volume, for an alternative account).

16. An alternative is to replace morphological word with prosodic word in the alignment constraint.

In sum, syllable structure and morphological structure (word-level) are usually isomorphic in Spanish, except when onset satisfaction is at stake, i.e. diphthongization, resyllabification. In OT terms, ALIGN-LST is a high-ranked constraint dominated by ONSET.

4. Syllable-repair mechanisms

In rule-based models of syllabification, repair of ill-formed syllables is done through additional rules of deletion or epenthesis (see for Spanish, Harris 1983, 1987, Hualde 1991). In some models, filters are also used to avoid the production of illicit outputs. In an OT approach, the traditional notions of epenthesis and deletion correspond to violations of faithfulness constraints (MAX-IO, DEP-IO, etc). Deletion and epenthesis are no longer the result of language-specific, often adhoc, rules; they can be obtained through the general mechanism of interaction of faithfulness and markedness constraints. *Syllable repair* is a syllabic consequence of the basic mechanism that drives the phonology — producing the best output possible.

Finally, one more advantage of an optimality theoretic model is that it can account for the quality of the epenthetic vowel, rather than stipulating it for each language (Spanish = [e]). Since epenthetic segments are by definition absent from the input, faithfulness constraints are trivially satisfied; as a result, markedness constraints become relevant. Hence it is not surprising that the epenthetic vowel should consist of the least marked vocalic features.

(74)

	i	u	e	o	a
high	+	+	−	−	−
low	−	−	−	−	+
back	−	+	−	+	−
round	−	+	−	+	−

On the basis of the Spanish vowel inventory in (74), it is safe to assume that the marked, contrastive vowel features are [+low], [+round], [+high]. These are preserved when present in the input through the domination of the relevant faithfulness constraints over markedness:

(75) IDENT (low), IDENT (round), IDENT (high), IDENT (back) >> *[+low], *[+round], *[+high] *[+back]

When faithfulness constraints are trivially satisfied because no vocalic features are present in the input (epenthesis), markedness constraints emerge requiring an output that satisfies *[+low], *[+round], *[+high] *[+back]. Hence the output must be [−low], [−high], [−back], [−round] that is, [e], the default epenthetic vowel in Spanish.

5. Conclusions

In this article I provided an optimality-theoretic account of Spanish syllable structure that integrates all areas covered by traditional analyses of syllabification: syllable types, phonotactic restrictions, syllabification algorithms (or rules), domain of syllabification, and repair strategies. The descriptive facts in those areas can be explained through the general mechanism of interaction of universal markedness and faithfulness constraints. Cross-dialectal and intra-speaker variation is obtained through variation in the ranking of the constraints. This analysis also offers a comprehensive view of recent advances in Spanish syllabification that was well overdue, since the most recent studies of this type date back to the late 80s and early 90s (Harris 1989a, Hualde 1991). Yet the true driving force behind the writing of this article is the highlighting of the advantages of an optimality theoretic approach to syllabification in order to support the claim that the advent of OT has brought about significant improvement in syllabic theory. Among these advantages is the replacement of language-specific rules with universal constraints. A serial approach based on language-specific rules fails to capture/explain the similarity of syllabification rules across languages; since rules are independent, such similarity can only be the result of coincidence. That syllabification in OT is the result of the language-specific ranking of universal constraints provides an explanation for cross-linguistic similarities as well as variation. In addition, I show that serial analyses cannot capture the hidden motivation behind seemingly independent rules. In OT, such motivation is the result of trying to satisfy highly-ranked universal constraints through the violation of various other lower-ranked ones. For instance, the current analysis reveals that processes like onset strengthening, diphthongization, resyllabification all respond to the need to satisfy ONSET. An optimality-theoretic account also makes it possible to avoid the conditions on rule application (e.g. "Attach a second consonant to the onset, *if the resulting cluster is well-formed-i.e., obstruent or /f/ + liquid*) that were necessary in rule-based models in order to achieve descriptive adequacy; they are now directly obtained through constraint interaction. Furthermore, an optimality-theoretic framework allows the analyst to put dialectal variation in a broader perspective: dialectal variation corresponds to various logical ways of solving a problem (of obtaining a more optimal output). The result is a more restrictive and explanatory view of variation than that offered by serial models, in which languages were different because their rules were different. Finally, generalizations which were stipulatory in derivational analyses are now predicted by the theory. That the epenthetic vowel is Spanish is /e/ is not an accident. As predicted, when faithfulness to the input is not a requirement — precisely the case for epenthetic segments which by definition have no input correspondent — the lower ranked markedness constraints emerge, demanding the least marked output [e].

References

Baković, Eric. This volume. Hiatus resolution and cooperative interaction. In *Optimality-theoretic Studies in Spanish Phonology*, Fernando Martínez-Gil and Sonia Colina (eds). Amsterdam: John Benjamins.

Barlow, J. and J. Gierut. 1999. Optimality theory in phonological acquisition. *Journal of Speech, Language, and Hearing Research* 42: 1482–98.

Clements, N. 1990. The role of sonority in core syllabification. In *Papers in Laboratory Phonology* I: *Between the Grammar and Physics of Speech*, J. Kingston and M. Beckman (eds), 282–333. Cambridge: CUP.

Colina, S. 1995. A Constraint-based Approach to Syllabification in Spanish, Catalan and Galician. PhD dissertation, University of Illinois, Urbana-Champaign.

Colina, S. 1996. Spanish truncation processes: The emergence of the unmarked. *Linguistics* 34: 1199–1218.

Colina, S. 1997. Identity constraints and Spanish resyllabification. *Lingua* 103: 1–23.

Colina, S. 1999. Reexamining Spanish glides: Analogically conditioned variation in vocoid sequences in Spanish dialects. In *Advances in Hispanic Linguistics. Papers from the 2nd Hispanic Linguistics Symposium*, J. Gutiérrez-Rexach and F. Martínez-Gil (eds), Vol. 1, 121–134. Somerville MA: Cascadilla.

Colina, S. 2002. An account of inter and intradialectal variation in Spanish /s/ aspiration. In *Structure Meaning and Acquisition in Spanish. Papers from the 4th Hispanic Linguistics Symposium*, J. Lee, K. Geeslin and J.Clancy Clements (eds), 230–243. Somerville MA: Cascadilla.

Gnanadesikan, A. 2004. Markedness and faithfulness constraints in child phonology. In *Constraints in Phonological Acquisition*, R. Kager, J. Pater and K. Zonneveld (eds), 73–108. Cambridge: CUP.

Harris, J.W. 1983. *Syllable Structure and Stress in Spanish*. Cambridge MA: The MIT Press.

Harris, J.W. 1987. Epenthesis processes in Spanish. In *Studies in Romance Languages*, C. Neidle and R. Núñez-Cedeño (eds), 107–122. Dordrecht: Foris.

Harris, J.W. 1989a. Our present understanding of Spanish syllable structure. In *American Spanish Pronunciation*, P.C. Bjarkman and R.M. Hammond (eds), 151–169. Washington DC: Georgetown University Press.

Harris, J.W. 1989b. Sonority and syllabification in Spanish. In *Selected Papers from the Linguistic Symposium on Romance Languages* 17, C. Kirschner and J. DeCesaris (eds), 139–153. Amsterdam: John Benjamins.

Hooper, J. 1976. *An Introduction to Natural Generative Phonology.* New York NY: Academic Press.

Kahn, D. 1976. *Syllable-based Generalizations in English Phonology.* Cambridge MA: The MIT Press.

Hualde, J.I. 1989a. Procesos consonánticos y estructuras geométricas en español. *Lingüística* 1: 7–44.

Hualde, J.I. 1989b. Silabeo y estructura morfémica en español. *Hispania* 72: 821–831.

Hualde, J.I. 1991. On Spanish syllabification. In *Current Studies in Spanish Linguistics*, H. Campos and F. Martínez-Gil (eds), 475–493. Washington DC: Georgetown University Press.

Hualde, J.I. 1994. La contracción silábica en español. In *Gramática del español*, V. Demonte (ed.), 629–647. México DF: El Colegio de México.

Hualde, J.I. 1997. Spanish /i/ and related sounds: an exercise in phonemic analysis. *Studies in the Linguistic Sciences* 27: 61–79.

Hualde, J.I. 1999a. La silabificación en español. In *Fonología de la lengua española contemporánea*, R. Núñez-Cedeño and A. Morales-Front (eds), Washington DC: Georgetown University Press.

Hualde, J.I. 1999b. Patterns in the lexicon: Hiatus with high unstressed high vowels in Spanish. In *Advances in Hispanic Linguistics. Papers from the 2nd Hispanic Linguistics Symposium*, J. Gutiérrez-Rexach and F. Martínez-Gil (eds), Vol. 1, 182–197. Somerville MA: Cascadilla.

Hualde, J.I and Prieto, M. 2002. On the diphthong/hiatus contrast in Spanish: Some experimental results. *Linguistics* 40: 217–234.

Kager, R. 1999. *Optimality Theory*. Cambridge: CUP.

Kenstowicz, M. and Kisseberth, C. 1979. *Generative Phonology*. New York NY: Academic Press.

Itô, J. and A. Mester. 1994. Reflections on CodaCond and alignment. In *Phonology at Santa Cruz* III, J. Merchant, J. Padgett and R. Walker (eds), 27–46. Santa Cruz CA: LRC.

Levin, J. 1985. *A Metrical Theory of Syllabicity*. PhD dissertation, MIT.

Lombardi, L. 1999. Positional faithfulness and voicing assimilation in optimality theory. *Natural Language and Linguistic Theory* 17: 267–302.

Martínez-Gil, F. 1996. El principio de la *distancia mínima de sonoridad* y el problema de la vocalización consonántica en el español dialectal de Chile. *Hispanic Linguistics* 8: 201–246.

Martínez-Gil, F. 1997. Obstruent vocalization in Chilean Spanish: A serial versus a constraint-based approach. *Probus* 9: 165–200.

Martínez-Gil, F. 2000. La estructura prosódica y la especificación vocálica en español: El problema de la sinalefa en ciertas variedades de la lengua coloquial contemporánea. In *Panorama de la fonología española actual*, J. Gil Fernández, (ed.), 511–560. Madrid: Arco Libros, S.L.

Martínez-Gil, F. 2001. Sonority as a primitive phonological feature. In *Features and Interfaces in Romance*, J. Herschensohn, E. Mallén and K. Zagona (eds), 203–222. Amsterdam: John Benjamins.

Martínez-Gil, F. 2003. Resolving ordering paradoxes of serial derivations: An optimality-theoretical account of the interaction of spirantization and voicing assimilation in Peninsular Spanish. In *Theory, Practice, and Acquisition: Papers from the 6th Hispanic Linguistics Symposium and the 5th Conference on the Acquisition of Spanish and Portuguese*, P. Kempchinsky and C.E. Piñeros (eds), 40–67. Somerville MA: Cascadilla.

Martínez-Gil, F. 2004. Hiatus resolution in Chicano Spanish. Paper presented at the 34th Linguistics Symposium on Romance Languages, University of Utah. Salt Lake City UT.

McCarthy, J 2002. *A Thematic Guide to Optimality Theory*. Cambridge: CUP.

McCarthy, J. and A. Prince. 1993a. *Prosodic Morphology* I: *Constraint Interaction and Satisfaction.* Report no. RuCCS-TR–3. New Brunswick NJ: Rutgers University Center for Cognitive Science.

McCarthy, J. and A. Prince. 1993b. Generalized alignment. In *Yearbook of Morphology*, G. Booij and J. van Maarle (eds), 79–153. Dordrecht: Kluwer.

McCarthy, J. and A. Prince. 1994. The emergence of the unmarked. In *Proceedings of the North East Linguistic Society* 24, M. Gonzàlez (ed), 333–79. Amherst MA: GLSA.

Morales-Front, A. 1994. A Constraint-based Approach to Spanish Phonology. PhD dissertation, University of Illinois, Urbana-Champaign.

Núñez-Cedeño, R.A. and Morales-Front, A. 1999. *Fonología generativa contemporánea de la lengua española*. Washington DC: Georgetown University Press.

Ohala, D. 1999. The influence of sonority on children's cluster reductions. *Journal of Communication Disorders* 32: 397–422.

Piñeros, C.E. 2000. Prosodic and segmental unmarkedness in Spanish truncation. *Linguistics* 38: 63–98.

Piñeros, C.E. 2001. Segment-to segment alignment and vocalization in Chilean Spanish. *Lingua* 111: 163–188.

Piñeros, C.E. This volume. The phonology of implosive nasals in five Spanish dialects: An optimality account. In *Optimality-theoretic Studies in Spanish Phonology*, F. Martínez-Gil and S. Colina (eds). Amsterdam: John Benjamins.

Prince, A. and P. Smolensky. 1993. *Optimality Theory: Constraint Interaction in Generative Grammar.* Report no. RuCCS-TR–2. New Brunswick NJ: Rutgers University Center for Cognitive Science.

Rice, K. 1992. On deriving sonority: A structural account of sonority relationships. *Phonology* 9: 61–100.

Roca, I. 1991. Stress and syllables in Spanish. In *Current Studies in Spanish Linguistics*, H. Campos and F. Martínez-Gil (eds), 599–635. Washington DC: Georgetown University Press.
Selkirk, E.O. 1984. On the major class features and syllable theory. In *Language Sound Structure*, M. Aronoff and R.T. Oehrle (eds), 107–136. Cambridge MA: The MIT Press.
Steriade, D. 1982. Greek Prosodies and the Nature of Syllabification. PhD dissertation, MIT.
Wiltshire, C. This volume. Prefix boundaries in Spanish varieties: A non-derivational OT account. In *Optimality-theoretic Studies in Spanish phonology*, F. Martínez-Gil and S. Colina (eds). Amsterdam: John Benjamins.

Appendix 1. List of constraints and constraint ranking by process

Segment types in the nucleus
*Nuc/obstruent >> *Nuc/nasal >> *Nuc/liquid >> Faith, *Nuc/vowel

Segment types in the onset
*Onset/vowel >> Faith >> *Onset/ liquid >> *Onset/ nasal >> *Onset/obstruent

Segment types in the coda
*Coda/vowel>>Faith>>*Coda/obstruent>>*Coda/nasal>>*Coda/liquid>> *Coda/glide

Diphthongization: [pi̯érðe] > /pierde/
*Onset/glide, Onset >> *Complex Nucleus, *Nuc/glide, Max-IOμ
Onset >> *Complex Nucleus, *Coda/glide, *Coda, Max-IOμ

Onset strengthening: [kre.yen̥.do] > /kre-iendo/
*Onset/glide, Onset >> Max-IOμ, Ident (son)

Coda deletion: [osoleto] > /obsoleto/
*Coda/obstruent, Dep-IO >> Max-IO

Coda retention: [obsoleto] > /obsoleto/
Dep-IO, Max-IO >> *Coda/obstruent

Obstruent devoicing in coda position: [dikno] > /digno/
* Sonorant [−voice] >> *Coda [+voice] >> Agree (voice)>> Ident (voice)

Regressive voice assimilation of coda obstruents: [fuðβol] > /futbol/
Agree (voice)>> *Coda [+voice]>> Ident (voice)

Continuacy neutralization: [fuðβol] ~ [futβol] > /futbol/
*Coda stop>> *Coda fricative, Ident(continuant), Prominence [−cont],*Coda stop >> *Coda fricative >> Ident(continuant)

Place features retained in obstruents: [fuðβol] ~ [futβol] *[fupβol] *[fuββol] > /fuDbol/
$\text{Ident}^{\text{Obstr}}$(place) >> Ident(place)
$\text{Ident}^{\text{Obstr}}$(place)>> Coda Cond

Non-coronal coda obstruents deleted. [klú] >/klub/
*Coda obstruent, Dep-IO >> Max-IO

Coronal coda obstruents retained [mes] > /mes/
$\text{Ident}^{\text{Obstr}}$(place), Have place >> *Dor >> *Labial >> Max-IO>> *Coronal, Ident(place)

Preservation of place features of word-internal non-coronal coda obstruents in latinate words (formal context) [dikno] > /digno/
Ident$^{\text{Obstr}}$(place), Have place, Max-IO, Dep-IO >> *Dor >> *Labial >> *Coronal, Ident(place) (latinate words)

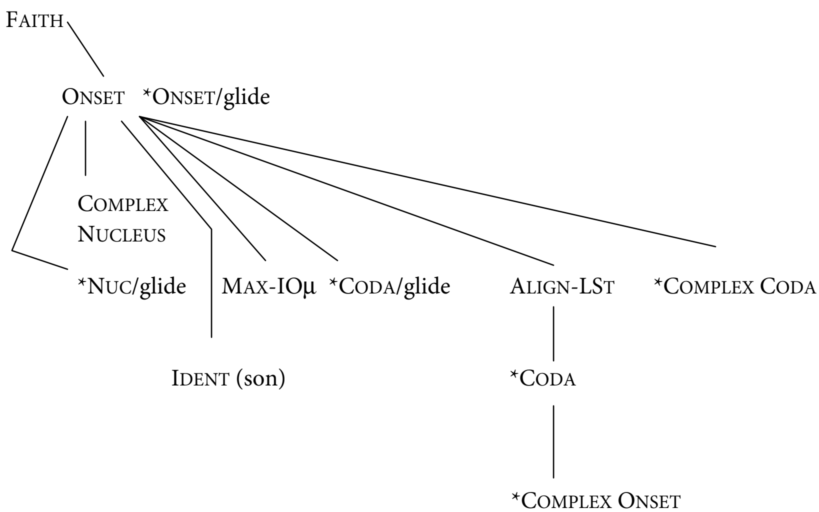
Complex codas [bises] < /biseps/
*Complex Coda >> Max-IO
*Complex Coda >> Max-IO, *Coda/obstruent >> *Coda /nasal >> *Coda /liquid >> *Coda/ glide

Resyllabification [má.so.sos] [kluβ.lin.do]
Onset >> Align (Stem, L, Syllable, L) >> *Coda

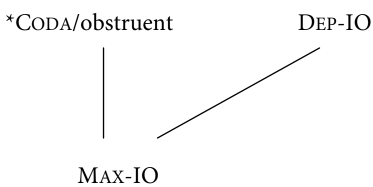
Diphthongization across words [mi̯a.mi.ɣo] > /miamigo/
Onset >> Align-LSt, Max-IOμ

Onset strengthening across words [desyelo] > / des+ ielo /
Onset /glide, Onset >> Align-LSt >> Max-IOμ, Ident (son)

Appendix 2. Summary of constraint rankings



Obstruent coda deletion



Obstruent coda retention

Max-IO   Dep-IO

| /

*Coda/obstruent

Obstruent devoicing in coda position

*Sonorant [–voice]
|
*Coda [+voice]
|
Agree (voice)
|
Ident (voice)

Voice assimilation of coda obstruents

Agree (voice)
|
*Coda [+voice]
|
Ident (voice)

Neutralization of continuacy

*Coda / stop, Prominence [–cont]
|
*Coda / fricative, Ident(continuant),

Place features retained in obstruents

Ident$^{\text{Obstr}}$(place)
|
Coda Cond, Ident(place) (Piñeros, this volume)

Non-coronal coda obstruents deleted. Coronal coda obstruents retained

Ident$^{\text{Obstr}}$(place), Have place
|
*Dor
|
*Labial
|
Max-IO
|
*Coronal, Ident(place)

Preservation of the place features of word-internal non-coronal coda obstruents in **latinate** words (formal context)

IDENT^{OBSTR}(place), HAVE PLACE
|
MAX-IO, DEP-IO
|
*DOR
|
*LABIAL
|
*CORONAL, IDENT(place)

Complex codas

*COMPLEX CODA
|
MAX-IO, *CODA/obstruent
|
*Coda / nasal
|
*Coda / liquid
|
*CODA / glide

Exceptional hiatuses in Spanish*

Teresa Cabré and Pilar Prieto
Universitat Autònoma de Barcelona / Institut Català de Recerca i Estudis Avançats and Universitat Autònoma de Barcelona

This paper provides a close examination of how Spanish speakers syllabify sequences of vocoids of rising sonority within the lexicon (e.g., *piano* 'piano', *persiana* 'blind' or *historia* 'history'). A survey with 246 words administered to 15 Peninsular Spanish speakers has enabled us to examine in a quantitative way the strength of prosodic and morphological conditions on the appearance of the so-called exceptional hiatuses (Navarro Tomás 1948; Hualde 1999, 2005; Colina 1999). The data in our study reveals that the word initiality effect is not as strong as stated in the literature and that there are large differences between speakers: within the same dialect, half of the informants have the word-initiality effect in words such as *piano* 'piano' or *diálogo* 'dialogue', while the rest have practically generalized the presence of a diphthong in this position. Interestingly, morpheme boundary effects are found in conservative speakers and their conditions differ depending on the paradigm: (a) in nominal forms, gliding is blocked when there is an intervening morpheme boundary and when the glide is a high back vowel (*virt*[u.ˈo]*so* 'virtuous' vs. *od*[ˈjo]*so* 'hateful', *act*[u.ˈa]*l* 'present' vs. *cord*[ˈja]*l* 'cordial'); (b) in verbal paradigms, gliding is blocked when there is an intervening morpheme boundary and when the high vowel can be stressed in some form of the paradigm (*conf*[i.ˈa]*r* 'to trust', *confío* 'I trust' vs. *camb*[ˈja]*r* 'to change', *cambio* 'I change'). In general, the situation indicates that language change is in progress and that, for some speakers, the presence of lexical items that are pronounced with a hiatus is gradually disappearing. The article presents an analysis in terms of a correspondence-based OT analysis which captures the prosodic and analogical forces governing this process together with the inter-speaker variation found in the data.

* We are grateful to Glòria Claveria, Timothy Face, James W. Harris, José Ignacio Hualde, Michael Kenstowicz, Joan Mascaró, Dolors Poch, and María Ohannesian for helpful discussion of some parts of the materials included in the article. Thanks are also due to Àngel Gallego, Ana María Escobar, Anna Gavarró, Marta Saceda-Ulloa, and Luis Eguren for helping us to find informants and of course to all speakers who responded to our questionnaire. All errors are of course ours. This research was funded by grants 2002XT–00036 and 2001SGR 00150 from the Generalitat de Catalunya and BFF2003–06590 and BFF2003–09453-C02-C02 from the Ministry of Science and Technology of Spain.

Keywords: Spanish vowel contacts, Spanish diphthongs and hiatuses, paradigmatic effects, morpheme boundary effects, prosodic and prominence effects, microvariation

0. Introduction

Sequences of unstressed high vowel plus vowel have tended to contract into diphthongs in all Romance languages. French and Italian, for example, display a systematic tendency to diphthongize these sequences in all word positions (Fr. *croire* [ˈkʁwaʁ] 'to believe', *soigner* [swaˈɲe] 'to soothe', It. *piano* [ˈpjano] 'piano', *fiasco* [ˈfjasko] 'fiasco'; see Tranel 1987, Saltarelli 1970).[1] In Catalan, vowel sequences of rising sonority tend to be pronounced as diphthongs in many contexts: *quasi* [ˈkwazi] 'almost', *estació* [əstəˈsjo] 'station', *camioneta* [kəmjuˈnɛtə] 'van', *àvia* [ˈaβjə] 'grandmother' (Cabré & Prieto 2004). The same is true in Spanish: *paciencia* [paˈθjen̪θja] 'patience', *precio* [ˈpɾeθjo] 'price', *camión* [kaˈmjon] 'truck'). In this language, the so-called historical rising diphthongs *ie*, *ue*, which arose as a systematic development of stressed mid-low vowels [ɛ, ɔ] in Vulgar Latin (*ferru* > *hierro* 'iron'; *ovu* > *huevo* 'egg') are systematically syllabified as diphthongs in all prosodic contexts.

Even though the presence of historical diphthongs might be interpreted as an important source of pressure to obtain gliding everywhere, exceptional hiatuses are found in Peninsular Spanish. The following near-minimal pairs have been obtained from many speakers: *pl*[ˈje]*gue* 'fold' vs. *cl*[i. ˈe]*nte* 'client'; *d*[ˈwe]*lo* 'mourning' vs. *d*[u. ˈe]*to* 'dueto'; *s*[ˈje]*ndo* 'being' vs. *r*[i.ˈe]*ndo* 'laughing'.[2] Within the Western Romance area, Catalan and Spanish are probably the languages that display the strongest antidiphthong effects in some specific contexts. Some studies have pointed out that the presence of hiatuses in both languages is conditioned by prosodic and analogical factors (see Navarro Tomás 1948; Hualde 1999, 2005; Colina 1999 for Spanish; and Cabré & Prieto 2004 for Catalan). For example, both languages have been reported to prefer hiatuses in word-initial position: Cat. *t*[i.ˈo] 'log', *m*[i.ˈɔ]*l* 'mewl', *d*[u.ˈa]*na* 'custom', *v*[i.

1. In French, the only systematic exception is due to a special segmental restriction which disallows a glide after a complex onset composed of a stop or a fricative followed by a liquid. As F. Dell (1980: 218) shows "/iV/ is realized as [ijV] after an onset+/l/ groups and as [yV] everywhere else: *oublier* [ubliye], *étudier* [etüdye], *quatrième* [katriyem], *troisième* [trwazyem]". In Italian, some studies have reported the existence of paradigmatic effects, that is, hiatuses may be maintained if a related word has the stress on the high vowel. For instance, there is a contrast between *sp*[ˈja]*nti* 'you unroot' (< **splantare*) and *sp*[i.a]*nti* 'people who spy' because of [sˈpia] 'spy' (Hualde & Prieto 2002 for more references).

2. We must also keep in mind that sequences of two different high vocoids are generally pronounced as rising diphthongs. As Hualde (2005: §5.4) notes, "*viuda* 'widow' rhymes with *suda* '(s)he sweats', and not with *vida* 'life', which indicates that the nuclear vowel is /u/; whereas *cuida* '(s)he keeps after' rhymes with *vida* 'life'. This is always true for closed syllables (i.e., *Luis* [ˈlwis] 'Louis') but we find some cases of falling diphthongs in open syllables (i.e., *muy* [ˈmuj] 'very'). In Catalan, this works in the opposite way (*viuda* 'widow' and *cuina* 'kitchen' rhyme with *vida* 'life' and *pruna* 'plum', but of course only assonantally).

ˈɔ]*la* 'viola', *d*[i.ˈa]*ble* 'devil', *d*[i.ə]*dema* 'diadem'; Span. *p*[i.ˈa]*no* 'piano', *cl*[i.ˈe]*nte* 'client', *r*[i.ˈe]*l* 'track', *r*[i.ˈe]*ndo* 'laughing', *d*[i.ˈu]*rno* 'diurnal'). On the other hand, Spanish has been reported to favor the presence of a hiatus when a morpheme boundary is present (e.g., *respet*[u.ˈo]*so* 'respectful', *virt*[u.ˈo]*so* 'virtuous', *man*[u.ˈa]*l* 'manual', *punt*[u.ˈa]*l* 'punctual') or when a stressed high vowel is present in the morphological paradigm (*f*[i.ˈa]*r* 'to trust', cf. *fían* 'trust.3pl.Pr.Ind'; *gu*[i.ˈa]*ba* 'guide.3sg.Pst.Imp', cf. *guía* 'guide').

The aim of this study is to provide a broad empirical description of the distribution of hiatus and diphthongs in sequences of vocoids of rising sonority within the lexicon. The data comes from a survey with 246 words administered to 15 speakers of Peninsular Spanish. The questionnaire was carefully designed to test the effects of within-word position, prominence status, syllable structure and morphological and paradigm factors on gliding decisions. The effects under examination are the following: (1) word-initial positional effect: that is, gliding tends to be blocked in word-initial position (e.g., *p*[i.ˈa]*no* 'piano', *d*[i.a]*dema* 'diadem'), except for the historical diphthongs (e.g., *p*[ˈje]*dra* 'stone', *f*[ˈwe]*go* 'fire'); (2) morphological and paradigm effects, that is, gliding tends to be blocked when a morpheme boundary is present and when the high vowel is stressed in morphologically related words (e.g., *conf*[i.ˈa]*r* 'to trust', cf. *confío* 'I trust 1sg.Pr.Ind'; *act*[u.ˈa]*r* 'to act', cf. *actúo* 'I act 1sg.Pr.Ind'). The results reveal that not all speakers evidence a word-initiality effect nor a morpheme boundary effect on the presence of exceptional hiatuses. While 8 out of 15 speakers have the word-initiality effect somewhat active (they display between 26% and 48% of hiatuses in words such as *piano*), the rest of the speakers syllabify as diphthongs between 52% and 100% of the cases in the same position.

For ease of presentation, we will distinguish between a conservative variety — for those speakers that show less than 50% of diphthongs — and an innovative variety for the other group of speakers. There is no clear separation between speakers of an innovative variety (which displays a more consistent tendency to glide formation in all positions) and speakers of a conservative variety (which keeps unexpected hiatuses in certain positions). Instead, we find a more gradual situation: while the lower average from the innovative group displays 51.9% of diphthongs in word-initial position, the higher average from the conservative group is 48.1% of diphthongs in the same position. It is worth pointing out that there is evidence that some lexical items were produced with a diphthong in Classical Spanish, as early as the XVIIth century (e.g., *rienda* 'rein', *ruiseñor* 'nightingale', *liviana* 'light', *Santiago* 'proper name', *furioso* 'furious', *violeta* 'violet', *diosa* 'Goddess', etc).[3]

With respect to the influence of morphological factors, Spanish has been claimed to have general sensitivity to the presence of morpheme boundaries and paradigm pressure effects (Hualde 1999, Colina 1999, Pensado 1999). Yet our data reveals that these effects are different in the nominal and the verbal paradigms: while in nominal paradigms they are circumscribed to specific vowel sequences u+ˈV (*virt*[u.ˈo]*so*

3. We thank Joan Mascaró for providing us with these examples from Lope de Vega (Montesinos' edition).

'virtuous' vs. *od*[ˈjo]*so* 'hateful', *act*[u.ˈa]*l* 'present' vs. *cord*[ˈja]*l* 'cordial'), in verbal paradigms the antihiatus environments need the joint presence of a morpheme boundary and a stressed high vowel in other forms of the paradigm (*conf*[i.ˈa]*r* 'to trust', *confío* 'I trust' vs. *camb*[ˈja]*r* 'to change', *cambio* 'I change').

The second part of this article presents a prosodic/identity constraint analysis of the hiatus/diphthong distribution in Peninsular Spanish (Prince & Smolensky 1993; McCarthy & Prince 1994, 1995; Benua 1995). This analysis will allow us to capture the interplay between both prosodic and morphological requirements together with the idiolectal variation present in the data. In OT terms, the difference between innovative and conservative speakers will be interpreted as the generalization of a prosodic constraint in the innovative variety. At the same time, idiolectal variation will be interpreted as the set of analogical/correspondence relationships each speaker establishes with other words in the lexicon.

The paper is organized as follows. Section 1 presents the methodology used to gather the data and the main corpus used for this study. Section 2 presents quantitative results on hiatus/diphthong pronunciations together with a discussion of the prosodic patterns found in the data. Section 3 compares Spanish with Catalan and summarizes the main similarities and differences found between the two. Finally, Section 4 presents an analysis of the data within the Optimality/Correspondence Theory framework, focussing especially on how exceptional hiatuses and idiolectal differences are accounted for.

1. Methodology and questionnaire.

In order to better understand the conditions which favor and disfavor glide formation in sequences of unstressed high vowel + vowel, we administered a questionnaire with 246 common words to 15 speakers of Peninsular Spanish (see the complete questionnaire in the Appendix). The lexical items included in the questionnaire covered the following eight main types of word prosodic configurations (see Table 1). Table 1 also presents examples of the eight configuration types and the number of items included in the questionnaire for each type of configuration. The first four word types (groups 1 to 4) contain the target vocoid sequence in word-initial position: in group 1 the vowel sequence is in a potential monosyllabic word (e.g., *Dios* 'God'), in group 2 the sequence is in word-initial stressed position (e.g., *diana* 'target') and in groups 3 and 4 in word-initial unstressed position. The difference between groups 3 and 4 is the distance between the beginning of the word and the stressed syllable. The last four word types (groups 5 to 8) contain the vocoid sequence in word-medial and in word-final position (both stressed and unstressed). Note that the first vocoid in the sequence of two vocoids VV is always a high vowel. Also bear in mind that CV in parentheses expresses syllable optionality, and optional complex onsets and codas are not represented. Finally, compounds and prefixed words (30 examples) and falling sonority sequences (6 examples) are also included in the questionnaire and will be analyzed separately.

We selected words with different prosodic patterns and different mophological and segmental shapes. No word in the questionnaire contains the so-called historical diphthongs *ie*, *ue* because speakers diphthongize such historical words without any excepcion, showing a complete unsensitivity to all prosodic and segmental conditions that block glide formation. Historical diphtongs arose as a systematic development of open *e, o* in stressed position in Vulgar Latin (ferru > *hierro* 'iron'; ovu > *huevo* 'egg'). Such diphthongs alternate with the corresponding mid vowels in unstressed positions: *d*[we]*le* '3sgIP' – *doler* 'to hurt', *d*[je]*nte* 'tooth' dental 'dental', *pr*[we]*ba* 'proof', *probar* 'to prove', *apr*[je]*to* '1sgIP' *apretar* 'to press'.[4]

Table 1. Prosodic word configuration types (and number of items) included in the questionnaire.

	Prosodic word types	Examples	Number of words in the database
1	C[i,u]	*Dios* 'God' *Luis* 'Louis'	18
2	C[i,u]V'.CV	*miope* 'short-sighted' *diálogo* 'dialogue'	27
3	C[i,u]V.CV'.(CV)	*diadema* 'diadem' *violín* 'violin'	24
4	C[i,u]V.CV.CV'.(CV)	*diagonal* 'diagonal' *violinista* 'violinist'	12
5	CV.C[i,u]V'.(CV)	*camión* 'truck' *persiana* 'blind'	56
6	(CV).CV.C[i,u]V. CV'.(CV)	*avioneta* 'aeroplane' *evaluarán* 'they will evaluate'	30
7	CV.CV.C[i,u]V'.(CV)	*material* 'material' *delicioso* 'delicious'	25
8	(CV).CV'.C[i,u]V	*historia* 'history' *ingenua* 'naive.fs'	18

In order to test the effects of syllable structure and morphological factors, we carefully controlled that each group of words in Table 1 contained enough examples with complex onsets, morphological boundaries and morphologically-related items. For example, within group 1, 4 items contained a morpheme boundary and underlying stress (*dual* 'dual', *criar* 'to raise', *fiar* 'to trust', *liar* 'to tie') and 5 items a complex onset (*cruel* 'cruel', *prior* 'prior', *criar* 'to raise', *truhán* 'crook', *trial* 'dirtbike race'). Within group 2, 6 items contained a morpheme boundary and underlying stress (*fiable* 'trustworthy', *viaje* 'trip', *diario* 'daily', *riada* 'flood', *fianza* 'security', *cruento* 'bloody') and 4 complex onset (*cliente* 'client', *cruento* 'bloody', *triunfo* 'triumph', *criollo* 'creole').

The informants were asked to parse the target items into syllables according to their phonological intuitions. In general, speakers showed clear intuitions about syllabification: a lexical item was always parsed with either a diphthong or a hiatus by a given speaker and only in some isolated cases were both solutions possible. We assume that if the speaker's syllabification intuition of the vowel sequence was a hiatus

4. Yet, not all historical diphthongs show this contrast (for instance: *miedo* 'fear' *miedoso* 'fearful'), nor all stressed mid vowels turned into historical diphthongs (for instance, *temo* '1sgIP' — *temer* 'to fear').

this means that the speaker can produce such sequence with a hiatus in slow speech. This indeed does not preclude that this vowel sequence may also be pronounced with a diphthong in faster speech rates. However, crucially, pronunciation of this sequence with hiatus is possible.

In the first interviews, we asked informants to slowly read the database while we were annotating and transcribing whether we heard a pronunciation with a diphthong or with a hiatus: yet the main problem with this methodology was that our parsing of the data was 'erroneous' in some cases. Typically, we classified as diphthongs vowel sequences that were considered to be hiatuses by the speaker. Thus the informants' intuitions were often more conservative than our perception. Indeed, Face & Alvord (2004) report some degree of confusion in a recent perception experiment: when listeners were presented with hiatuses in words that inherently contained a diphthong (and the other way around), there was a tendency to perceive a diphthong. As Face & Alvord (2004:561) point out "there is a tendency to perceive diphthongs rather than hiatuses when there is conflicting evidence [acoustic vs. lexical information] as to which is present in a given word."

Even though recent production studies agree that the acoustic difference between Spanish diphthongs and hiatuses lies in the mean duration values of the two vocoids (Aguilar 1999, Hualde & Prieto 2002), there is overlap in durational values for both categories: that is, even though in general the mean duration of hiatuses is longer than the mean duration of diphthongs, some groupings have durational values that are in between and that could be ambiguous to the hearer. Speech rate is also a confounding factor that clearly influences the duration of the vowel sequences. In sum, this provides evidence that it is not completely safe to rely on production and perception data to describe the distribution of hiatuses and diphthongs in Spanish. In this study, we are especially interested in describing the speakers' intuitions obtained through linguistic judgments. We leave the production and perception mechanisms of hiatus vs. diphtongs for a future study.

Fifteen speakers of Peninsular Spanish answered the questionnaire. They come from Madrid (7 speakers), Valencia (2 speakers), Barcelona (5) and Granada (1). We checked that all informants from Catalan areas had Spanish as their mother tongue.[5] The majority of speakers ranged from ages 19 to 30 (only four of them were older than 30). They were language students and professors, thus we are confident that they have enough linguistic training to perform syllabic parsing. After having analyzed the data, we can reasonably say that there are no significant differences between the Spanish varieties spoken in the different cities (mainly between Madrid and Barcelona) and that the results are quite consistent across regional varieties. For example, within the same dialect we find speakers of the same age for whom the word-initiality effect is somewhat active and others who have completely generalized the presence of a diphthong in this position.

5. We should note that Barcelona (and Valencia) speakers have at least some knowledge of Catalan. They were selected as a function of their linguistic background and language usage: they have Spanish as their first language and speak mainly Spanish with relatives and friends.

2. Exceptional hiatuses in Spanish

It should first be noted that the hiatus/rising diphthong lexical distribution within the lexicon in Peninsular Spanish is subject to a certain amount of idiolectal variation: two speakers of the same dialect and age do not always agree about which words can be produced with a diphthong. That is why we will first report on general tendencies and degree of variation found in the data. Table 2 reports the results of the syllabification intuitions task for each group: the main result, reported in the third column, is the mean percentage of words syllabified with a diphthong in each of the main word prosodic configurations under study. For group 1, not all data was included to calculate the means: we realized that complex onsets and morphological boundaries systematically blocked glide formation in group 1 for some speakers and thus we excluded these words from the data set. Finally, as a raw measure of the dispersion of the data, the last column reports the minimum and maximum percentages of words pronounced with a diphthong by a given speaker.

Table 2. Mean percentage of diphthong/hiatus solutions according to word configuration type.

Group	Prosodic word type	Mean percentage of reported diphthongs	Minimum/ maximum percentage of reported diphthongs
1	*Dios* 'God', *Luis* 'Louis'	87.9%	72.2–100%
2	*miope* 'short-sighted' *diálogo* 'dialogue'	58.2%	25.9–100%
3	*diadema* 'diadem' *violín* 'violin'	70.5%	33.3–100%
4	*diagonal* 'diagonal' *violinista* 'violinist'	93.3%	75–100%
5	*camión* 'truck' *persiana* 'blind'	75.9%	60.7–100%
6	*avioneta* 'airplane' *evaluarán* 'they will evaluate'	91.3%	73.3–100%
7	*material* 'material' *delicioso* 'delicious'	80%	68–100%
8	*historia* 'history' *ingenua* 'candid.fs'	97.7%	83.3–100%

Even though inter-speaker variation is quite high, the results in Table 2 reveal the existence of a contrast between two groups of data, namely, words belonging to group 2 and, to a lesser extent, group 3, and the rest. Groups 2 and 3 are the ones that show a larger data dispersion, meaning that while some speakers report only a weak preference for the presence of diphthongs, others report diphthongs quite consistently. Note that groups 2 and 3 have the rising sequence in initial position and only differ from group 1 in word length. Groups 2 and 3 also differ from group 4 in that a stressed syllable is located right after the target vowel sequence (group 3) or one syllable to the right (group 4).

By contrast, the rest of the words (groups 4, 5, 6, 7, and 8) show a quantitative preference to pronounce the items with a diphthong consistently across speakers and manifest the general gliding tendency found in Spanish (*d*[ˈja]*gonal* 'diagonal' (4), *pers*[ˈja]*na* 'blind' (5), *av*[ˈjo]*neta* 'airplane' (6), and *mater*[ˈja]*l* 'material' (7)). Even though at first sight it might look like the difference in diphthong production between groups 3 (70.5%) and 5 (75.9%) is small, it is worth pointing out that the dispersion degree in both groups is noticeably different: from a maximum of 100% of diphthongs to a minimum of 33.3% in group 3 compared with a minimum of 60.7% in group 5. That is, to some extent, speakers in the conservative range show an initiality effect in group 3, while in group 5 all speakers have generalized the syllabification with a diphthong. Moreover, we have to take into account that more than a half of the words in group 5 have a morpheme boundary in between the vocoid sequence (30 out of 56 words) and 11 of them have a /u/+V sequence (see Section 3.4 "Morpheme boundary effects" for the relevance of this effect on the hiatus/diphthong distribution); by contrast, only 4 words out of 24 in group 3 contain a morpheme boundary (*cri+atura* 'creature', *pi+edad* 'pity', *pi+adoso* 'pious', *du+alista* 'dualist').

2.1 Word initiality effects

As has been reported by Hualde (1999, 2005) and Colina (1999), general anti-diphthong environments are those in word-initial position: *v*[i.ˈo]*la* 'viola', *d*[i.ˈa]*blo* 'devil', *c*[i.a]*nuro* 'cyanide'. By contrast, glides are preferred in word-medial and word-final positions (e.g., *histor*[ja] 'history', *id*[ˈjo]*ma* 'language'). The contrasting pairs in (1) demonstrate the existing contrast between vocoid sequences located at the beginning of the word (left-hand column) and those located in word-medial position (right-hand column). As we will see later, this initial effect is circumscribed to sequences where the position of the lexical stress is right next to the high vocoid or one syllable away (*v*[i.o]*lín* 'violin' vs. *v*[jo]*linista* 'violinist') and to sequences that are not potentially monosyllabic (e.g., *d*[i.ˈa]*na* 'target' vs. *D*[ˈjo]*s* 'God').

(1)

Word-initial		Word-medial	
c[i.ˈa]*tica*	'sciatica'	*as*[ˈja]*tica*	'Asian.fem'
d[i.ˈa]*na*	'target'	*med*[ˈja]*na*	'median'
cr[i.ˈo]*llo*	'creole'	*patr*[ˈjo]*tico*	'patriotic'
b[i.ˈo]*logo*	'biologist'	*rad*[ˈjo]*logo*	'radiologist'
m[i.ˈo]*pe*	'short-sighted'	*id*[ˈjo]*ma*	'language'
r[i.ˈa]*da*	'flood'	*barr*[ˈja]*da*	'neighborhood'

In our data, group 2 and (to a lesser degree) group 3 are the ones that show the widest data dispersion in the database: while several speakers reported diphthongs in 29.2% and 33% respectively of words in this group, other speakers reported diphthongs in 100% of words. Table 3 shows the mean percentage of diphthong solutions in word-initial position for prosodic word types 2 and 3 separated by speaker. The results for group 2 (*p<u>ia</u>no* 'piano', *d<u>ia</u>na* 'target') are shown in the first column and the results for group 3 (*d<u>ia</u>dema* 'diadem', *v<u>io</u>lín* 'violin') in the third column. First, large speaker differences are found in both groups of words, so that we can roughly identify conservative and innovative speakers for the regional varieties under consideration. For example, for words in group 2 around half of the speakers (7) belong to an innovative range (between 100% and 51.9% of words had diphthongs, with an average of 82.5%) while the other half belong to a conservative range (between 48.1% and 25.9%, with a mean percentage of 37.2%). Words in group 3 are pronounced more generally with a diphthong: in this case, 13 out of 15 speakers have more than 50% of words with diphthongs, with an average of 70.4% of diphthong pronunciation across speakers.

Table 3. Mean percentage of diphthong identification in groups 2 and 3, separated by speaker. Coding used for speakers: B=Barcelona area; Gr=Granada; M=Madrid area; V=Valencia.

	Group 2 "piano"	**Group 3 "diadema"**
Speaker	**% reported diphthongs**	**% reported diphthongs**
1 B	48.1%	58.3%
2 B	25.9%	91.6%
3 B	100%	95.8%
4 B	44.4%	41.6%
5 B	51.9%	62.5%
6 M	100%	100%
7 M	66.6%	79.1%
8 M	33.3%	54.1%
9 M	100%	91.6%
10 M	33.3%	58.3%
11 M	59.2%	79.1%
12 M	40.7%	33.3%
13 Gr	100%	95.8%
14 V	40.7%	62.5%
15 V	29.2%	54.1%

The results in Table 3 indicate that we are faced with not a clear separation into two groups of speakers (innovative vs. conservative), but rather with a gradation. There is one group of speakers which tends to syllabify the majority of words with a diphthong (and belong to a more innovative variety) and another group which keeps the unexpected hiatuses in word-initial positions (and thus belongs to a more conservative variety), but there are also speakers in the middle range. From the behavior of words of type 3 (e.g., *diadema*), we can conclude that word-initiality effects are progressively becoming weaker (as they are weaker in this position for all speakers).

There are several systematic exceptions to word-initial hiatuses for all speakers. A first systematic exception (and exceptional hiatuses in general) are words which contain the so-called historical diphthongs *ie* and *ue* such as *d*[ˈje]*nte* 'tooth' *pr*[ˈwe]*ba* 'proof'. Although significant differences can be observed between the historical diphthongs *ie* and *ue* and the corresponding sequences of vocoids in initial position for some speakers in some specific words (*b*[i.ˈe]*la* 'connecting rod', *cl*[i.ˈe]*nte* 'client', *r*[i.ˈe]*l* 'track'), we should acknowledge that historical diphthongs might have acted as segmental attractors,[6] as the presence of diphthongs is quite general in equivalent sequences such as (*V*[ˈje]*na* 'Vienna', *c*[ˈje]*ncia* 'science', *s*[ˈwe]*ter* 'sweater', *d*[ˈje]*ta* 'diet', *s*[ˈwe]*co* 'Swedish').

A second exception to word-initial hiatuses is found in potential monosyllabic words (group 1), which tend to be pronounced with a diphthong (*Dios* 'God', *Juan* 'John', *fiel* 'faithful', *miau* 'mew', *Luis* 'Louis'). Table 4 shows the mean percentages of diphthong solutions in potential monosyllabic words separated by speaker. We have excluded from the data set those words which contain a morphological boundary (*fiar* 'to trust', *liar* 'to tie') and words with a complex onset (*cruel* 'cruel', *prior* 'prior', *truhán* 'crook'), which some speakers systematically syllabify with a hiatus. In the table, the informants that showed sensitivity to morphological boundaries and complex onsets are marked with an asterisk:

Table 4. Mean percentage of diphthong identification in group 1, separated by speaker. Coding used for speakers: B=Barcelona area; Gr=Granada; M=Madrid area; V=Valencia.

	Group 1 "Dios"
Speaker	**% reported diphthongs**
*1 B	90%
*2 B	100%
3 B	100%
4 B	72.2%
*5 B	100%
6 M	94.4%
7 M	94.4%
*8 M	80%
9 M	100%
*10 M	90%
11 M	80%
*12 M	90%
13 Gr	88.8%
*14 V	80%
*15 V	60%

We have to point out that those words with a gender or epenthetic vowel in group 2 with a paradigmatic relationship with words without it in group 1 have the same behavior. That is, paradigms such as *dios* (m.sg.), *diosa* (f.sg), *dioses* (m.pl.), *diosas* (f.pl.);

6. As Hualde points out (1999:194), the group of words with *ie*, *ue* from diphthongization of mid vowels "is large enough (…) to analogically attract other words".

Luis (m.), *Luisa* (f.) or *fiel* (m./f.sg.), *fieles* (m./f.pl.) are all pronounced with a glide as the unmarked form (masculine or singular) in group 1.[7]

It is important to highlight that the informants that show sensitivity to morphological boundaries and complex onsets in potential monosyllabic words (e.g., *truhán* 'crook', *liar* 'to tie') are those that belong to the 'conservative' range in words belonging to group 2 (e.g., *piano*), that is, those speakers that tend to keep exceptional hiatuses in word-initial position. The reader will observe that speakers marked with an asterisk in Table 4 are the ones that have the lowest percentage of diphthongs in Table 3. Only two informants show disagreement: while informant 5B has diphthongs in 51.9% of words belonging to group 2 (the lowest in the innovative group), he shows clear sensitivity to morpheme boundaries and complex onsets; similarly, informant 4B reported diphthongs in 44.4% of items in group 2 and shows sensitivity to complex onsets and morpheme boundaries in 5 out of 8 items in this group. In relation to group 3, except for 2 conservative speakers, the rest show a clear preference for a diphthong (> 50%), indicating that word-initiality effects are weaker in this group of words. In general, the speakers who display lower percentages of diphthong production in group 3 correspond to the same conservative speakers who showed this effect in group 2. Only informant 2B displays a contradictory result (25.9% diphthongs in group 2 vs. 91.6% diphthongs in group 3).

2.2 Distance-to-stress effects

Distance of the vocoid sequence from the main word stress is another factor which conditions glide formation: the greater the distance, the greater the tendency to pronounce a diphthong. We have seen that indeed for some speakers a hiatus appears word-initially when the stress is located in the vowel next to the high vowel (*d*[i.ˈa]*logo* 'dialogue', *d*[i.ˈa]*metro* 'diameter') or at most one syllable to the right (*d*[i.a]***frag****ma* 'diaphragm', *c*[i.a]***nu****ro* 'cyanide'; see also group 4 in Table 2). Yet once the stress moves further to the right the same sequence is pronounced with a diphthong (*d*[ja]*go****nal*** 'diagonal', *d*[ja]*cro****ní****a* 'diachrony', *c*[ja]*nu****ra****to* 'cyanide', *d*[ja]*pa****són*** 'diapason', *d*[ja]*posi****ti****va* 'slide'). The productivity of this pattern can be seen in (2) — NB: the stressed syllable is marked in boldface:[8]

7. As shown by Kenstowicz (2005), another case of paradigm uniformity in Spanish is the process of diminutive formation. For example, *cit* is the diminutive allomorph for both the masculine and feminine forms of *ratón*/*ratona* 'mouse' (*ratoncito* 'mouse' (dim.m.) and *ratoncita* 'mouse' (dim.f.) are the diminutive), in spite of the different syllabic form of the corresponding bases (*ra.ton* vs. *ra.to.na*).

8. Distance-to-stress effects in Spanish have also been reported in previous studies. Hualde (1999, 2005:§5.4.1) points out that "many Castilian speakers syllabify for instance *d*[i.ˈa]*logo* 'dialogue', *d*[i.a]*logo* 'I dialogue', but *d*[ja]*logar* 'to dialogue'; or *d*[i.ˈa]*metro* 'diameter' but *d*[ja]*metral* 'diametral'. This condition may also operate in cases of morphologically-conditioned hiatuses so that the hiatus of *du-o* 'duet' is preserved in *du-al* 'dual', *du-eteo* 'duet' and *du-alismo* 'dualism', but not in *dualidad* 'duality' where the stress is further away".

(2)	*d*[i.ˈa]*logo* 'dialogue'	*d*[i.a]***lo**ga* 'engage-in- -dialogue.3sg.Pr.Ind'	*d*[ja]*lo**gar*** 'engage-in- -dialogue.Inf'	*d*[ja]*loga**ré*** 'engage-in- -dialogue.1sg.Fut'
	d[i.ˈa]*blo* 'devil'	*d*[i.a]***bó**lico* 'diabolical'	*d*[ja]*bo**lis**mo* 'satanism'	*d*[ja]*boli**cal*** 'diabolical'
	v[i.ˈo]*la* 'viola'	*v*[i.o]***lín*** 'violin'	*v*[jo]*li**nis**ta* 'violinist'	*v*[jo]*lonce**lis**ta* 'cellist'
	d[u.ˈa]*l* 'dual'	*d*[u.a]***lis**ta* 'dualist'	*d*[wa]*li**dad*** 'duality'	*d*[wa]*liza**ción*** 'dualisation'

This tendency is again clear in words that have a high stressed vowel in morphologically related words, as is shown in (3).

(3)	*p*[ˈi.o] 'pious'	*p*[je]***dad*** 'pity'	*p*[ja]*do**sí**simo* 'very pious'
	b[ˈi.o] 'bio'	*b*[i. ˈo]*logo* 'biologist'	*b*[jo]*lo**gí**a* 'biology'
	d[ˈi.a] 'day'	*d*[i.ˈa]*rio* 'daily'	*d*[ja]*ria**men**te* 'daily'
	cr[ˈi.o] 'child'	*cr*[i.a]***tu**ra* 'creature'	*cr*[ja]*tu**ri**ta* 'little creature'
	d[ˈu.o] 'duet'	*d*[u.a]***lis**ta* 'dualist'	*d*[wa]*li**dad*** 'duality'

Our questionnaire contained 12 words of type 4, that is, word-initial sequences with the lexical stress located one syllable to the right of the target vowel sequence. The average percentage of diphthong production in this group is quite high, 93.3%, as expected. Table 5 shows the mean percentage of diphthong solutions obtained for groups 2 (*piano*) and 4 (*diagonal*), listed by speaker. If we compare the syllabification intuitions in the two groups we see that in group 4 glide formation is active for every speaker, even for speakers in the 'conservative' range who showed 'sensitivity' to initial position. The results in Table 5 show that 8 speakers syllabified 100% of the vowel sequences of words in group 4 as diphthongs and the rest reported a consistently high presence of diphthongs (the lowest percentage was 75%).

It is worth pointing out that the lowest average of diphthong identification (75%) represents 3 examples out of a total of 12 words. Moreover, the specific words which represent exceptions are not consistent across speakers, with only one word emerging twice as a hiatus (*piamontés* 'person from the Piemonte region' can be interpreted as a compound).

2.3 Syllable structure and segmental effects

Evidence that syllable structure does not play a substantial role in gliding comes from examples showing that the structure of the onset is irrelevant for this process. Complex

Table 5. Mean percentage of diphthong identification in groups 2 (*piano*) and 4 (*diagonal*), separated by speaker. Coding used for speakers: B=Barcelona area; Gr=Granada; M=Madrid area; V=Valencia.

	Group 2 "piano"	**Group 4 "diagonal"**
Speaker	**% reported diphthongs**	**% reported diphthongs**
1 B	48.1%	100%
2 B	25.9%	100%
3 B	100%	100%
4 B	44.4%	91.6%
5 B	51.9%	100%
6 M	100%	100%
7 M	66.6%	100%
8 M	33.3%	91.6%
9 M	100%	100%
10 M	33.3%	75%
11 M	59.2%	83.3%
12 M	40.7%	91.6%
13 Gr	100%	100%
14 V	40.7%	91.6%
15 V	29.2%	75%

onset seems to block glide formation only in potentially monosyllabic words such as *tr*[ua]*n* 'crook', *pr*[io]*r* 'prior'. Examples in (4) show how glide formation of word-final sequences is not blocked by the presence of complex onsets (also true of word-medial cases such as *patr*[jo]*tismo* 'patriotism', *patr*[ˈjo]*tico* 'patriotic'). In fact, we also have examples of words with a complex onset that are pronounced with a diphthong where we would expect a hiatus (e.g., *tr*[ju]*nfo* 'triumph', *tr*[ju]*nfante* 'triumphant').

(4)

Final position (unstressed)		Final position (stressed)	
patr[ja]	'homeland'	*repatr*[ˈja]*r*	'to repatriate'
sobr[jo]	'temperate.masc'	*anfitr*[ˈjo]*n*	'host'
Calabr[ja]	'Calabria'	*Adr*[ˈja]*n*	'Adrian'
ebr[ja]	'drunk.fem.'	*Gabr*[ˈje]*l*	'Gabriel'
industr[ja]	'industry'	*industr*[ˈja]*l*	'industrial'
ampl[jo]	'broad.masc'	*Cebr*[ˈja]*n*	'last name'
panopl[ja]	'panoply'	*embr*[ˈjo]*n*	'embryo'
bibl[ja]	'Bible'	*histr*[ˈjo]*n*	'actor'

Medial position (unstressed)		Medial position (stressed)	
patr[jo]*tismo*	'patriotism'	*patr*[ˈjo]*ta*	'patriot'
ampl[ja]*ción*	'enlargement'	*patr*[ˈja]*rca*	'patriarch'
embr[jo]*nario*	'embryonnic'	*vidr*[ˈjo]*so*	'vitreous'
sobr[je]*dad*	'sobriety'	*Adr*[ˈja]*tico*	'Adriatic sea'
septentr[jo]*nal*	'northern'	*bibl*[ˈjo]*filo*	'bibliophile'
patr[ˈja]*rca*	'patriarch'	*histr*[ˈjo]*nico*	'histrionic'

Segmental factors might also play a role in the diphthong/hiatus contrasts under discussion. As noted before, common exceptions to initial prominence effects are words with *ie* or *ue* that are not historical diphthongs themselves (*V*[ˈje]*na* 'Vienna', *c*[ˈje]*ncia* 'science', *s*[ˈwe]*co* 'Swedish', *s*[ˈwe]*ter* 'sweater'). That suggests that historical diphthongs have acted as lexical attractors for the same non-historical vowel sequences, as we have said before. The tendency to pronounce *ie* and *ue* with a diphthong is also clear in Catalan, a language with non-historical rising diphthongs in the lexicon. In Catalan, the vowel combinations *ue*, *ie* are often produced as diphthongs in contexts where hiatus is the norm presumably because of Spanish influence (e.g., *suec* [ˈswɛk] 'Swedish', *Viena* [ˈbje.na] 'Vienna', etc.; see Cabré & Prieto 2004).

It is worth pointing out that not only the historical diphthongs *je*, *we* have acted as segmental attractors. Sequences of two high vowels *wi*, *ju* are generally pronounced as rising diphthongs, as it has been noted in the literature, even in initial position of the word, that is, in that position in which prominence acts as a gliding blocker. In order to confirm this tendency we passed a complementary questionnaire with 30 words (such as *buitre* 'vulture', *ciudad* 'city', *cuidado* 'care', *cuidas* 'to look after.2sgIP', *cuidar* 'to look after, Inf.', *diurético* 'diuretic', *juicio* 'judgement', juicioso 'prudent', *Luisa* 'Louise', *piular* 'to cheep, Inf', *ruido* 'noise', *ruidoso* 'noisy', *ruina* 'ruin', *ruinoso* 'ruinous', *suicida* 'suicidal', *suicidio* 'suicide', *Suiza* 'Switzerland', *triunfo* 'triumph', *triunfar* 'to triumph, Inf.', *viuda* 'widow', *viudez* 'widowhood', and others in non initial position). The general solution was a rising diphthong, except for the adverb *muy* [ˈmuj]'very', which seems to be more resistant to this tendency.

Similarly, the back vowel /u/ is always a glide after a velar consonant as it has been pointed in the literature:[9] *guante* [ˈɡwan̪te] 'glove', *cuando* [ˈkwan̪do] 'when', *ungüento* [uŋˈɡwen̪to] 'ointment'. The sequence velar consonant + u constitutes another attractor and forces glide formation in lexical forms even in case that the high vowel has underlying stress: *evacúa* [eβaˈku.a] (3sgPI) '(s)he evacuates vs. *evacuar* [eβaˈkwaɾ] (Inf.) *evacuará* [eβakwaˈɾa] (3sgFut). Conversely, /u/ acts as a gliding blocker in cases that are generally pronounced with a glide, as we will see in the next section (*peruano* [peɾu.ˈano] 'Peruvian', *carruaje* [karu.ˈaxe] 'carriage'; compare *congruente* [koŋɡɾu.ˈen̪te] 'congruent' vs. *nutriente* [nuˈtɾjen̪te] 'nutrient').

Finally, some segments have been singled out in the literature as gliding blockers. Hualde (1999: 191) has noted "that hiatus is especially favored after word-initial [r] (*riel* [riˈel] 'track')". Yet this tendency is general neither in word-initial position (e.g., *ruido* [ˈrwiðo] 'noise', *ruina* [ˈrwina] 'ruin') or in word-final position (*fanfarr*[ja] 'bluster', *bandurr*[ja] 'bandurria'). In any case, further research is needed in order to determine the extent to which segmental subregularities might play a role in this process.

2.4 Morpheme boundary effects

It has been contended that Spanish glide formation shows sensitivity to the presence of morpheme boundaries and that a rising sonority sequence is usually pronounced with

9. As Hualde (1999:191) says, "After a velar, there is no hiatus involving /uV/".

hiatus if there is an intervening suffix boundary (see Hualde 1999, 2005). The results from our database show that, fairly consistently, stressed suffixes that are preceded by /u/ trigger a hiatus pronunciation (but not for all speakers) while those preceded by /i/ trigger a diphthong pronunciation: *actu+al* [aktu.ˈal] 'present' vs. *labi+al* [laˈβjal] 'labial'. Systematic exceptions to the general gliding tendency in group 5 for conservative speakers are the following: *aduana* 'customs', *estuario* 'estuary', *actual* 'current', *congruente* 'congruent', *carruaje* 'carriage', *peruano* 'Peruvian', *actuar* 'to act', and *usuario* 'customer'. (5) illustrates this contrast with the nominal suffixes -*oso,* and -*al*:

(5) Morpheme boundary effects

Preceded by *i-*		Preceded by *u-*	
lab[ˈja]*l*	'labial'	*man*[u.ˈa]*l*	'manual'
coloqu[ˈja]*l*	'colloquial'	*us*[u.ˈa]*l*	'usual'
mater[ˈja]*l*	'material'	*act*[u.ˈa]*l*	'current'
artific[ˈja]*l*	'artificial'	*virt*[u.ˈa]*l*	'virtual'
arter[ˈja]*l*	'arterial'	*punt*[u.ˈa]*l*	'punctual'
celest[ˈja]*l*	'celestial'	*sens*[u.ˈa]*l*	'sensual'
fil[ˈja]*l*	'filial'		
cop[ˈjo]*so*	'copious'	*virt*[u.ˈo]*so*	'virtuous'
nerv[ˈjo]*so*	'irritated'	*afect*[u.ˈo]*so*	'affectionate'
prec[ˈjo]*so*	'pretty'	*respet*[u.ˈo]*so*	'respectful'
val[ˈjo]*so*	'valuable'	*fruct*[u.ˈo]*so*	'fruitful'

The examples in (6) show that vowel contraction into a diphthong is quite systematic across morpheme boundaries separating the high front vowel from nominal suffixes such as -*ante, -ente*, and -*ación*, provided that such sequences are located in diphthong-favoring environments (see previous section)

(6)

-ante, -ente		*-ación*	
negoc[ˈja]*nte*	'businessman'	*humil*[ja]*ción*	'humiliation'
rad[ˈja]*nte*	'radiant'	*med*[ja]*ción*	'mediation'
defic[ˈje]*nte*	'deficient'	*concil*[ja]*ción*	'conciliation'
comed[ˈja]*nte*	'comedian'	*ampl*[ja]*ción*	'enlargement'
estud[ˈja]*nte*	'student'	*var*[ja]*ción*	'variation'
princip[ˈja]*nte*	'beginner'	*act*[wa]*ción*	'performance'
exped[ˈje]*nte*	'file'	*sit*[wa]*ción*	'situation'
var[ˈja]*nte*	'variant'	*eval*[wa]*ción*	'evaluation'
asfix[ˈja]*nte*	'suffocating'		

The antidiphthong effects of the sequence u+ˈV in nominal paradigms are quite consistent for conservative speakers. While hiatuses are observed in u+ˈV sequences, no hiatuses are found with unstressed sequences. So words such as *defectuoso* 'defective' and *habitual* 'customary' are found among the exceptions to this gliding pattern, whereas *insinuación* 'insinuation', *continuidad* 'continuity', *actualidad* 'present time', and *virtuosísimo* 'the most virtuous' are always syllabified with a diphthong, as has already been noted in the literature (Hualde 1990:190). This contrast between /u/ and /i/ can also be found in other Romance languages such as Catalan (Cabré & Prieto 2004) or Romanian

(Chitoran 2002a, 2002b). In general, /u/ is less prone to become a glide than /i/ in the same environment, except for those sequences preceded by a velar consonant (*Juana* 'Joan', *adecuar* 'to adapt'). Phonetic reasons seem to be at the origin of this tendency: as we know, the total duration of Spanish /i/+V diphtongs is shorter than the corresponding /u/+V diphthongs (e.g., *siete* 'seven' vs. *cueto* 'surname'; *idiota* 'idiot' vs. *cuota* 'quota'; Monroy Casas 1980:80). Crosslinguistically [jV] is more general than [wV]: in other words, glide formation seems to be subject to a universal ranking, that is *w >> *j.

On the other hand, Spanish has many more cases of suffixes preceded by /i/ than suffixes preceded by /u/, and thus we can conclude that the presence of a morpheme boundary is not the crucial factor in deciding whether a vocoid sequence is going to be pronounced with a diphthong or a hiatus. The only context that blocks gliding across morpheme boundaries is the potentially monosyllabic words such as those in group 1 (*fiar* 'to trust', *liar* 'to tie', *dual* 'dual') and other verbal forms (as we will see in Section 2.5). Thus in derived nominal forms the so-called morpheme boundary effects cited in the literature are basically limited to u+ˈV contexts.

We have also examined the behavior of some vocoid sequences of falling sonority. A clear gliding tendency is observed with such sequences when they are separated by a morpheme boundary (6 examples in our database): they are pronounced with a diphthong in 97.7% of the cases (*heroicidad* 'heroicity', *ingenuidad* 'ingenuity'). This situation contrasts with that of Catalan: in this language this morphological boundary prevents diphthong formation from applying in vowel sequences of falling sonority (*-dor*, *prove-ïdor* type).

As is well-known, compounds and prefixed words differ from suffixed words in both morphological and phonological behavior. The phonological behavior of vowel sequences across prefix and compound boundaries is close to what we might find across word-boundaries (phonological processes, sandhi processes, etc.; see Hualde 1989 for Spanish and Mascaró 1986 and Jiménez 1999 for Catalan), and thus we will consider this group of words as distinct from suffixed words. In our data, compounds and prefixed words made up a total of 30 examples. We found great variation in the data. Some speakers reported diphthongs everywhere except for cases with initial stress on the second word. Indeed, as Pensado (1999:4457) also argues, compounds may be pronounced with a hiatus when the second vowel in the sequence is stressed and less commonly if the second vowel in the sequence is unstressed. The examples in (7) illustrate the relevant contrasts with examples such as *barbihecho* (pronounced with hiatus) 'cleanshaven' vs. *barbiespeso* 'with a thick beard' (pronounced with a diphthong), *bienio* [bi.ˈenjo] 'two-year period' vs. *bianual* [bjaˈnwal] 'biennial'). In fact, only 3 informants reported less than 50% of diphthongs in unstressed position.

(7) Compounds

V2 stressed			V2 unstressed		
boqui**an**cho	[i.ˈa]	'wide-mouthed'	boquia**bier**to	[ja]	'open-mouthed'
barbi**he**cho	[i.ˈe]	'clean shaved'	barbies**pe**so	[je]	'with athick beard'
anti**á**cido	[i.ˈa]	'anti-acid'	antiaci**dez**	[ja]	'anti-acidity'
tri**án**gulo	[i.ˈa]	'triangle'	triangu**lar**	[ja]	'triangular'

The data above confirms a consistent gliding tendency across prefix and compound boundaries except for cases with initial stress on the second word. This behavior of vowel sequences is similar to that of postlexical sequences in many Romance languages, including Catalan, Spanish, and Brazilian Portuguese (see Cabré & Prieto 2005 and references therein). However, further work will be needed in order to elucidate the conditions that govern the variation found in the data.

2.5 Paradigm and derivational effects

Let us now examine the strength of paradigm uniformity effects on diphthong/hiatus distribution in vowel sequences of rising sonority. The literature on exceptional hiatuses in Spanish has argued that a stressed high vowel in the morphological paradigm favors the presence of a hiatus. As Navarro Tomás (1948: 159) pointed out, "analogy favors the presence of a hiatus, especially in verbal forms where in the same paradigm one finds cases of stressed *i* or *u*: *guiaba* 'guide.3sg.Pst.Imp' (*guía* 'guide'); *liamos* 'tie.1pl.Pr.Ind' (*lías* 'tie.2sg.Pr.Ind'); *acentuar* 'to stress' (*acentúo* 'stress.1sg.Pr.Ind'), *actuamos* 'perform.1pl.Pr.Ind' (*actúan* 'perform.3pl.Pr.Ind'), etc.".

In accordance with Navarro Tomás' observations, verbal roots ending in *i*- and *u*- that are stressed somewhere in the paradigm show a uniformity effect that blocks glide formation from applying (especially for conservative speakers). The examples in (8) show the contrast between this type of verbs (which are consistently pronounced with a hiatus) and those with a root ending in *i*- or *u*- that cannot be stressed in the paradigm, with a larger number of examples in the lexicon. In the latter cases, the hiatus solution is completely excluded (Cabré & Ohannesian 2005).

(8) Verbal paradigm effects

Hiatus (words with stressed *i*-, *u*- in paradigm)

act[u.ˈa]*r*	'to act'	cf. *actú.a*	'he/she acts'
acent[u.ˈa]*r*	'to stress'	cf. *acentú.o*	'I stress'
eval[u.ˈa]*r*	'to evaluate'	cf. *evalú.o*	'I evaluate'
punt[u.ˈa]*r*	'to score'	cf. *puntú.o*	'I score'
conf[i.ˈa]*ban*	'they trusted'	cf. *confí.an*	'they trust'
env[i.ˈa]*mos*	'we send'	cf. *enví.o*	'I send'
esp[i.ˈa]*ndo*	'spying'	cf. *espí.o*	'I spy'
gu[i.ˈa]*r*	'to guide'	cf. *guí.o*	'I guide'

Diphthong (unstressed *i*-, *u*- in paradigm)

averig[wa]*r*	'to find out'	cf. *averi.guo*	'I find out'
meng[wa]*r*	'to reduce'	cf. *men.guo*	'I reduce'
camb[ˈja]*r*	'to change'	cf. *cam.bio*	'I change'
envid[ˈja]*r*	'to envy'	cf. *envi.dio*	'I envy'
od[ˈja]*r*	'to hate'	cf. *o.dian*	'they hate'
asoc[ˈja]*r*	'to associate'	cf. *aso.cio*	'I associate'
aprec[ˈja]*r*	'to value'	cf. *apre.cio*	'I value'
limp[ja]*r*	'to clean'	cf. *lim.pian*	'he/she clean'

Let us note that verbal forms must meet three restrictions in order to yield a hiatus: (a) the verbal forms must contain a morpheme boundary between the verbal root and the inflective suffixes (*actu+ar* 'to act', *confi+ar* 'to trust'); that is why the verbal forms *dio* 'give.3sg.PassPerf' and *vio* 'see.3sg.PassPerf' are always pronounced with a diphthong (d_R+io, v_R+io), in contrast with *lió* 'tie.3sg.PassPerf' and *fió* 'trust.3sg.PassPerf' (li_R+o, fi_R+o); (b) the last high vowel of the verbal root has to be stressed in other members of the paradigm; (c) finally, the hiatus is maintained especially when the stress is located on the vowel that immediately follows the root (*act*[u.ˈa]*mos* 'perform.1pl.Pr.Ind', *conf*[i.ˈa]*mos* 'rely on.1pl.Pr.Ind'). Once the stress is moved to the right, the paradigm effects disappear (*act*[wa]*remos* 'perform.1pl.Fut', *conf*[ja]*remos* 'rely on.1pl.Fut').

Strikingly, the effects in nominal derivational paradigms are quite different. As we have seen in Section 2.1 above, the antidiphthong effects across morpheme boundaries happen generally after root-final /u+/ (e.g., *man*[u.ˈa]*l* 'manual', *afect*[u.ˈo]*so* 'affectionate'), and not after root-final /i+/ (as in *lab*[ˈja]*l* 'labial', *cop*[ˈjo]*so* 'copious' or *arter*[ˈja]*l* 'arterial'). Yet there is a substantial difference between both cases, namely, the root-final front high vowel *-i* (e.g., *labi-al*) has a correspondence in the non derived word (e.g., *labi-o*), whereas this is not the case with the root-final back high vowel *-u*, which show allomorphy with the base (e.g., *manu-al*, base form *man-o*). Moreover, the examples in (9) show that even if root-final /i/s are stressed in the base form, derived forms are pronounced with a diphthong. This demonstrates that, contrary to what happens in verbal paradigms, underlying stress does not crucially affect the vocalic outcome in derived nominal forms. Conversely, deverbal forms can maintain the hiatus outcome for conservative speakers in cases such as *confianza*, *alianza, variante*. The theme vowel plays an important role here, as it happens with the verbal paradigms. Finally, when the stress moves to the right the effects of morpheme boundaries disappear and glide formation is always the solution.

(9) Denominal forms (words with stressed final-root *i-*)

Mar[ˈja]*no*	'Mariano'	cf. *María*	'Maria'
sangr[ˈje]*nto*	'bloody'	cf. *sangría*	'bleeding'
polic[ˈja]*l*	'police-related'	cf. *policía*	'police'
val[ˈjo]*so*	'valuable'	cf. *valía*	'value'
man[ˈja]*tico*	'eccentric'	cf. *manía*	'peculiarity'
gestor[ˈja]*l*	'agency-related'	cf. *gestoría*	'agency'
roc[ˈje]*ro*	'pilgrim to Rocío'	cf. *Rocío*	'Rocío'
abac[ˈja]*l*	'abbey-related'	cf. *abadía*	'abbey'
nav[ˈje]*ro*	'shipping'	cf. *navío*	'ship'

3. Spanish and Catalan exceptional hiatuses

The distribution patterns of rising diphthong vs. hiatus found in conservative speakers of Peninsular Spanish are partially similar to the situation of the innovative variety of Catalan reported by Cabré & Prieto (2004). In both languages, the presence of exceptional hiatuses is partially conditioned by prosodic and morphological factors.

Table 6 summarizes the main similarities and differences found between Peninsular Spanish and Catalan. The table compares the solutions of the innovative Catalan variety with the conservative Spanish variety. In general, both languages show sensitivity to some prosodic constraints, that is, preference for hiatus word-initially (*b*[i.ˈo]*logo* 'biologist' vs. *rad*[ˈjo]*logo* 'radiologist') and distance-to-stress effects (*d*[i.a]*fragma* 'diaphragm' vs. *d*[ja]*metral* 'diametral').

The two languages differ strongly in the non-observance of the minimal binarity effect (Cat. *miol* [mi.ˈɔl] 'mew' vs. Span. *Dios* [ˈdjos] 'God'): both conservative and innovative Spanish speakers consistently report diphthongs in this environment. In the next section, we will argue that the Spanish outcome is favored by the default status of the trochee in the language, which entails an avoidance of iambic feet such as *[di.ˈos]. Finally, Catalan and Spanish differ with respect to the effects of uniformity in morphologically related words: while conservative Spanish speakers report the presence of hiatus in related words with stressed final-root *i-* (namely, deverbal nouns and throughout the verbal paradigm: e.g., *conf*[i.ˈa]*nza* 'trust', *conf*[i.ˈa]*r* 'to trust', cf. *conf*[ˈi]*o* 'I trust'), this is not the case in Catalan (*conf*[ˈja]*nça*, 'trust', *conf*[ˈja]*r* 'to trust', cf. *conf*[ˈi]*o* 'I trust').

Table 6. Summary table comparing similarities and differences between Catalan and Spanish hiatus/diphthong distributions within the lexicon.

	Central Catalan (innovative variety)	**Peninsular Spanish (conservative variety)**
Word-bisyllabicity effects	**yes** (Ll[u.ˈi]s 'Louis', *m*[i.ˈɔ]*l* 'mew')	**no** (L[ˈwi]s 'Louis', *D*[ˈjo]*s* 'God')
Word-initiality effects	**yes** (*b*[i.ˈɔ]*leg* 'biologist' vs. r*ad*[ˈjɔ]*leg* 'radiologist')	**yes** (*b*[i.ˈo]*logo* 'biologist' vs. *rad*[ˈjo]*logo* 'radiologist')
Distance-from-stress effects	**yes** (*d*[i.ˈa]*ble* 'devil' vs. *d*[jə]*bolical* 'diabolical')	**yes** (*d*[i.ˈa]*blo* 'devil' vs. *d*[ja]*bolical* 'diabolical')
Related word leveling effects	**no** (*conf*[ˈja]*r* 'to trust' vs. *conf*[ˈi].*o* 'I trust'; *conf*[ˈja]*nça*, *act*[ˈwa]*r* 'I act' vs. ***act***[ˈu]*o* 'I act')	**yes** (*conf*[i.ˈa]*r* 'to trust' vs. *conf*[ˈi].*o* 'I trust'; *conf*[i.ˈa]*nza*, *act*[u.ˈa]*r* 'I act' vs. ***act***[ˈu]*o* 'I act')
Morpheme-boundary effects	**no** (*lab*[ˈja]*l* 'labial', *glor*[ˈjo]*s* 'glorious', man[j]àtic)	**no** (except of /u/+; e.g., *lab*[ˈja]*l* 'labial', *glor*[ˈjo]*so* 'glorious', man[j]ático)
Historical rising diphthongs	**no** (*mel* 'honey', *foc* 'fire')	**yes** (*miel* 'honey', *fuego* 'fire')

Thus, the following are two important differences between the presence of exceptional hiatuses in Catalan and in Spanish: (1) the minimal binarity effect on words (Cat. *miol* [mi.ˈɔl] 'mew', Ll[u.ˈi]s 'Louis' vs. Span. *Dios* [ˈdjos] 'God', L[ˈwi]s 'Louis'); (2) the paradigm uniformity effects in verbal forms (Cat. *conf*[ˈja]*r* 'to trust', *act*[ˈwa]*r* 'to act' vs. Span. *conf*[i.ˈa]*r* 'to trust', *act*[u.ˈa]*r* 'to act') and leveling effects in deverbal nouns (Cat. *conf*[ˈi]*o* 'I trust'; *conf*[ˈja]*nça* Span. *conf*[ˈi]*o* 'I trust'; *conf*[i.ˈa]*nza*); (3) finally, the word-initiality effects are stronger in Catalan: while our Catalan informants displayed a high percentage of hiatuses in this position, Spanish speakers differed greatly with regard to the observance of the initiality effect.

4. An OT analysis of the data

The data reviewed in the preceding sections has made manifest the fact that the pronunciation of rising vocoid sequences in Peninsular Spanish is undergoing a change in progress: the distribution of exceptional hiatuses reported by the literature is restricted for many speakers to isolated lexical items. Only half of our informants appear to be sensitive to the word-initiality effect, and most of them are sensitive to it to a lesser degree (e.g. the behavior of group 3 in words such as *diadema*, where the presence of a diphthong has been generalized). The goal of this section is to account for the conservative Peninsular Spanish system as shown by half of our informants in terms of hierarchy constraints. The innovative system can be obtained with a reranking and lowering of the constraints that prevent glide formation.

In relation to the phonemic status of vocoid sequences, we claim that glides in sequences of rising sonority are derived from vowels except for the historical diphthongs *ie*, *ue*. We cannot predict the occurrence of such diphthongs. Thus *fuego* 'fire', *viento* 'wind', *trueno* 'thunder', *pliegue* 'fold' are always realized with a diphthong and nothing can prevent it. If we consider the historical diphthongs *ie*, *ue* to be underlying we will have no trouble explaining their presence in these positions (see also Chitoran 2002a, 2002b for Romanian).[10] As mentioned above, glide formation is generally blocked in initial position (e.g., *diana* 'target', *biólogo* 'biologist', *cliente* 'client'), except for monosyllabic words such as *Dios* 'God'. Glide formation is also blocked in this initial position in syllables with complex onsets (cf. *prior* 'prior', *truhán* 'crook'). With regards to the position of prevocalic glides as belonging to the onset or to the nucleus, we do not assume any strict position because we can find arguments that support to both positions (Harris 1983, 2000, Harris & Kaisse 1999, Roca 1997). In any case, the position of glides within the syllable is not a crucial assumption in our analysis.

Glide formation is triggered by a general instantiation of the Onset Principle. Within OT, Onset expresses the general prosodic restriction that every syllable must have an onset and motivates the strong preference for CV syllables rather than V syllables. To express the fact that only high vowels becoming glides in this context, we assume that the restriction against having high vowels in the margins of the syllable ($*M/V_{[+high]}$) is dominated by Onset, while the restriction against having non-high vowels in the margins ($*M/V_{[-high]}$) dominates the constraints just mentioned (for similar strategies for Catalan, see Cabré & Prieto 2004; for Romanian, see Chitoran 2002a, 2002b). This explains the stronger resistance displayed by low vowels to become glides, even under syllabic pressure. The table in (10) shows that the ranking

10. Historical diphthongs have to be marked in some way in the lexicon due to the fact that they show a complete insensitivity to all prosodic and segmental conditions that block glide formation.

$^{*}M/V_{[-high]}$ > Onset > $^{*}M/V_{[+high]}$ correctly predicts the optimal output *cam*[ˈjo]*n* 'truck'. Even though we are aware that syllable and metrical structure are constructed in parallel and might also interact with the constraints presented in this section, we are not dealing with the constraints which assign metrical structure and stress and just assume that they are already present in our input form. Input forms are shown in orthographical form and contain morphological boundaries and stress.

(10) camiˈon

Candidates	$^{*}M/V_{[-high]}$	Onset	$^{*}M/V_{[+high]}$
a. cam[io]n		*!	
☞ b. cam[ˈjo]n			*

The abovementioned set of ordered constraints explains the preference for an unstressed high vowel followed by another vowel to become a glide in the phonetic form. In fact, as we have seen in Section 2.1, this tendency is quite systematic in all contexts except when the vowel sequence is in word-initial position (e.g., *piano* 'piano', *viola* 'viola').[11] We argue that the greater phonological salience typical of word-initial positions, which is quite pervasive crosslinguistically, is preventing the occurrence of glide formation. As Beckman (1997: 2) points out, "positional faithfulness constraints call for output preservation of underlying contrasts in specific psycholinguistically prioritized or perceptually prominent linguistic positions". We express this fact through a faithfulness constraint ($\text{Max}_{\text{INIT-}\mu}$) which requires every word-initial mora to have a corresponding output.[12] In languages such as Spanish or Catalan, a secondary prominence can be observed in the assignment of rhythmic stresses on the word-initial syllable (see Harris 1983 for Spanish, Prieto & van Santen 1996, Prieto 2003).

The greater prosodic prominence of word initial positions might be rooted in articulatory constraints on gestural dynamics. Recent phonetic research has demonstrated that consonant gestures are controlled more tightly (that is, they exhibit less temporal overlap) word-initially than word-medially (Byrd 1996, Chitoran, Goldstein & Byrd 2002). In general, the same thing is true of [CiV] sequences in Romanian (Chitoran & Hualde 2002). Following recent literature on the idea that sound change will occur in least noticeable contexts first (Steriade 2001), we will claim that contexts where the change would be more salient (that is, word-initially) are more resistant to glide formation. In other words, glide formation is more prone to occur in contexts

11. Hualde wonders "What could be the reason for this preference for hiatus in initial position, which goes against the general 'anti-hiatus' preference in the language? Here I must confess ignorance. It could be that there is some phonetic or other reason for it, having to do, for instance, with articulatory ease or with parsing. Or, on the contrary, the reason could be an accident of lexical distribution, starting from a small bias in this direction and progressively the strong becoming stronger." (Hualde 1999:193–4).

12. The Faithfulness constraint $\text{Max}_{\text{INIT-}\mu}$ can be understood as a condition within the family of Positional Faithfulness Constraints. Other mechanisms that have been used to refer to this initial faithfulness are IDENTσ for Spanish (Colina 1999) and UNIFORMITYv (Jiménez 1999), which maintains the syllabic properties of vowels.

where the change is least noticed and less prone to occur in contexts where the change would be more salient.

The following table shows how the highest position of $\textsc{Max}_{\text{INIT-}\mu}$ correctly predicts the tendency to pronounce hiatus in words such as *miope* [mi.ˈope] 'target' or *diálogo* [di.ˈaloɣo] 'dialogue'.

(11) di'an+a

Candidates	$\textsc{Max}_{\text{INIT-}\mu}$	Onset	$*M/V_{[+high]}$
☞ a. m[i.ˈo]pe		*	
b. m[ˈjo]pe	*!		*

di'alog+o

Candidates	$\textsc{Max}_{\text{INIT-}\mu}$	Onset	$*M/V_{[+high]}$
☞ a. d[i.ˈa]logo		*	
b. d[ˈja]logo	*!		*

To account for the presence of an obligatory back glide after a velar consonant (*c*[ˈwa]*tro* 'four', *J*[ˈwa]*na* 'John.fem', *adec*[ˈwa]*r* 'to accommodate'), we propose the existence of a segmental constraint which disallows the presence of a high back vowel after a velar consonant, namely, $*C_{velar}uV$. There are some contexts in which the vowel and the corresponding glide alternate (e.g., *lic*[ˈu.o] 'liquify.1sg.Pr.Ind' > *lic*[ˈwa]*r* 'to liquify'; *evac*[ˈu.a]*s* 'evacuate.2sg.Pr.Ind' > *evac*[ˈwa]*r* 'to evacuate'; *adec*[ˈu.a] 'accommodate.1,3sg.Pr.Subj' > *adec*[ˈwa]*r* 'to accommodate'), providing evidence in favor of its non-phonemic status.[13] The constraint $*C_{velar}uV$ dominates $\textsc{Max}_{\text{INIT-}\mu}$. The tableau in (12) illustrates how the candidate *c*[u.ˈa]*tro* is not chosen because it crucially violates this segmental constraint.

(12) cuatr+o

Candidates	$*C_{[velar]}uV$	$\textsc{Max}_{\text{INIT-}\mu}$
a. c[u.ˈa]tro	*!	
☞ b. c[ˈwa]tro		*

When a rising sonority vocoid sequence with no preceding consonant is located in word-initial position (*yuca* 'yucca', *yogur* 'yogurt', *yema* 'yoke', *yanqui* 'yankee', *yambo* 'iamb')[14] it always becomes a diphthong. In these cases, the prominence of the first mora competes with a consecutive double violation of the Onset Principle which we formalize as Onset+Onset. We have to distinguish between *diana* 'target' (with only one violation of onset) and *yarda* 'yard' (with a double violation of onset). Thus,

13. Even though Spanish has not completely generalized the position of verbal root stress on the last vowel (*'cambi+o* 'change.1sg.Pr.Ind' *vs. con'fi+o* 'rely on..1sg.Pr.Ind') as Catalan has (*can'vi+o* 'change.1sg.Pr.Ind'; *con'fi+o* 'rely on..1sg.Pr.Ind'), the forms with root stressed of verbs such as *licuar*, *adecuar* have popularly generalized final stress (cf. *lic*['ua] 'liquify.3sg.Pr.Ind', *adec*['ua] 'accommodate.3sg.Pr.Ind') (see also Hualde 2005).

14. The only exception for some speakers is the word *hiato* 'hiatus'.

Onset+Onset dominates $\text{Max}_{\text{INIT-}\mu}$ (*yarda* vs. *diana*), which in its turn dominates Onset (Onset+Onset >> $\text{Max}_{\text{INIT-}\mu}$ >> Onset). The following tableau shows that *yambo* surfaces with a glide because otherwise it would violate the higher-ranked constraint Onset+Onset, as follows:

(13) yamb+o

Candidates	Onset+Onset	$\text{Max}_{\text{INIT-}\mu}$	Onset
☞ a. [ja]mbo		*	
b. [ia]mbo	*!		**

As we have seen in Table 2, another systematic exception to word-initial hiatuses is potentially monosyllabic words (e.g., *Dios* 'God', *Luis* 'Louis'), except for words with a complex onset or a morphological boundary (*truhán* 'crook', *prior* 'prior', *fiar* 'to trust', *liar* 'to tie'). We interpret this phenomenon as a manifestation of the strong dispreference of Spanish for iambic forms. The preference for trochees in Spanish in contrast with Catalan is very well-known and is manifested in truncated and hypocoristic forms (see Prieto 1992 for Spanish and Cabré 1993 for Catalan).[15] The default status of the trochaic foot in the language, Trochee, can also be observed in stress assignment (Harris 1983, Ohannessian 2004, Roca 1997). Thus we can safely assume that Trochee[16] is located quite high in the Spanish hierarchy and indeed it dominates $\text{Max}_{\text{INIT-}\mu}$. This explains the opposite behavior of two types of words (type 1: *Dios* vs. type 2: *diana*), as we can see in (14).

(14) Dios

Candidates	Trochee	$\text{Max}_{\text{INIT-}\mu}$	Onset
☞ a. d[ˈjo]s		*	
b. d[i.ˈo]s	*!		*

diana

Candidates	Trochee	$\text{Max}_{\text{INIT-}\mu}$	Onset
☞ a. d[i.ˈa]na			*
b. d[ˈja]na		*!	

But *truhán* 'crook' or *prior* 'prior' are pronounced with a hiatus, at least for conservative speakers. The structure *CCG only is shown active when is combined with $\text{Max}_{\text{INIT-}\mu}$, that is, when an output violates both constraints.[17] Thus we need a constraint conjunction *CCG + $\text{Max}_{\text{INIT-}\mu}$ to block glide formation from applying in these words, as shown in the following tableau.

15. There are no hypocoristic iambic forms in Spanish in general. The common forms *mamá* and *papá* are French loanwords which coexist with the traditional *mama* and *papa*.

16. We have to combine Trochee with a constraint such as Parse Foot in order to block an iambic minimal word.

17. The constraint *CCG is also used by Jiménez (1999:68) for Catalan. We owe this constraint conjunction proposal to M. Kenstowicz.

(15) prior

Candidates	*CCG + $\text{Max}_{\text{INIT-}\mu}$	Trochee	$\text{Max}_{\text{INIT-}\mu}$	Onset
☞ a. pr[i.ˈo]r		*		*
b. pr[ˈjo]r	*!		*	

We have observed that verbal paradigms with roots ending in stressable *i* or *u* can maintain the hiatus (*act*[ˈu.o] 'perform.1sg.Pr.Ind', *act*[u.ˈa]*mos* 'perform.1pl.Pr.Ind', *conf*[ˈi.o] 'rely.1sg.Pr.Ind', *conf*[i.ˈa]*mos* 'rely.1pl.Pr.Ind').[18] We interpret this as a case of output to output faithfulness applying across different forms of the verbal roots. Within the Optimal Paradigm proposal, this faithfulness relationship is understood as follows: "The stem (shared lexeme) in each paradigm member is in correspondence relation with the stem in every other paradigm member. (…) There is no distinctive base — rather, every member of a paradigm is a base of sorts with respect to every other member." (McCarthy 2005: 173). For this study, we assume that the constraint OPMax_{V} guarantees uniformity effects among outputs belonging to root paradigms. Similarly, a uniform pronunciation obtains across nominal paradigms such as *dios, diosa, dioses, diosas*, following the pattern of the unmarked masculine singular form — note that the plural forms correspond to group 2 in Table 1 and, correspondingly, a pronunciation with hiatus would be predicted. The following three tableaux exemplify some cases from the paradigm of the verb *confiar* 'to rely' with stressed final-root high vowel (e.g., *confío* [koɱˈfio]), from the paradigm of the verb *cambiar* 'to change', with unstressed final-root high vowel (e.g., *cambio* [ˈkambjo]), and finally, an example of a nominal paradigm such as *dios* d[ˈjo]s, *dioses* d[ˈjo]ses. In the first two cases the constraints Trochee and $\text{Max}_{\text{INIT-}\mu}$ are not relevant. Nevertheless, they are relevant for nominal paradigms such as *dios*, *dioses*, as shown below, where we need Trochee to force gliding on the word *dios*.

(16) confí+o, confí+ár, confí+ámos, confí+ába …

Candidates	OPMax_{V}	Trochee	$\text{Max}_{\text{INIT-}\mu}$	Onset
☞ a. conf[i.ˈa]ba				*
b. conf[ˈja]ba	*!			

cámbi+o, cámbi+ár, cámbi+ámos, cámbi+ába …

Candidates	OPMax_{V}	Trochee	$\text{Max}_{\text{INIT-}\mu}$	Onset
☞ a. camb[ˈja]ba				
b. camb[i. ˈa]ba	*!			*

18. As mentioned above, in order for gliding to be blocked the morpheme boundary has to be between the verbal root and the inflective suffixes. That is why the verbal forms dio 'give.3sg.PassPerf' and vio 'see.3sg.Past' are always pronounced with a diphthong (d_{R}+io, v_{R}+io), in contrast with lió 'tie.3sg.Past' and fió 'trust.3sg.PassPerf' (li_{R}+o, fi_{R}+o).

diós, diós+es …

Candidates	OPMax$_{V}$	Trochee	Max$_{INIT-\mu}$	Onset
a. d[i.ˈo]s, d[i.ˈo]ses		*!		**
b. d[ˈjo]s, d[i.ˈo]ses	*!		*	*
c. d[i.ˈo]s, d[ˈjo] ses	*!	*!	*	*
☞ d. d[ˈjo]s, d[ˈjo] ses			**	

In our view, the blocking of glide formation in nominal roots ending in /u-/ and followed by stressed sufixes such as *-aje, -oso, -al, -ario* must be accounted for in a different way. Examples such as *virtu+oso* 'virtuous', *defectu+oso* 'defective', *carru+aje* 'carriage', *vestu+ario* 'clothes', *usu+ario* 'user', *actu+al* 'current', *virtu+al* 'virtual' are pronounced with hiatus by Spanish conservative varieties, whereas other examples with the same sufixes attached to roots ending in /i/ are pronounced with a diphthong (e.g., *copi+oso* 'copious', *nervi+oso* 'irritated', *furi+oso* 'violent', *besti+ario* 'bestiary', *incendi+ario* 'incendiary', *labi+al* 'labial', *fili+al* 'filial', *material* 'material'). This contrast shows that we are facing a segmental requirement: in general, /u/ is less prone to gliding (except when preceded by a velar consonant). This tendency has also been found in Catalan (Cabré & Prieto 2004). We consider this segmental requirement to be only a minor faithfulness constraint as it applies to very few cases (the number of roots ending in /u/ is lower than those ending in /i/, making these cases quite exceptional). As we have seen in Section 2.4, the tendency for /i/+V diphthongs to be shorter than /u/+V diphthongs (e.g., *siete* 'seven' vs. *cueto* 'surname'; *idiota* 'idiot' vs. *cuota* 'quota') might be the phonetic reason behind this tendency.

With the conditions presented so far (*CCG+Max$_{INIT\mu}$ >> OPMax$_{V}$, Trochee >> Max$_{INIT-\mu}$ >> Onset), we account for the distribution of diphthongs and hiatuses in the most part of the output forms. Still, these requirements do not account for the distance-to-stress effects. As we have seen in the preceding sections, all cases of exceptional hiatuses become glides when stress moves to the right. It looks as if there is a tendency to reduce the length of the pretonic sequence once the distance between the beginning of the word and the position of the stress is increased. This apparent syllable-counting effect has been interpreted as a prosodic tendency that disfavors a succession of more than two syllables, which will be named *Lapse (Cabré & Prieto 2004, Wheeler 2005). This constraint, together with its counterpart *Clash, have been shown to be active in the prosodic phonology of different languages (Nespor & Vogel 1989). In this paper, instead, we will argue that a more general principle (through the constraint Prosodic Prominence) might be able to both account for this fact and also better motivate the general behavior of gliding crosslinguistically.[19] As is well known, a variety of factors have an influence on vowel shortenings and lengthenings, and thus influence the tendency to glide formation in certain positions. As mentioned before, a variety of phonetic studies have shown that syllables in prominent positions (stressed positions, word-initial positions, or monosyllabic words) are phonetically longer than syllables in corresponding non-prominent positions. Following Steriade

19. We owe this suggestion to M. Kenstowicz.

(2001), we interpret that a longer acoustic duration in prominent positions makes syllables more perceptible and thus speakers tend to reject gliding in prominent positions; conversely, it is easier that speakers accept gliding in less salient non-prominent positions. In other words, production and perceptual reasons are at the basis of this phenomenon. Following this line of argumentation, we propose a Faithfulness condition called Prosodic Prominence which agglutinates three prominence conditions that apply to syllables in terms of acoustic duration: (1) syllables in stressed positions are more prominent than syllables in unstressed positions (they are longer and thus more perceptible); (2) syllables in word-initial position are more prominent than syllables in non-initial positions; and (3) syllables in short stems are more prominent than syllables in longer stems. Summarizing, the following prominence hierarchies obtain: *stressed* >> *unstressed*, *word-initial* >> *non word-initial*, *short stem* >> *long stem*. The prominence level of a given syllable is obtained through a computation of these three pairs of prominence levels. If the syllabic prominence obtained is high, this will be a clear indicator that glide formation should be blocked. In general, blocking of glide formation is only possible when these three prominent conditions apply to the same syllable. As a consequence, syllables where the change would be more salient (that is, stressed positions, word-initial positions, short words) will be more resistant to glide formation.

This computation of the level of prominence automatically obtains the desired results. In a word like *dia* 'day', the word-initial syllable has the maximum concentration of prominence, as the three conditions obtain. By contrast, in a word like *violinista,* the word-initial syllable is 'weakened' by the fact that it belongs to a longer word. Thus the application of condition 3 ("syllables in short stems are more prominent than syllables in longer stems") guarantees that the longer the word, the greater the tendency to pronounce a diphthong, as generally the distance from the beginning of the word to the stressed syllable is longer in longer stems. Speaker variation also follows from the fact that the computation of the prominence level obtains an increasing gradation in prominence strength. We have seen that indeed for some speakers a diphthong also appears word-initially when the stress is located in the vowel next to the high vowel, like in the word *diablo*. The next step down in prominence strength is found when the word is one syllable longer, like in the case of *violín*, where the majority of speakers produce a diphthong.

The constraint ProsodicProm dominates $\text{MAX}_{\text{INIT-}\mu}$ and the other constraints that block glide formation, guaranteeing that the initial high vowel will become a glide when the vowel belongs to a long word. The tableaux in (17) illustrate the contrast between *diablo* 'devil'and *violinista* 'violinist'.

(17) diáblo

Candidates	ProsodicProm	$\text{Max}_{\text{INIT-}\mu}$	Onset
d[ja]blo		*	
☞ d[i.a]blo			*

violínísta

Candidates	ProsodicProm	$Max_{INIT-μ}$	Onset
v[i.o]linista	*!		*
☞ v[jo]linista		*	

If we take some examples from the verbal paradigms *fiar* 'to entrust', *confiar* 'to trust', and *desconfiar* 'to distrust', it is clear that ProsodicProm dominates $OpMax_V$. Clearly, glide formation applies when the stress is away from the word-initial position despite the fact that the high vowel of the root is stressed in some forms of the paradigm. Conversely, the hiatus is maintained in words where the stress is located close to the prominent word-initial position. Note that all other constraints are irrelevant in the tableau in (18).

(18)

	ProsodicProm	$OPMax_V$
☞ a. fí.o / fi.ámos / fi.arémos		
b. fí.o / fi.ámos / fjarémos	*!	*
c. fí.o / fjámos / fjarémos	*!	*
☞ a. confí.o / confi.ámos / confjarémos		*
b. confí.o / confi.ámos / confi.arémos	*!	
c. confío / confjá.mos / confjarémos	*!	*
☞ a. desconfí.o / desconfjámos / desconfjarémos		*
b. desconfí.o / desconfi.ámos / desconfi.arémos	*!	
c. desconfí.o / desconfi.ámos / desconfjarémos	*!	*

(19) summarizes the hierarchy of prosodic conditions that account for the situation found in the conservative varieties of Peninsular Spanish. As shown above, ProsodicProm is the strongest constraint in the hierarchy, followed by $OpMax_V$ and Trochee. Both the segmental constraint $*C_{[velar]}uV$ and the prosodic constraints Onset+Onset are only active when these exceptional cases appear.

(19) ProsodicProm >> $OpMax_V$, Trochee >> $Max_{INIT-μ}$ >> Onset >> $*M/V_{[+high]}$

On the basis of this hierarchy we can also explain what has happened in innovative varieties: the constraints blocking glide formation have weakened and slipped down in the hierarchy. Isolated exceptions found among some speakers will be interpreted as lexicalized items rather than active prosodic restrictions.

As we have already noted, the hiatus/diphthong distribution exhibits another type of microvariation, namely variation across speakers. Even though speakers of the same Spanish variety share a tendency to diphthongize in certain prosodic contexts, they also present somewhat different surface distributions of hiatuses and diphthongs across lexical items. It is evident that while simple constraint reranking accounts for parametric dialectal differences, it cannot explain this type of variation present in the data.[20] In

20. As McMahon (2000: 235) has argued, constraint reranking contributes to a view of synchronic language systems as static linguistic stages and language change as a sudden shift from one linguistic stage to another: "The status of OT as a model operating with completely ranked constraints, each

this vein, there have been some recent attempts to derive variation in synchronic phonology within OT. One of the most common solutions adopted has been to weaken the requirement for total ranking of constraints (Anttila 1997, Anttila & Cho 1998, Nagy & Reynolds 1997). Taking up a suggestion by Prince & Smolensky (1993) about "crucial nonranking",[21] Anttila (1997) takes the view that "crucial nonranking" reflects variation in the empirical domain. Unless specifically blocked, absence of ranking will appear as a possibility provided by the theory. Similarly, Nagy & Reynolds (1997: 37) propose the existence of "floating constraints, whereby some particular constraint within a single grammar may be represented as falling anywhere within a designated range in the ranking hierarchy". This lack of decision between candidates generates alternative or optional outputs of a given input, but, as Anttila (1997) observes, this does not allow common frequency or subregularity effects to be captured.

Clearly, Spanish glide formation data is not subject to free variation, as it is not the case that a speaker can alternatively pronounce *p*[i.ˈa]*no* and *p*[ˈja]*no* (this only occurs very sporadically). Rather, certain prosodic patterns display clear quantitative tendencies and, within each group, each speaker decides which set of words will be pronounced with a diphthong or a hiatus. The unranked or floating constraint solution is not able to account for the "net of lexical relationships" which are established by each speaker nor to make explicit quantitative predictions on the output because we are not dealing with a phenomenon of grammatical undeterminacy.

Intuitively, idiolectal variation in the case at hand responds to the difference between analogical relationships that each speaker establishes between different lexical items. One possible reason for the emergence of these "individualized grammars" is that gliding is not a perceptually salient phenomenon in connected speech, which can easily induce speakers to start establishing a particular net of lexical relationships. We propose to encode the expression of this type of variation by resorting to differences between individual speakers in the establishment of analogical relationships between lexical items. We will adopt Itô & Mester (1997: 439) instantiation of this idea within Correspondence Theory: each speaker is able to set up a series of idiosyncratic correspondence relations between different lexical items which become active in the evaluation process. Thus, some lexical idiosyncratic marking is needed to explain idiolectal variation (and expressed by the presence of the relevant correspondent in the evaluation tableau). It might well be that some identity and analogical patterns emerge in this net of lexical relationships within each particular grammar.

hierarchy converging unambiguously and categorically on a single output for each input form, would seem to preclude the analysis of variation."

21. "We asume that the basic hypothesis is that there is some total ranking which works; there could be (and typically will be) several, because a total ranking will often impose noncrucial dominance relations (noncrucial in that either order will work). It is entirely conceivable that the grammar should recognize nonranking of pairs of constraints, but this opens up a possibility of crucial nonranking (neither can dominate the other; both rankings are allowed), for which we have not yet found evidence. Given present understanding, we accept the hypothesis that there is a total order of domination on the constraint set; that is, that all nonrankings are noncrucial." (Prince & Smolensky 1993:51).

6. Conclusion

We have shown that the process of glide formation in rising sonority sequences in the conservative variety of Peninsular Spanish can be accounted for in terms of a correspondence-based OT analysis (McCarthy & Prince 1994, 1995; Benua 1995). In this variety, the presence of exceptional hiatuses can be regarded as a process closely conditioned by prosodic and analogical conditions: exceptional hiatuses basically appear in word-initial position (*p*[i.ˈa]*no* 'piano') and as a result of uniformity effects in paradigmatically-related words (*conf*[i.ˈa]*r* 'to trust', cf. *confío* 'I trust'). By contrast, vowel sequences in word-medial and word-final positions are quite systematically reported as diphthongs (*cam*[ˈjo]*n* 'truck', *cam*[ˈjo]*neta* 'van'). With respect to the morpheme boundary effects, the data reveal that they differ depending on the paradigm: while in nominal items gliding is blocked when there is an intervening morpheme boundary and when the glide is a high back vowel (*virt*[u.ˈo]*so* 'virtuous' vs. *od*[ˈjo]*so* 'hateful', *act*[u.ˈa]*l* 'current' vs. *cord*[ˈja]*l* 'cordial'), in verbal paradigms, gliding is blocked when there is an intervening morpheme boundary and when the high vowel can be stressed in other forms of the paradigm (*conf*[i.ˈa]*r* 'to trust', cf. *confío* 'I trust' vs. *camb*[ˈja]*r* 'to change', cf. *cambio* 'I change').

Regarding the prosodic conditions, we have argued that a general phonetically grounded constraint called Prosodic Prominence is able to better motivate the general behavior of gliding crosslinguistically. As is well known, a variety of phonetic studies have shown that syllables in prominent positions (stressed positions, word-initial positions, or monosyllabic words) are phonetically longer than syllables in non-prominent positions. This constraint has the function of evaluating the prominence level of a given syllable taking into account the following three comparisons: *stressed* >> *unstressed*, *word-initial* >> *non word-initial*, *short word* >> *long word*. Following Steriade (2001), we interpret that a longer acoustic duration in prominent positions makes syllables more perceptible and thus speakers tend to reject gliding when the three prominence conditions are met; conversely, it is easier that speakers accept gliding in less salient non-prominent positions. As a consequence, contexts where the change would be more salient will be more resistant to glide formation.

We are aware that we need more than 15 informants from different generations and more than 246 words to state that there is a change in a specific direction in the distribution of diphthongs / hiatuses in Spanish, this is out of the scope of this paper. Nevertheless the results show a situation with many more diphthongs that literature has reported and with great variation. One of the first descriptive findings of this article is that there are clear differences between speakers in the surface distribution of exceptional hiatuses. First, half of the speakers have practically generalized the presence of a diphthong in word-initial position and in morphological environments: for example, only half of the informants have the word-initiality effect in words such as *piano* 'piano' or *diálogo* 'dialogue' (+50% hiatus), and practically all speakers have generalized the presence of a diphthong in words such as *diadema* (with the stress located one syllable after the vowel sequence). Similarly, paradigm effects are practically null for some innovative speakers. This situation reveals that Spanish shows a strong tendency to onglide formation for many speakers. We have also hypothesized that this tendency has been favored by the prior existence of frequent historical diphthongs coming from the "breaking" of mid vowels, which have acted as lexical attractors for other vowel sequences of rising sonority within the lexicon. It is not surprising that Spanish represents a more advanced stage of diphthongization than Catalan, a language which does not have historical diphthongs (see Cabré & Prieto 2004).

Finally, interspeaker variation in the data has been accounted for by assuming that each speaker is able to set up a set of idiosyncratic correspondence relations between different words which are active in the evaluation process. This intuitively accounts for the fact that the emergence of these individualized grammars in the hiatus/diphthong distribution patterns responds to the different analogical relationships each speaker establishes between different lexical items.

References

Aguilar, L. 1999. Hiatus and diphthong: Acoustic cues and speech situation differences. *Speech Communication* 28: 57–74.

Anttila, A. 1997. Deriving variation from grammar. In *Variation, Change and Phonological Theory*, F. Hinskens, R. van der Hout and L.W. Wetzels (eds), 35–68. Amsterdam: John Benjamins.

Anttila, A. and Cho, Y.Y. 1998. Variation and change in optimality theory. *Lingua* 104: 31–56.

Beckman, J.N. 1997. Positional faithfulness, positional neutralisation and Shona vowel harmony. *Phonology* 14: 1–46.

Benua, L. 1995. Identity effects in morphological truncation. In *Papers in Optimality Theory*, J. Beckman, L. Walsh Dickey and S. Urbanczyk (eds), 77–136. Amherst MA: Graduate Linguistics Association.

Byrd, D. 1996. Influences on articulatory timing in consonant sequences. *Journal of Phonetics* 24: 209–244.

Cabré, T. 1993. Estructura gramatical i lexicó: El mon mínim català. PhD dissertation, Universitat Autònoma de Barcelona.

Cabré, T. and Prieto, P. 2004. Prosodic and analogical effects in lexical glide formation in Catalan. *Probus* 16: 113–150.

Cabré, T. and Prieto, P. 2005. Positional and metrical prominence effects on vowel sandhi in Catalan. In *Prosodies*, S. Frota, M. Vigário and M.J. Freitas (eds), 123–157. Berlin: Mouton de Gruyter.

Cabré, T. and Ohannesian, M. 2005. Hiatus et diphtongues croissantes dans le paradigme verbal espagnol. Paper presented in *4th Décembrettes. Colloque international de Morphologie*. Toulouse — Le Mirail.

Colina, S. 1999. Reexamining Spanish glides: Analogically conditioned variation in vocoid sequences in Spanish dialects. In *Advances in Hispanic Linguistics*, J.Gutiérrez-Rexach and F. Martínez-Gil (eds), 121–134. Somerville MA: Cascadilla.

Chitoran, I. 2002a. *The Phonology of Romanian: A constraint-based approach*. Berlin: Mouton de Gruyter.

Chitoran, I. 2002b. The phonology and morphology of Romanian diphthongization. *Probus* 14: 205–246.

Chitoran, I. and Hualde, J.I. 2002. Variability in hiatus resolution: A phonetic study of [CiV] sequences in two Romance languages. Paper presented at the *Laboratory Phonology Conference* VIII, Haskins Laboratories.

Chitoran, I., Goldstein, L. and Byrd, D. 2002. Gestural overlap and recoverability. Articulatory evidence from Georgian. In *Papers in Laboratory Phonology* 7, C. Gussenhoven, N. Warner and T. Rietveld (eds), 419–447. Cambridge: CUP.

Dell, F. 1980 *Generative Phonology and French Phonology*. Cambridge: CUP.

Face, T. and Alvord, S. 2004. Lexical and acoustic factors in the perception of the Spanish diphthong. *Hispania* 87: 553–564.

Harris, J.W. 1983. *Syllable Structure and Stress in Spanish*. Cambridge MA: The MIT Press.

Harris, J.W. 2000. High vocoids in Spanish syllables. Ms, MIT.

Harris, J. and Kaisse, E. 1999. Palatal vowels, glides and obstruents in Argentinian Spanish. *Phonology* 16: 117–190.

Hualde, J. I. 1989. Silabeo y estructura morfémica en español. *Hispania* 72(4): 821–831.

Hualde, J.I. 1991. On Spanish syllabification. In *Current Studies in Spanish Linguistics*, H. Campos and F. Martínez-Gil (eds), 475–493. Washington DC: Georgetown University Press.

Hualde, J.I. 1999. Patterns in the lexicon: Hiatus with unstressed high vowels in Spanish. In *Advances in Hispanic Linguistics*, J. Gutiérrez-Rexach and F. Martínez-Gil (eds), 182–198. Somerville MA: Cascadilla.

Hualde, J.I. and Prieto, M. 2002. On the diphthong/hiatus contrast in Spanish: Some experimental results. *Linguistics* 40(2): 217–234.

Hualde, J.I. 2005. *The Sounds of Spanish*. Cambridge: CUP.

Itô, J. and Mester, A. 1997. Correspondence and compositionality: The Ga-Gyo variation in Japanese phonology. In *Derivations and Constraints in Phonology*, I. Roca (ed.), 419–462. Oxford: Clarendon Press.

Jiménez, J. 1999. *L'estructura sil·làbica del català*. Barcelona/València: Publicacions de l'Abadia de Montserrat.

Kenstowicz, M. 2005.Paradigmatic uniformity and contrast. In L.J. Downing, T.A. Hall and R. Raffelsiefen (eds). *Paradigms in Phonological Theory*, 145–169. Oxford: OUP.

Mateus, M.H. and d'Andrade, E. 2000. *The Phonology of Portuguese*. Oxford: OUP.

McCarthy, J. and Prince, A.M. 1994. The Emergence of the Unmarked. Ms. University of Massachusetts, Amherst and Rutgers University.

McCarthy, J. and Prince, A.M. 1995. Faithfulness and reduplicative identity. In J.N. Beckman, L. Walsh Dickey, ans S. Urbanczyk (eds.), *Papers in Optimality Theory,* 249–384. Amherst, Massachusetts: Graduate Linguistic Student Association.

McCarthy, J. 2005. Optimal paradigms. In L.J. Downing, T.A. Hall, and R. Raffelsiefen (eds.), *Paradigms in Phonological Theory*, 170–210. Oxford: Oxford University Press.

McMahon, A. 2000. The emergence of the optimal? Optimality theory and sound change. *The Linguistic Review* 17: 231–240.

Monroy Casas, R. 1980. *Aspectos fonéticos de las vocales españolas*. Madrid: Sociedad General Espanyola de Librería.

Nagy, N. and Reynolds, B. 1997. Optimality theory and variable word-final deletion in Faetar. *Language Variation and Change* 9: 37–55.

Navarro Tomás, T. 1948. *Manual de pronunciación española* (4th ed.). New York NY: Hafner.

Nespor, M. and Vogel, I. 1989. On clashes and lapses. *Phonology* 6: 69–116.

Pensado, C. 1999. Morfología y fonología: Fenómenos morfofonológicos. In *Gramática Descriptiva de la Lengua Española*, I. Bosque and V. Demonte (eds), Vol. III, chap. 68, 4423–4504. Madrid: Espasa Calpe.

Ohannessian, M. 2004. *La asignación del acento en castellano*. Ph. D. Dissertation, Universitat Autònoma de Barcelona.

Prieto, P. 1992. Truncation processes in Spanish. *Studies in the Linguistic Sciences* 22(1): 143–158.

Prieto, P. and van Santen, J. 1996. Secondary stress in Spanish: Some experimental evidence. In *Aspects of Romance Linguistics*, C. Parodi, C. Quicoli, M. Saltarelli and M.L. Zubizarreta (eds), 336–356. Washington DC: Georgetown University Press.
Prieto, P. 2003. Correlats acústics de l'accent secundari en català. *Estudios de Fonética Experimental* 12: 107–142.
Prince, A.M. and Smolensky, P. 1993. Optimality Theory: Constraint interaction in generative grammar. Ms. Rutgers University and University of Colorado at Boulder.
Roca, I. 1997. There are no glides, at least in Spanish: An optimality account. *Probus* 9: 233–265.
Saltarelli, M. 1970. *A Phonology of Italian in a Generative Grammar*. The Hague: Mouton de Gruyter.
Steriade, D. 2001. The phonology of perceptibility effects: The P-map and its consequences for constraint organization. Ms. MIT. Available at http://web.mit.edu/Linguistics/www/ bibliography/steriade.html.
Tranel, B. 1987. *The Sounds of French*. Cambridge: CUP.
Wheeler, M. 2005. *The Phonology of Catalan*. Oxford: Oxford University Press.

Appendix 1. Cuestionario

Nombre: ____ Edad: ______________________

Procedencia geográfica: ____

(Pronuncie las palabras siguientes con una elocución normal y separe las sílabas fonéticas resultantes con un guión. Cuando aparezca algún diptongo en sílaba átona de vocoides altas, señale el núcleo silábico con un acento)

reimprimir	reinstaurar	reiniciar
reunir	reubicar	reinstalar
bianual	biunívoco	bienio
triángulo	triangular	triunvirato
preuniversitario	semiótico	semiesfera
semiexperto	semialcalino	contraindicación
contraindicar	sobrehumano	sobreintoxicación
antiestético	antialcalino	antiácido
antiasmático	pluriempleo	intrauterino
boquiabierto	estadounidense	francohispano
comerciante	obediente	coloquial
material	celestial	artificial
defectuoso	delicioso	valeriana
italiano	Sebastián	anfitrión
escorpión	estudiante	calumniar
heroicidad	laicismo	continuidad
homogeneidad	espontaneidad	ingenuidad
mediación	aviación	foniatría
propietario	embrionario	apasionante
cristianismo	pediatría	ambiental
avioneta	idiomático	misionero
aduana	copioso	foniatra
confianza	congruente	avión

camión	misión	caviar
guardián	precioso	pensión
cordial	arterial	bestial
actual	social	trivial
labial	colegial	filial
maniático	radiólogo	asiático
idioma	patriarca	pediatra
ambiente	peruano	genuino
boniato	patriota	barriada
idiota	radiante	ambiente
embrión	Daniel	Gabriel
silueta	carruaje	maniobra
estuario	usuario	cristiano
jesuita	bestial	Adrián
bandurria	historia	Cecilia
mutua	patria	fatua
perpetua	ingenua	continua
demonio	asiduo	sobrio
amplio	biblia	ebrio
novia	bestia	odio
Dios	Lyon	riel
dual	prior	truhán
fuel	dio	vio
ruin	bies	fiar
cruel	criar	trial
Juan	Luis	liar
miope	sueco	piano
diana	dieta	viola
diálogo	diácono	diócesis
Viena	viaje	triunfo
quieto	ruina	fianza
diablo	diario	criollo
cliente	cruento	ciática
fiable	liana	Suiza
Juana	riada	biela
miopía	piedad	piadoso
diadema	dialecto	dualista
violín	violento	diamante
criatura	pionero	Piamonte
cianuro	biológico	diabólico
diagnosis	suicidio	diabetes
lionesa	pianista	clientela
triunfante	Priorato	ruinoso
diagonal	diapositiva	diocesano
violentar	triunfador	fluorescencia
diapasón	prioridad	violinista
piamontés	biología	diamantino

insinuar	insinuaremos	insinuación
habituar	habitual	habituaremos
evaluar	evaluación	evaluarán
continuar	continuidad	continuación
conciliar	conciliador	conciliación
aliar	alianza	aliado
variante	variación	variabilidad
repatriar	reconstruir	construiremos
actuar	actuaremos	actuación
ampliar	ampliación	ampliarán
confiar	confianza	confiaria
saciar	expiar	expiación

The Spanish stress window*

Iggy Roca
University of Essex

This paper offers an OT analysis of the word stress patterns of Spanish non-verbs, paying close attention to the interaction with the parse of abutting vowels and to the partly diverging behaviour of traditional words (native or assimilated) and foreign forms in common use. Central to the analysis are several right-alignment constraints relating some metrical material (foot boundaries and the foot head) to the morphological constituent 'stem'. The syllabification of abutting vowels is principally driven by ONSET. An important aspect of the analysis concerns the identity of the stress bearers, in particular whether they project from rime vowels or from syllable heads.

Keywords: abutting vowels, glides, non-verb stress, stress bearers, stress windows

0. Preliminaries

There is agreement in the literature that Spanish word stress invariably falls within a three-syllable window (3σW) on the right edge of the word.[1] The situation, however, is more complex than may appear at first. It is the purpose of this paper to scrutinise this complexity as fully as space permits, in an attempt to shed robust light on the issue.

---

* Parts of this paper were presented as a poster at the 12th Manchester Phonology Meeting in 2004, and I am grateful to a number of participants for questions and comments. Also to René Kager for answering theoretical questions during writing, to María Ohannesian for discussion of the data analysed in Section 3.2, and to two anonymous readers for raising various objections to the originally submitted version. Last, I thank Fernando and Sonia for the invitation to contribute and for their friendly editing. Naturally, responsibility for the present text is exclusively mine.

1. The prosodic word if we assume with Nespor & Vogel (1986) that clitic constructions are 'clitic groups' larger than prosodic words: Spanish (verb) clitic constructions do not exhibit stress-window restrictions, as can be seen in *lle.ván.do|.se* 'carrying away', *lle.ván.do|.se.lo* 'carrying it away, *lle.ván.do|.se.nos.lo* 'carrying it away from/for us', and in principle longer forms (syntax puts a limit on the number of strung clitics). On the other hand, if the clitic group is not recognised (cf. Selkirk 1995, for instance), the domain of the Spanish 3σW will need to be the morphological word, at least in verbs. The leading role we will see the morphological stem plays in the assignment of non-verb stress indeed points in this direction.

A few general remarks about Spanish stress are first in order. There is a clear divide between verb and non-verb stress.[2] Verb stress is morphologically determined, as follows (NB throughout the paper, the stressed vowel is identified by an acute accent ´ where required by the official orthography, and by a grave accent ` elsewhere, if relevant; hiatus is marked with a full stop also where relevant): (1) penultimate in strong preterites (e.g. ***cù**pe* 'I fitted in', *cu**pì**ste(is)* 'you(-PL) fitted in') and mostly in the presents (*ca**mì**no* 'I walk', *cami**nè**mos* 'let us walk'),[3] (2) on the left edge of the future indicative and conditional morphemes (*canta**ré*** 'I will sing', *canta**rè**mos* 'we will sing', *canta**rí.a*** 'I/he would sing', *canta**rí.a.**mos* 'we would sing'), and (3) otherwise on the theme vowel (*can**tàr*** 'to sing', *can**tà**ba* 'I/he used to sing', *can**tá**bamos* 'we used to sing', *can**tà**ste*'you sang', *can**tà**steis* 'you-PL sang', *can**tà**ra* 'I/he sang-SUBJ, *can**tá**ramos* 'we sang-SUBJ', *can**tà**se* 'I/he sang-SUBJ', *can**tá**semos* 'we sang-SUBJ', *can**tà**re* 'I/he sing-FUTSUBJ', *can**tá**remos* 'we sing-FUTSUBJ'). By contrast, non verb-stress (stress in nouns, adjectives, adverbs, and indeed all remaining word types) looks less principled: word final (*me**nú*** 'menu'), *ani**màl*** 'animal'), penultimate (*ca**mì**no* 'way', *ca**ní**bal* 'canibal') or antepenultimate (***pá**rrafo* 'paragraph', *hi**pér**baton* 'hyperbaton'), for no apparent reason. Also, the role of syllable weight is not obvious: cf. e.g. *Fró**mis**ta*, a place name in Old Castille, or *Wà**shing**ton*, but **có**loi**de*, **cón**tin**uo***, **pér**sia**na* (cf. *co**lòi**de* 'colloid', *con**tì**nuo*** 'continuous', *per**sià**na* 'window blind').

Faced with these riches, it is little wonder that a variety of proposals, at loggerheads on specific points, have over the decades appeared in the literature.[4] Such proposals share the characteristic of partial data coverage, deliberately and explicitly in some cases. Data shortfall obviously risks vitiating the analysis at root. We set out to remedy this shortcoming here, by bringing in as many data as is possible in the present context. This includes, not only stress data, but, crucially, syllabification data also. For clarity of presentation, the matter is approached step by step, from the simpler to the more complex. Space restrictions force us to limit the discussion to non-verb stress, in the event the more challenging, as we have just seen.

The gist of the results we will achieve is as follows. Two alignment constraints pull stress towards the right edge of the morphological stem, with varying degree of success. A number of factors influence foot size: (1) the pre-eminence of FtBin-Max$^{\sigma}$ and FtBin-Min, the latter with lexically restricted scope; (2) the σ or μ setting of FtBin-Min; (3) the parse of abutting vowels, controlled by the relatively high ranking of Onset, crucially outranked by MaxPk. As a result of all these factors, the three-syllable

2. This divide is not always acknowledged in the literature. Harris (1989), for instance, asks (rhetorically) in the title "How different is verb stress in Spanish?", answering at the close of the paper: "Not at all" (p. 257). Likewise, in Harris (1995) a single algorithm is shared by verbs and non-verbs in all but quantity sensitivity and stress bearer projection, significantly at the cost of lesser data coverage.

3. "Mostly" because of the final stress in the 2nd pl (*camináis* 'you-PL walk', *caminéis* 'you-PL walk-SBJ', *vivís* 'you-PL live'). We do not have space to go into this issue here.

4. Harris (1995) supplies references up to 1995 (see in particular his note 2 on p.885). Later contributions include Lipski (1997), Roca (1997a, 1999 [in a broader Romance context], 2005c), Piñeros (2000a, 2000b), Bárkány (2002a), and Oltra-Massuet & Arregi (2005). See also note 50.

window can shrink down to two or even one syllable, and contain from a minimum of one to a maximum of four vowels.

The structure of the paper is as follows. Section 1 provides the OT machinery responsible for the basic structure of Spanish non-verb stress: a set of ranked constraints that account for the three co-existing alternative stress patterns (oxytone, paroxytone and proparoxytone) and their respective levels of markedness. Section 2 focuses on the syllabification of abutting vowels and their effects on stress location, involving narrowing of the three-syllable window. Indeed, the vowel syllabification in question leads to the redefinition of the stress bearers as vowels, instead of syllables (i.e., syllable heads). Section 3 examines incoming foreign data in conflict with this resetting: this situation suggests the validity of both values (syllables and vowels), in two different lexical sets, foreign and native, respectively. Finally, in Section 4 the paper is summarised, and some conclusions are drawn.

1. Forms with no abutting vowels

For ease of presentation, we shall first consider forms with no abutting vowels. Forms with abutting vowels are examined in Section 2.

1.1 Patterns

Spanish non-verbs can be V- or C-ending, each with one of three stress patterns, O#, PO#, and PPO#,[5] as exemplified in (1), where, in the interest of economy, only a handful of (fully representative) forms are supplied for each pattern. The reason for the separation of the *-Vs* and *-C* endings will become clear presently:

(1)

O#	V-ending:	*sofá*, *carné*, *café*, *bisturí*, *dominó*, *menú* 'sofa, ID card, coffee, scalpel, (game of) dominoes, menu'
	Vs-ending:	*feligrés*, *ciprés*, *ananás*, *trasdós, anís*, *mentís*, *autobús* 'parishioner, cypress, pine apple, extrados, aniseed, denial, bus'
	C-ending:	*sutil, candor, amén, tapiz, animal*, *corcel, postrer, bazar* 'subtle, candour, amen, tapestry, animal, steed, last, (toy) shop'
PO#	V-ending:	*mofa*, *carne*, *pistola, sabana, albaricoq<u>e,*[6] *pomada, borrego* 'mockery, meat, hand gun, savahna, apricot, ointment, lamb'
	Vs-ending:	*cutis*, *colitis*, *hipnosis*, *Aquiles*, *iris*, *tenis*, *mecenas*, *cosmos* '(facial) skin, colitis, hypnosis, Achilles, iris, tennis, patron, cosmos'

5. O = oxytone; PO = paroxytone; PPO = proparoxytone; PPPO = preproparoxytone. '#' denotes computation of the stress locus from the end of the word.

6. The <u> of <qu> has no phonetic counterpart, and accordingly it will be thus marked where necessary to prevent possible misunderstanding. The digraph <qu> stands for [k], normally thus spelled before *i*, *e*, where <c> stands for [θ] or [s] (as a function of geographical accent): the letter <k> is generally not used in Spanish autochthonous or nativised forms.

	C-ending:	*útil, cóndor, crimen, lápiz, caníbal, cárcel, cráter, alcázar* ‘useful, condor, murder, pencil, cannibal, prison, crater, (Moorish) fortress’
PPO#	V-ending:	*epístola, sábana, nómada, lóbrego, lúgubre, vástago, sinécdoq<u>e* ‘epistle, bed sheet, nomad, gloomy, lugubrious, off-spring, synecdoche’
	Vs-ending:	*tétanos*, *efemérides*, *intríngulis*, *análisis, exégesis, ósmosis*, *Hércules*, *Sócrates*, *Géminis* ‘tetanus, event anniversary, tricky aspect, analysis, exegesis, osmosis, Hercules, Socrates, Gemini’
	C-ending:[7]	*régimen, espécimen, ínterin, ómicron, Júpiter, hipérbaton* ‘regime/diet, specimen, interim, omicron, Jupiter, hyperbaton’ *Washington, Manchester, Nuremberg (*German *Nürnberg), Heidelberg, Dusseldorf (*German *Düsseldorf), Amsterdam, Rotterdam, Parkinson*

There are clear markedness differences between these patterns: PPO# is supermarked (SM) in $C^{\neg s}$-ending forms ($C^{\neg s} \neq s$), and marked (M) in V(s)-ending forms; PO# and O# are marked (M) or unmarked (U), also as a function of the word's ending. This markedness ranking, commonplace in the literature, has robust empirical support. First, the unmarked patterns affect a crushing majority of Spanish native words, as testified by the following percentages from an electronic search on 91,000 words (Núñez Cedeño & Morales-Front 1999: 211): (1) -V# PO# = 88%, -C# O# = 97.80 %; (2) -V# PPO# = 11.10%, -C# PO# = 2.03%; (3) -V# O# = 0.87, -C# PPO# = 0.05%. Second, non-lexical items tend to show up with the unmarked patterns: cf. household trade names like *Adìdas*, *Colgàte*, *Palmolìve*, *Profidén*, *Paracetamòl*, *Okàl*, *Arièl*, acronyms like FÌFA, ÒNU, ÙSA, NÀTO, SÌDA, RÈNFE, UNÈD, INÈF, INÈM, CEPÀL, and so on. Third, imitation and elicited speech tests on a group of 50 3–5 year old Mexican-Americans revealed an inverse correlation between rate of children's performance errors and markedness (Hochberg 1988). Fourth, in an experiment reported in Waltermire (2004), involving 41 native speakers assigning stress to 60 nonce written words, V-ending words showed a significant tendency to PO stress (78.26%), and C-ending words to O stress (73.19%). Fifth, as Harris (1975:60) appositely observes, "the official orthography — one of the best in the world — leaves [V-ending] penultimate [and most C-ending final] stress unmarked but marks stress in all other positions".

The markedness taxonomy that stems from these facts is tabulated in (2), where we temporarily ignore the special behaviour of the *-Vs#* subset of *-VC#*:

(2)

	-V#	-C#		
PPO#	M	SM	*epístola*	*hipérbaton*
PO#	U	M	*pistòla*	*caníbal*
O#	SM	U	*menú*	*animàl*

7. The *régimen*-headed subset includes learnèd Latin forms officially incorporated in the Spanish lexicon, and the *Wàshington*-headed subset foreign words (essentially, Germanic proper nouns) in present colloquial use.

We do not have space here to review the various proposals made in the literature to account for (typically only some of) these patterns.[8] Instead, I shall highlight two facts that I believe are uncontroversial: (1) the word-final vowel (possibly followed by *s*, hence the *-Vs* division in (1)) is often a (partly gender-related) inflectional ending to be referred to here as 'the desinence' (D), the remainder of the word being 'the stem' (S);[9] (2) D, if present, is stressless, without exception. When account is taken of such D stresslessness, the paradigms in (2) above can be rationalised as in (3) ('ʼ]' signals the right S boundary), now with *-Vs* included and with O# reclassified as U, appropriately, as we will see:

(3)	PPO]	SM				*hipérbaton*]	
	PO]	M	*epístol*]*a*	*ósmos*]*is*		*caníbal*]	
	O]	U	*pistòl*]*a*	*hipnòs*]*is*	*anís*]	*animàl*]	*menú*]

It can be noticed that once the domain of Spanish stress distribution (NB not necessarily of the 3σW) is defined as S, markedness becomes context-free, and its expression thus simpler and more transparent. This gives a strong hint that the relevant criterion for markedness concerns the position of the stress in the stem, not in the word.

Three questions arise next: (1) why is D always stressless?; (2) why is stress 'mobile' within S?; (3) why are all SM forms C-ending? These questions are best answered in a panchronic context.

1.2 Historical flashback

Spanish is of course evolved Latin. The facts of Latin stress are well known, and can be summarised as follows (see Roca 2005c for a more detailed presentation): (1) never O# (in words with more than one syllable); (2) PO# if the penult is heavy (also in all disyllables); (3) PPO# otherwise. A common pre-OT analysis of these facts (in Halle & Vergnaud 1987, for instance), involves: (1) last syllable extrametricality; (2) heavy syllable 'accenting' (= lexical stressing, in effect); (3) construction of a left-headed quantity-sensitive word-rightmost foot. A tentative OT rendering would be as in (4) (cf. Apoussidou & Boersma 2003:122):[10]

---

8. Some such review is undertaken in Roca (2005c).

9. The Spanish S-D divide is familiar, and will not be discussed here. Awareness of it is long-standing: cf. e.g. Saporta 1959, 1962, in a taxonomic morphological context. It was brought to bear on stress in Hooper & Terrell (1976), and is further discussed in, among others, Harris (1980, 1983, 1985, 1991a, 1992, 1999), Klein (1989), Roca (1989, 1997, 1999, 2005b, 2005c), Morin (1999), Colina (2003a), Roca & Felíu (2003), Oltra-Massuet & Arregi (2005), and Bermúdez-Otero (this volume), to which sources the interested reader can refer. Note that D is denoted by a variety of terms in the literature, including 'gender vowel', 'theme vowel', 'class marker', 'word marker', 'terminal element', and 'form-class morpheme'. Crucially, D cannot simply be identified with -V(s)#, despite the frequent overlap: the motivation for D is morphological, not phonological.

10. FtBin is to be interpreted at this point as a requirement of exactly two moras in the foot. Definitions of the other constraints (or of closely related variants) are provided below: see (6) for Al-Σ, (7)

(4) *calidum* 'hot-ACC', *amorem* 'love-ACC', *amor* 'love-NOM', *amo* 'I love'

	TROCH	NONFIN	FTBIN	AL-Σ#	WSP	PARSEσ
☞(càli)dum				*	*	*
ca(lì)dum			*!	*	*	**
ca(lìdum)		*!	*		*	*
cali(dùm)		*!				**
☞ a(mòː)rem				*	*	**
(àmoː)rem			*!	*	*	*
amoː(rèm)		*!			*	**
☞ (à)mor			*	*	*	*
(àmor)		*!	*		*	
a(mòr)		*!				*
☞ (à)moː			*	*	*	*
(àmoː)		*!	*		*	
a(mòː)		*!				*

Now, three facts characterising the passage from Latin to Spanish are of critical consequence to modern Spanish stress: (1) the Latin stressed syllable overwhelmingly remains so in Spanish, a generalisation we shall for ease of reference dub 'Law of Stressed Syllable Constancy' (*c**à**lidum* > *c**à**ldo* 'broth'; *am**ì**[ː]cum* 'friend' > *am**ì**go*, *am**ò**[ː]rem* 'love' > *am**ò**r*);[11] (2) Spanish Ds correspond to Latin (accusative) case endings, which, being in the word's final syllable, were invariably stressless (*càli**dum***, *amì[ː]**cum***); (3) the Latin vowel quantity opposition was lost, with long vowels becoming short (Lat *am**i**[ː]cum* > Sp *am**i**go*). These three facts had important effects on the Spanish metrical system. Thus, from 2 it follows that the Spanish D is never stressed. From 1 it follows that the word's final syllable can be stressed in Spanish, following deletion of the Latin final vowel ('apocope': *amò**re(m)*** > *am**ò**r*).[12] From 3 (and 1) it follows that Spanish stress can be S-final (whether O# or PO#) even in a light syllable (in effect an open syllable: *am**ì**.g*]*o*). The situation is summed up in (5):

for PARSEσ, (10) for TROCH, (16) for NONFIN, (54) for WSP.

11. The situation is summed up thus in Menéndez Pidal (1962:36, §5bis): "El acento se mantiene inalterable desde el tiempo de Plauto, de Horacio, de Prudencio, hasta el de Cervantes y hasta el nuestro, informando como un alma a la palabra, […] a pesar de los cambios más profundos que sus demás elementos puedan sufrir" [Stress remains unaltered from the time of Plautus, Horatius, Prudence, until the time of Cervantes and our own, informing the word as a soul, […] in spite of the more profound changes its other elements may undergo].

12. Also following the subsequent introduction of V-ending Os from other languages, French mainly (*sofá* 'sofa', *menú* 'menu', *chalé* 'country-like house', *buró* 'writing desk', etc.), but also Arabic (*alhelí* 'wall flower', *carmesí* 'crimson', *zahorí* 'diviner', etc.), Romani (*gachí* 'bird/broad', *parné* 'dough (=money)'; *cañí*, *caló*, *calé* all 'gypsy', etc.), Amerindian (*ñandú* 'rhea', *ají* 'chilli', *maní* 'peanut'), Turkish (*pachá* 'pasha'), etc. Crucially, these forms were not assimilated to the Spanish U PO# pattern associated with V-ending words, in contrast with what tends to happen in English, mutatis mutandis: cf. Eng *sòfa*, *mènu*, *chàlet*, *bùreau*, *pàsha*, etc.

(5)

	Latin	Spanish
D stressless	yes	yes
	*amì[ː]c]**um***	*amìg]**o***
σ# stress status	stressless	stressless or stressed
	*amì[ː]**cum**, amò[ː]**rem**, à**mor***	*amì**go*** vs. *am**òr***
σ]X# stress status	stressed iff heavy	stressed or stressless
	*am**ì**[ː]c]um* vs. *c**àlid**]um*	*am**ìg**]o* vs. *c**álid**]o* 'hot'

The position we have now reached enables us to appreciate that a suitable formulation of Spanish stress requires incorporating: (1) systematic D stresslessness; (2) S-final stress unmarkedness; (3) S-penultimate stress markedness.

We shall implement exclusion of the desinence from the Spanish metrical domain by requiring alignment of the foot and the stem right boundaries, as follows:

(6) Al-Σ] "ALIGN(Foot, Stem)-Right"
The right edge of any foot (Σ) coincides with the right edge of the stem (])

The introduction of Al-Σ] has two highly desirable consequences: (1) limiting Spanish metrical feet to one per word;[13] (2) right-aligning such a foot with S, thus in effect making D extrametrical. This is illustrated in tableau (8) below, where feet are provisionally left open on the left, pending completion of the metrical procedure we are introducing. The competition is between Al-Σ] (6) and Parseσ (7), which encourages footing. Because of the temporary informal left-open feet, only failure to parse D is in effect scored at this point. Stress bearers are given in bold, for ease of recognition:[14]

(7) Parseσ
Syllables (σ) are parsed into feet

(8) *albaricoq<u>e* 'peach'

	Al-Σ]	Parseσ
☞ albari**co**)q<u>]**e**		*
albari**co**)q<u>]**e**)	*!	
alba)ri**co**)q<u>]**e**	*!*	*

We can see that, with D thus outside the domain of Spanish metrification, its stresslessness falls out automatically (see, however, the paragraph under (19) on p. 250 below).

13. As in the rest of the paper, we are concerned here with the 'lexical level' of the phonology, not with the 'postlexical level' where secondary stress (with the concomitant additional footing) may be assigned. For the status of levels in OT, see note 19. Spanish secondary stress is discussed, among others, in Roca (1986), Harris (1991b), Scharf et al. (1995a, b), Prieto & van Santen (1996), Díaz-Campos (2000).

14. We are computing violations of alignment constraints gradiently, in line with tradition. McCarthy (2002) puts forward an alternative interpretation, according to which all constraint violations are computed categorically. Gradient computation will be seen to play a decisive role in evaluations (33) and (46) below (also in (59), less relevantly).

1.3 Unmarked vs. marked stress

Two of our questions still remain unanswered. They relate to (1) the mobility of stress within S, and (2) the segmental shape of SM forms, at the moment all C-ending.

Among the possible answers to (1) is the postulation of a trochee vs. iamb opposition (e.g. *e(písto)l*]*a* vs. *(pistò)*]*a*). However, here we shall assume that the Spanish foot is consistently trochaic, in line with much of the literature and on evidence from: (1) SM stress (*hi(pérba)ton*, *(régi)men*, etc. ostensibly necessitate a non-final trochee); (2) truncation, both ordinary (*colègio* > *còle* 'school', *micrófono* > *mìcro* 'microphone', *bolígrafo* > *bòli* 'ball pen'; cf. also *proletàrio* > *prolèta* 'proletarian', *anarquìsta* > *anàrco* 'anarchist', *manifestación* > *manìfa* 'demonstration', *masoquìsta* > *masòca* 'masochist', *pegatìna* > *pegàta* 'sticker'), and hypochoristic (*Mercèdes* > *Mèrce*, *Terèsa* > *Tère*, *Remèdios* > *Rème*, *Geràrdo* > *Gèrar*, *Fernàndo* > *Fèrna(n)*; also *José* > *Jòse*, most tellingly): cf. Prieto (1992a), Lipski (1995), Colina (1996b), Piñeros (2000a,b), Felíu (2001); (3) secondary stress, at least according to Harris (1991b) (cf. constructions like *(ˌ**para**) (ˈti)* 'for you', with the clitic *para* trochaic: not **(paˌ**ra**) (ˈti)*, with an iamb); (4) some diminutive formation, claimed to operate on bisyllabic bases, also trochaic (*sol* 'sun' → *(ˌ**sole**)(ˈcito)*, not *so(ˈlito)*: Crowhurst 1992, Prieto 1992b; Harris 1994 and Colina 2003, however, dispute the analysis).

The Spanish preference for S-final stress (i.e. O] = U) suggests intervention of an (eventually low-ranking, but still fully active) constraint Al-V́] (Cohn & McCarthy 1994 make an analogous proposal for Indonesian):

(9) Al-V́] "ALIGN(Stressed V, Stem)-Right"
The stressed vowel (V́) is last in the stem (])

The joint action of Al-Σ] (6), Al-V́] (9) and Troch (10) below yields degenerate, rather than binary, feet in U forms like *pistòla*, *animàl* or *menú*, FtBin$^{\sigma}$min (11) therefore being irrelevant to the corresponding evaluations, displayed in (12):

(10) Troch "Trochee"
Feet are left headed

(11) FtBin$^{\sigma}$min "Minimal foot binarity"[15]
Feet are minimally binary (in terms of syllables)

15. The split of FtBin into FtBinmin and FtBinmax is argued for in Hewett (1994). As is well known, Prince & Smolensky (1993) allow for syllabic or moraic computation of FtBin, parametrically. Our superscripted σ makes it explicit that the computation being adopted is syllable-based.

(12) *pistola* 'pistol', *animal* 'animal', *menú* 'menu'

	Troch	Al-Σ]	Al-V́]	Parseσ
☞ pis(tò)l]a				**
(písto)l]a			*!	*
(pistò)l]a	*!			*
pis(tòl]a)		*!		*
☞ ani(màl)]				**
a(nímal)]			*!	*
a(nimàl)]	*!			*
a(ní)mal]		*!	*!	**
☞ me(nú)]				*
(ménu)]			*!	
(menú)]	*!			

PO] stress in forms like *epístola* 'epistle' or *caníbal* 'cannibal' obviously calls for a binary trochee: *e(písto)l*]*a*, *ca(níbal)*], an outcome we shall implement with a high-ranking FtBin$^{\sigma}$min. On the face of it, thus, the opposition U vs. M stress requires reverse rankings for FtBin$^{\sigma}$min and Al-V́], a stand (with equivalent constraints) indeed at times taken in the literature: cf. Rosenthall (1994), for instance. However, such double ranking seems undesirable, on account of formal complexity and, more importantly, learnability. Accordingly, we shall adopt a single ranking FtBin$^{\sigma}$min >> Al-V́], with the scope of FtBin$^{\sigma}$min crucially bound to a lexical class we shall identify by a diacritic *, hence FtBin$^{\sigma}$min*, as in (13) below.[16] Note in particular that there is no way to earmark the Spanish PO] class in a principled fashion, in contrast to Latin, where the trigger could be defined phonologically, viz., as a light word penult:

(13) FtBin$^{\sigma}$min* "Minimal foot binarity"
Feet are minimally binary (in terms of syllables)

The overall ranking now runs as in (14), with Al-V́] appositely downgraded below both Al-Σ] (cf. **epis(tòl*]*a)* ≺ *e(písto)l*]*a*) and FtBin$^{\sigma}$min* (cf. **epis(tò)l*]*a* ≺ *e(písto)l*]*a*).

(14) Troch, Al-Σ], FtBin$^{\sigma}$min* >> Al-V́], Parseσ

The evaluations in (15) below, with the appropriate lexical mark * in the input, illustrate. Note, importantly, that here and elsewhere we are assuming that an undominated FtBin$^{\sigma}$max prevents feet of more than two syllables. For convenience, we shall assume integration of FtBin$^{\sigma}$max in GEN, along the lines of Hyde's (2002:318) 'Foot Cap' condition. The undominated constraint Troch will be omitted from tableaux henceforth, as will low-ranking Parseσ, which plays no significant role in these or other evaluations:

16. Arguments for lexically-bound singly ranked constraints can be found in Smith (2001), for instance.

(15) *epístola* 'epistle', *caníbal* 'cannibal'

*	AL-Σ]	FTBIN$^{\sigma}$min*	AL-V́]
☞ e(písto)l]a			*
epis(tò)l]a		*!	
epis(tòl]a)	*!		
☞ ca(níbal)]			*
cani(bàl)]		*!	

FTBIN$^{\sigma}$min* is obviously irrelevant to O] forms (= U), by definition lacking the * marking (compare the evaluations in (12) above). Also to desinenced words with less than three syllables, where * would simply be inconsequential, lexicon optimisation therefore promoting a simpler lexical representation without it.

The simple model just sketched provides a principled account of (1) all the native data (both patrimonial and learnèd),[17] and (2) V-ending O# forms subsequently incorporated into the Spanish lexicon. Importantly, the claim frequently made in the literature that these words are exceptional, indeed extragrammatical unintegrated loans, flies in the face of readily accessible everyday reality. Whitley (1976:318) provides a list of 71 such forms, and the gentilic suffix *-í* enables ad libitum multiplication (*bengalí* 'Bengali', *magrebí* 'Maghribi', *marroquí* 'Moroccan', *israelí* 'Israeli', *iraní* 'Iranian', *ceutí* 'from Ceuta', *marbellí* 'from Marbella', etc.). A quick check through the RAE dictionary yielded *ambigú* 'cinema refreshments hall', *menú* 'menu', *sofá* 'sofa', *buró* '(small) writing desk', *tisú* 'tissue', *maná* 'manna', *corsé* 'corset', *chalé* 'plush rustic-looking dwelling house', *carné* 'ID card', *tabú* 'taboo', *cebú* 'zebu', *champú* 'shampoo', *ñandú* 'rhea', *caribú* 'caribou', *grisú* 'firedamp', *alhelí* 'wallflower', *carmesí* 'crimson', *potosí* [*valer un* …] 'to be worth a million', *organdí* 'organdie', *maravedí* 'maravedi [an old coin]', *gachí* '[slang] bird/broad', *jabalí* 'boar', *borceguí* a type of walking book, *colibrí* 'humming bird', *frenesí* 'frenzy', most of them likely in the lexicon of the average Spanish speaker, and many in common use. There are also many proper nouns (*Belcebú* 'Beelzebub', *Mambrú* 'Mambrou', *Perú* 'Peru', *Alí* 'Ali', *Alcalá* town name, *José* 'Joseph', *Noemí* 'Naomi'), including some hypochoristic blends (cf. *Mariví* ← *María* 'Mary' + *Victoria* 'Victoria', *Marifé* ← *María* 'Mary' + *Fé* 'Faith'). Significantly, ordinary native speakers do not hold feelings of oddity with respect to these words. Indeed, their shape predominates in the early language, with frequent apparent iambs like *mamá* 'mummy', *papá* 'daddy', *pipí* 'weewee', *popó* 'car', etc.: a very young relation of mine actually made up *Tití*, *Totó*, *Tutú* to permanently name specific members of the family. The deliberate exclusion of the set from some analyses is therefore unwarranted, and fully circular: it is excluded simply because it does not fit the analysis.

17. 'Patrimonial' forms lived on orally from (Vulgar) Latin, whereas 'learnèd' forms joined the Spanish lexicon directly from Classical Latin through the written medium. Accordingly, learnèd items are exempt from most of the phonetic changes historically undergone by their patrimonial counterparts.

1.4 SM forms

The last issue pending concerns SM forms, which (at least at the moment) are all $C^{\neg s}$]#-ending PPO]#, thus with no D: *régimen*]#, *ómicron*]#, *hipérbaton*]#, *Júpiter*]#, *espécimen*]#, etc. Our present procedure cannot retract stress beyond the stem penult, and consequently we bring in a constraint NonFin** associated to this lexical class (**):

(16) NonFin** "Non finality"
Any foot is not word-final.

NonFin** needs to be undominated, crucially outranking Al-Σ], which it does by Panini's Theorem. Note that the marking ** necessarily entails * empirically, since ** would be useless in the absence of *, as demonstrated by candidate c. **re(gì)men* in (17):[18]

(17) *régimen* 'regime, diet'

**	NonFin**	FtBin$^{\sigma}$min*	Al-Σ]	Al-V́]
☞ (régi)men]#			*	**
re(gìmen)]#	*!			*
re(gì)men]#		*!	*	*
regi(mén)]#	*!	*!		

The plurals of such SM forms are potential 3σW infringers, given that the postconsonantal plural allomorph *-es* adds one syllable to the singular. This problem is typically overcome through rightward stress movement. The shift is minimal in *régimen*, which pluralises *regímenes*, prescriptively and usually.[19] However, minimal stress shift does not appear to be the most common solution, PO# plurals turning up more often, thus

18. Formalisation of this entailment falls beyond our present remit. Its logical connection with Panini's Theorem is, however, worth noting. In particular, as pointed out in Roca (1994), the Elsewhere Condition/Panini's Theorem is but a logical condition on learnability: should the more general rule (or constraint) precede (outrank) the more specific one, no empirical evidence for the more specific rule/constraint would be available to the learner. Likewise, a marking ** without * would be empirically equivalent to a marking * without ** (compare candidate c. *re(gì)men* in (17) with candidate b. *re(gìmen)*). Therefore, ** would be unlearnable.

19. An obviously 3σW-violating plural *régimenes*, heard erratically and truly occasionally, is suggestive of impromptu on-line realisation. This output seemingly implies domination of output-output [O-O] prosodic head faithfulness over the constraints responsible for the 3σW. Alternatively, plural formation (here with its extra syllable) could be assigned to a stratum ordered later than the stress stratum, stress thus remaining unaffected. This latter approach is of course incompatible with the absolute parallelism advocated in mainstream OT, but this stand has been questioned in Booij (1997), Rubach (1997, 2000, 2005), Kiparsky (2003), Roca (2005a), among others. On the other hand, while well established generally, O-O constraints must arguably be reserved for genuine surface-to-surface relations, and thus kept out of correspondences most plausibly involving lexical inputs. From this perspective, O-O faithfulness constraints would be disfavoured for Spanish plurals, indeed in step with the general facts: cf. overwhelmingly predominant *régimen* → *regímenes*, *ómicron* → *omicrònes*, etc.

hinting at emergence of the unmarked:[20] *omicr**ò**n*]*es*, *hiperbat**ò**n*]*es*, *Jupit**è**r*]*es*, etc.[21] The immediate question is whether and how the procedure we have in place achieves this PO# plural pattern.

PO# plural stress here in fact falls out from our present ranking, provided that NonFin** is reinterpreted as an anti-alignment constraint relating to S, rather than to the word:[22]

(18) ¬Al-Σ]** "¬ALIGN(Foot, Stem)-Right**"
A foot (Σ) and a stem (]) are not right-aligned

In particular, as (19) shows, a parse *omi(cròn*]*es)*, with an Al-Σ] violation, is favoured over **o(mícro)n*]*es*, which violates higher-ranking ¬Al-Σ]**. **Omi(crò)n*]*es*, in addition, violates also high-ranking FtBin$^{\sigma}$min*, as does **o(mí)cron*]*es*, while **(ómi)cron*]*es* decisively scores worse on Al-V́]:

(19) *omicrones* 'omicrons'

**	¬Al-Σ]**	FtBin$^{\sigma}$min*	Al-Σ]	Al-V́]
☞ omi(cròn]es)			*	
o(mícro)n]es	*!			*
o(mí)cron]es		*!	*	*
omi(crò)n]es	*!	*!		
(ómi)cron]es			*	*!*

Al-Σ] is thus not inviolable: indeed, it cannot be, since it is dominated. It is the joint effect of dominated Al-Σ], also dominated Al-V́] (cf. **ri*](*ó)* in (50) below) and undominated Troch (cf. **omi(cron*]*és)*) that ensures the consistent stresslessness of D.

The account of the default plural stress pattern of *ómicron* ~ *omicrònes* just offered raises the question of how *régimen* ~ *regímenes* is accommodated. In (17) above we saw

20. There can be vacillation and insecurity among speakers here, unsurprisingly. Note that Saltarelli's (1997) *omícrones* appears to be a gratuitous extrapolation from *regímenes*, on a free interpretation of the singulars listed in Roca (1990:149). Harris (1983:131) gives *omicrònes*.

21. There is frequent interference of prescription here. For instance, RAE (1973:182) mentions *especímenes* alongside *regímenes*, recommends *hipérbatos* (NB without *-es* and with *n* drop), from *hipérbaton*, and so on. All this is E-language, however. My claim is that *hiperbatònes*, *omicrònes*, etc. are likely to come out spontaneously from the singulars themselves, without outside prompting, and thus tap I-language in the sense of Chomsky (1986 et seq.). The comment obviously carries over to *régimen*. Here, however, the widespread use of the plural *regímenes* suggests that the prescriptive pattern has worked its way into the internalised lexicon of (most) speakers.

22. Anti-alignment is appealed to in Vachon's (1996) analysis of Russian stress, for instance. Conceptually, anti-alignment parallels Alderete's (2001) anti-faithfulness, in another domain. Indeed, NonFin constitutes an obvious instantiation of anti-alignment, related to the word boundary, viz. ¬Al-V́#. Accordingly, it is reasonable to construe ¬Al-Σ] as equivalent to NonFin in the stem domain. Compare in this connection Roca's (2005c) extension of the scope of Halle & Idsardi's (2005) Edge Marking parameter beyond the word edge, to the stem. Indeed, Oltra-Massuet & Arregi (2005) favour countenancing association of Edge Marking to <u>any</u> morphosyntactic boundary.

that the *régimen* ~ *regímenes* alternation follows straightforwardly from NonFin**, and consequently we can simply keep this constraint for this set, perhaps reformulating it as ¬Al-Σ#***, in the spirit of note 22. This solution seems preferable to an interpretation of the alternation *régimen* ~ *regímenes* as direct lexical allomorphy, an obvious alternative.[23] Note that the default status associated with the] boundary vis-à-vis # can plausibly be related to the pivotal role of], materialised in Al-Σ] and Al-V́], in the Spanish stress system.

1.5 The formal motivation of the 3σW

The model we have constructed automatically explains why inputs in violation of the 3σW are not reproducible by Spanish speakers. Consider forms with stress four syllables from the word end in the original (stress-initial) languages, e.g. *Schèveningen*, a Dutch seaside resort, *Bràtislava*, the capital of Slovakia, *Kàlevala*, the Finnish national epic, etc. Common-or-garden Spanish speakers are normally unable to reproduce these patterns.[24] As shown in the evaluation of *Kalevala* in (20), the impossibility of such PPPO# stress falls out from our present machinery. We naturally assume a lexical mark **. Also a D parse for the last *a*, advantageously: parsing final *a* in S would make preservation of input PPPO# stress even more awkward formally, since it would induce one further violation of Al-V́].

(20) (Finnish) *Kàlevala*

**	¬Al-Σ]**	FtBin$^{\sigma}$min*	Al-Σ]	Al-V́]
☞ Kale(vàl]a)			*	
(Kále)val]a			*	*!*
Ka(léva)l]a	*!			*
Kale(và)l]a	*!	*!		

It can be seen that the PPPO source is not formally replicable, matching empirical reality. Significantly, this outcome shows that unbridled stress mimicry is not available to Spanish speakers (cf. also note 24), contra a trend of opinion nicely encapsulated in the following citation: "Unshifted stress in loan words tells us absolutely nothing about the rules internalised by borrowers; all we learn is that mimicry of foreign stress patterns is possible" (Harris 1992:17–18).

Rather than literally mimicking, Spanish speakers at best place stress as far left as is consistent with the 3σW. Compare for instance a possible alternative realisation of Finnish *Kàlevala* as Spanish *Kalévala*, which plausibly involves drop of the ** lexical

23. The isolate *carácter* ~ *caractères* (NB not **carácteres*) 'character(s)', with a clearly prescriptive plural, could in principle be given a parallel analysis, with the constraint Al-Σ] replaced (formally, outranked) by Al-Σ#. However, both the isolation of the pair and the frequent occurrence of *carácteres* in relaxed speech arguably point to lexical suppletion here.

24. The basis for this claim goes beyond strong intuition and unfettered casual observation. As a for instance, English-learning Spanish speakers are known systematically to shift the stress in English PPPO forms like *category*, *mercenary*, *catamaran*, and so on, presumably against their conscious will to imitate the correct models.

mark with retention of *, a natural simplification process leading precisely to stress as leftmost as allowed by the Spanish metrical system.[25] This type of output is readily attested in the English place name *Canterbury*, maximally PPO on Spanish-speaking lips: *Cantèrbury*, not PPPO **Cànterbury*. Revealing in the same connection are also PO# pronunciations of source O# disyllables, e.g. *Mà<a>stricht* (< Dutch *Maastrìcht*) or *Àrtur* (< Catalan or Portuguese *Artùr* 'Arthur').[26] All this takes place irrespective of the source locus, of which Spanish speakers are normally unaware.

We revisit the important matter of mimicry in §2.4.2 below, turning now our attention to the effects of abutting vowels on the Spanish stress window.

2. Effects of abutting vowels

2.1 The 3VW#

Tautosyllabic abutting vowels induce narrowing of the 3σW#. Comparison of the forms in (21a) with their correspondents in (21b) illustrates the point:

(21) a. *mi.llón*], *hòs.ti*] *a*, *mé.ri.t*] *o*, *lá.pi.d*] *a*, *a.cró.ba.t*] *a*, *púr.pu.r*] *a*, *Hér.cu.l*] *es*
'million, host, merit, gravestone, acrobat, purple(N), Hercules'

b. *mi.llo.n-à.ri*] *o*, *hos.ti-à.ri*] *o*, *me.ri.t-ò.ri*] *o*, *la.pi.d-à.ri*] *o*, *a.cro.bà.c-i*] *a*, *pur.pú.r-e*] *o*, *her.cú.l-e*] *o*
'millionaire, wafer box, praise-worthy, lapidary, acrobatics, purple(A), Herculean'

If the Spanish stress bearers (the metrical atoms) were syllables (equivalently, syllable heads), as we have been assuming (cf. FtBin$^{\sigma}$min), this narrowing would be unexplainable:

(22)	**1**	**3** 2 1	**3** 2 1	**3** 2 1
	σ **σ**	σ **σ** σ σ	σ **σ** σ σ	σ **σ** σ σ
	mi.ll**ó**n	*mi.ll**ò**.na.rio	a.cr**ó**.ba.ta	*a.cr**ó**.ba.cia

On the other hand, if the metrical atoms are vowels (i.e. [-consonantal] segments: see §2.2.3 below), the narrowing will follow automatically:

(23)	**1**	**3** 2 1	**3** 2 1	**3** 2 1
	V **V**	V V **V** V V	V **V** V V	V V **V** V V
	mi.ll**ó**n	mi.llo.n**à**.rio	a.cr**ó**.ba.ta	a.cro.b**à**.cia

25. Analogy with *régimen* cannot be ruled out as an alternative. However, it seems reasonable to consider this a less likely option, given the prescriptive nature of the plural *regímenes*, responsible for the metrical autonomy of this form vis-à-vis its default counterpart *omicrònes*.

26. The Christian name of the current leader of the Catalan political federation *Convergència i Unió*, as such frequently spoken in the media.

These facts advise replacement of the 3σW# with a 3VW# (three vowel window), with the Spanish metrical atoms concomitantly identified with vowels. Both these goals are achieved by replacing FtBin$^{\sigma}$min* (13) with FtBin$^{\mu}$min* (24):

(24) FtBin$^{\mu}$min* "Minimal foot binarity"
Feet are minimally binary (in terms of moras = vowels)

We can reasonably assume that the selection of moras (alternatively, syllables) as stress bearers goes hand in hand with the setting FtBin$^{\mu}$ (alternatively, FtBin$^{\sigma}$). In turn, the equation moras = vowels follows from the ranking $V \rightarrow \mu >> {*\mu} >> C \rightarrow \mu$, which we also assume. $V \rightarrow \mu$ requires domination by $*_{ONS}[\mu$, formulated in (27) below, so as to restrict moraic status to rime vowels.

The identification of stress bearers with vowels faces two immediate challenges, and we see to them next.

2.2 Challenges

2.2.1 *The cuV sequence*

The first challenge involves the forms *ventrílocuo* 'ventriloquist' and *alícuota* 'aliquot',[27] with stress on the fourth vowel from the end. The first observation to be made about these forms concerns their learnèdness, or at least their learnèdness with these particular stress patterns. In particular, *ventrílocuo*, the more frequent of the two, tends to be realised as either *ventríloco* or *ventrilòcuo*, both in compliance of the 3VW# (cf. *alicuòta*, equivalently). For the (orthography-bound) realisations *ventrílocuo* and *alícuota*, a principled analysis compatible with the 3VW is still available. In particular, under this analysis, a *u* sandwiched between a velar consonant and a syllable peak parses in the onset, rather than in the syllable nucleus, as we can assume Spanish vowels otherwise do (cf. e.g. Harris 1983, Harris & Kaisse 1999). The constraints in (25) and (26) formally account for the respective situations (H = high vowel, i.e. *u*, *i* in Spanish):

(25) $*_{NUC}[u\ /_{ONS}[C^{velar}$ __ "No nucleus *u* after onset velar C"[28]

---

27. The RAE dictionary also includes *altílocuo*, *grandílocuo*, *magnílocuo*, *somnílocuo*, *vanílocuo*, but these are rarely, if ever, spoken.

28. We cannot probe the desired universal grounds of (25) here. An anonymous reader points to a possible parallel with English, and refers to Davis & Hammond (1995). However, these authors suggest that in English pre-*V Cu* is parsed as a complex onset regardless of the identity of *C*, whereas in Spanish we are limiting the onset parse to <u>post-velar</u> *u*. Note that constraint (25) must obviously be assumed to be dominated in such a way as to allow for the parse $_{ONS}[C^{velar}\ _{NUC}[u$ when no V follows, as in *cír.cu.lo* 'circle', for instance. In Harris (1969), [ku̯o] is analysed as /k^{w}o/, with ^{w} suggestive of a labial secondary articulation on /k/ in current feature theorising (Clements & Hume 1995 and Halle et al. 2000 provide competing formalisms). This analysis obviously disposes of the window problem, as *u* is no longer a vowel, and therefore a stress bearer. However, the solution is ad hoc in the absence of independent evidence for non-skeletal *u* in Spanish. Our approach is more principled, in particular given the possible connection with the (pre-OT) constraint proposed in Carreira (1990) against double skeletal attachment of the feature complex [+R, +B] (number (39) in Carreira 1990:165). On our

The vowel *u* does not parse in the nucleus after an onset velar consonant

(26) *H/Onset "No high vowels in onset"
High vowels do not parse in the onset

The required ranking is (25) >> (26).

In addition, we shall assume that only rime vowels are metrical, as indeed we must on general grounds: cf. Rosenthall's (1994:42) constraint SYLL-SEG ('if rt_i is linked directly to σ, then $*\mu_i$'), best relabelled $*_{ONS}[\mu$, as in (27).

(27) $*_{ONS}[\mu$ "No onset moras"
Onset segments are not linked to moras

$*_{ONS}[\mu$ would seem to be universally undominated, indeed to be part of GEN: the construct 'mora' was brought into metrical theory precisely to formalise the irrelevance of onset material to syllable weight (cf. Hyman 1985, Hayes 1989).

The effects of this machinery are illustrated in (28), with the onset-nucleus boundary informally signalled by '/', and the stress bearers in bold (undominated FtBin$^{\mu}$min* is being assumed):

(28) *ventrílocuo* 'ventriloquist', *alícuota* 'aliquot'

*	$*_{ONS}[\mu$	$*_{NUC}[u/_{ONS}[C_{velar}$ —	Al-Σ]	*H/On	*H/Nu [a]
☞ ven(tr**ílo**)cu/]**o**				*	
ventr**i**(l**ò**c**u**)/]**o**	*!			*	
ventr**i**(l**ò**c/**u**)]**o**		*!			*
☞ **a**(l**í**cu/**o**)]ta				*	
a(l**ícu**)/**o**t]**a**	*!		*!	*	
ali(c/**ú.o**)t]**a**		*!			*
a(l**ícu**/)**o**]ta	*!		*!	*	
ali(cu/**ò**t]**a**)			*!	*	

[a] Only /u/ is being computed here, for simplicity of presentation

Both patterns under discussion are now successfully accounted for by our grammar. Notice that we are allowing the foot's right boundary to cut through the syllable in *ventri(lòcu)/*]***o***, *ventri(lòc/**u**)*]***o***, *a(lícu)/ot*]*a*, *a(lícu/)**o***]*ta*, and similarly in some subsequent tableaux, mutatis mutandis. This contravenes both the Strict Layer Hypothesis [SLH] and the Syllable Integrity Condition of Halle (1990:167). However, our practice is consistent with an autosegmental construal of metrical structure, correspondingly assigned on a plane orthogonal to the syllable plane, albeit connected with it through the stress bearer projection (cf. Halle & Vergnaud 1987, Halle & Idsardi 1995). On this approach, metrical structure is thus simply removed from the prosodic hierarchy. From a perspective loyal to the integrity of the prosodic hierarchy (e.g. Selkirk 1995; also Hayes 1995:121ff, in a different context), the constraint enforcing this aspect of the SLH will obviously need to be low ranking (see Halle & Kenstowicz 1991:29 for

reinterpretation, the ban would be restricted to elements sharing a constituent, hence nucleus *u* and *o*. By contrast, onset *u* + nucleus *o* will by-pass the constraint, as will also onset *ku*, since *k* is not [+R].

related pre-OT discussion). In §2.3, §2.4.1 and §3.1 below, we will see that such a looser interpretation of the relationship between foot and syllable structure is of the essence in the evaluation of WSP (Weight-to-Stress Principle).

2.2.2 *The role of* Onset

The second, more robust, challenge to the 3VW# comes from the *náufrago* class, exemplified in (29) below. Here stress falls on the antepenultimate S vowel, the fourth one from the word end, consistently with the 3σW#, but contra the 3VW#:

(29) *náufrag*]*o*, *náutic*]*o*, *cáustic*]*o*, *Éufrat*]*es*, *cláusul*]*a*, *hidráulic*]*o*, *terapéutic*]*o*
'shipwreck, nautical, caustic, Euphrates, clause, hydraulic, therapeutic'

Our solution will call on the domination of Al-V́] by Onset:

(30) Onset
Syllables have onsets

(31) *náufrago* 'shipwrecked'

*	¬Al-Σ]**	FtBin$^{\mu}$min*	Onset	Al-Σ]	Al-V́]
☞ (náufra)g]o					**
na.(úfra)g]o			*!		*
(náu)frag]o				*!	**
nau(frà)g]o		*!			
nau(fràg]o)				*!	

In a nutshell, the need to satisfy Onset compels a less harmonic output vis-à-vis low-ranking Al-V́] (cf. candidate b). Notice that fulfilment of Al-Σ] presupposes that FtBin$^{\sigma}$max (which we are assuming integrated in GEN) is indeed computed on syllables, as in Hyde's (2002:318) FootCap proposal ("Feet are maximally disyllabic"). Crucially, it is compliance with Al-Σ] that blocks victory of a word-aligned trochee in the style of *omi(cròn*]*es)*:

(32) *náufrago* 'shipwrecked'

*	¬Al-Σ]**	FtBin$^{\mu}$min*	Onset	Al-Σ]	Al-V́]
☞ *nau(fràg]o)				*	
(náu)frag]o				*	*!*
cf. (náufra)g]o				✓	**

The domination of Al-V́] by Onset has further positive consequences. Consider forms like *colòid*]*e* 'colloid' and *caràỳ*] (<y> = [i̯]) 'good heavens!', with stress on the S-penultimate vowel (NB not on the last). On a 3VW, this is of course the M pattern, and therefore all such forms seemingly need to carry the lexical mark *. This development is undesirable for *caràỳ*, whose pattern, overwhelmingly majority, is clearly unmarked: *a.<h>í* is marked (NB <h> is silent), and **càray* absent from the native or assimilated vocabulary.[29] Likewise **cóloide*, plainly unacceptable in ordinary Spanish, thus revealing a systematic gap.[30] We therefore need the patterns in *carày* and *colòide* to come out as formally unmarked, and those in **còloide* and **càray* to be formally ruled out.

The two desired outcomes actually fall out from our present ranking, which crucially includes dominant Onset:

(33) *caray* 'good heavens!', *coloide* 'colloid'

	¬Al-Σ]**	FtBin$^{\mu}$min*	Onset	Al-Σ]	Al-V́]
☞ ca(rài)]					*
cara.(í)]			*!		
car(à.i)]			*!		*
(cára)i]				*!	**
(cárai)]					**!
☞ co(lòi)d]e					*
co(lò.i)d]e			*!		*
colo.(í)d]e			*!		
(cóloi)d]e					**!
(cólo)id]e				*!	**

We are of course assuming that sonority plays its due role in this or any other evaluation. In particular, (1) sonority sequencing needs to be adhered to: tautosyllabic *a̯**í**, with a syllable peak ***i*** lower in sonority than its non-peak sister a̯ is thus illegitimate; and (2) the foot head needs to stand on a syllable head (cf. the HeadBoundary Alignment constraint of Roca 1997b:254, in turn related to the Syllable Integrity Condition of Halle 1990:167): tautosyllabic **a(í̯*, for ***a*** a syllable head and *(í̯* a foot head, is thus also illegitimate. These are general principles of phonological structure (presumably part of GEN), and consequently they must be assumed also to be in force here.

2.2.3 *Lexical peaks*

Forms like *a<h>.í* 'there', *Ema.ús* 'Emmaus', or *A.ída* 'Aida', with hiatus (and a stressed H), are not compatible with our present procedure: cf. *¡ày!* 'ough!', *Manáus* 'Manaus', *àire* 'air', *ràuda* 'swift-fem', which are. Consequently, the procedure needs some readjusting.

These data drag along the vexed issue of 'glides', a term in common use embodying the idea that such segments differ in substance from vowels. However, I have ar-

29. Word-final *-i* is commonly stressed after C: cf. *rubí*, 'rubi', *zahorí* 'diviner', *bisturí* 'scalpel', *colibrí* 'humming bird', *maní* 'peanut', and many others. By contrast, after V word-final [i] (spelled *i* or *y*) is almost invariably stressless (*a.<h>í* is a rare exception): *Uru.guày*, *Para.guày*, *Bom.bày*, *bo.còy* 'vat', *con.vòy* 'convoy', *ca.rày* 'good heavens!', *jer.sèy* 'pullover', *samu.rái* 'samurai', *g<u>iri.gày* 'rumpus', *pai.pày* '(Filipino-style) fan, *bon.sái* 'bonsai', etc. Foreign forms like *hòckey* or *Dìsney* are discussed in §3.1 below.

30. Cf. lawful *Maracàibo* 'Maracaibo', *celulòide* 'celluloid', *prosàico* 'prosaic', *metalòide* 'metalloid', *Adelàida* 'Adelaide', *estòico* 'stoic', *mosàico* 'mosaic', *Pentatèuco* 'Pentateuch', and many such others. Notice the stress shift in e.g. *celulòide* < *célula* 'cell' or *metalòide* < *metàl* 'metal'.

gued elsewhere (cf. Roca 1991, 1997b) that (Spanish) 'glides' do not exist, and are simply vowels. The issue is thus not whether a particular segment is a 'glide' or a vowel: they are all vowels. The issue, rather, is how a particular vowel abutting another vowel syllabifies.

Spanish high vowels abutting another vowel have a strong tendency (NB crucially, not a necessity)[31] to parse tautosyllabically, i.e. to partake in what is traditionally known as a diphthong: in our OT account, this tendency is simply an effect of Onset, as we are seeing. Now, how are *a<h>.í*, *Ema.ús* or *A.ída* justified? The answer is in fact straightforward: OT outputs are the result of antagonistic interplay between faithfulness and markedness. In the present case, markedness favours the pattern in *ày*, *Emáus* and *Àida*. All these forms are perfectly legitimate, indeed unmarked, but they do not match the particular items in hand. The fact that these items contain hiatus thus shows that faithfulness is interfering.

We shall capture this faithfulness interference by means of a lexical syllable peak, along the lines of Roca (1991, 1997b) (cf. also Harris & Kaisse 1999).[32] Clearly, in order for this peak to make it to the surface, it needs protecting by a faithfulness constraint outranking the markedness constraint Onset. Again following Roca (1997b), we shall identify this constraint as Max-Pk, as follows:

(34) Max-Pk "MAX PEAK"
Lexical peaks are surface peaks

The evaluation of *a<h>í* runs as in (35), where the necessary input with the lexical peak vowel flanked by the corresponding informal syllable boundary dot is provided:

(35) *a<h>í* 'there'

.i	¬Al-Σ]**	FtBin$^{\mu}$min*	Max-Pk	Onset	Al-Σ]	Al-V́]
☞ a.(í)]				*		
(ái)]			*!			*
(á.i)]				*		*!

The downranking of Onset we are implementing has no adverse effect on the previous evaluations. However, the lexical peak machinery brings with it a sting. Thus, if lexical peaks always make it to the surface,[33] surface forms in the shape of **à.i*, with stress on the first, more open of two hiatic vowels, ought to be possible. In the evaluation in (35), such an output is ruled out by Al-V́], but it would nonetheless go through on an input /a.i*/:

31. Much of the literature mistakenly assumes this necessity, perhaps because of want of deep acquaintanceship with the data, irretrievable from the spelling.

32. We cannot go into the matter of whether and where such lexical peaks are (at least partially) predictable: some discussion in Roca (1991), Colina (1999), Hualde (1999), Hualde & M. Prieto (2002), Cabré & P. Prieto (this volume).

33. In the single word foot of the 'lexical level', our present matter of concern. Any secondary stress footing in Spanish is postlexical (cf. note 13).

(36) *a<h>í* 'there'

.i*	¬Al-Σ]**	FtBin$^{\mu}$min*	Max-Pk	Onset	Al-Σ]	Al-V́]
a.(í)]		*!		*		
(ài)]			*!			*
☞ *(à.i)]				*		*

Richness of the Base excludes a direct ban on a joint '* plus syllable peak' lexical marking. Indeed, such an input will be seen below actually to be available (see (46) and (47)). Notwithstanding this, forms like **à.i* are, not only non-existent, but seemingly impossible in Spanish (not necessarily in all languages). Roca (1997b:261) formulates the corresponding prohibition as a constraint *V́.H (equivalently in Harris & Kaisse 1999:140).[34] It would be desirable to improve on this brute force approach, but it is not immediately obvious how this can be achieved.

Our tentative solution will involve a positive interpretation of SonFall. In Rosenthall (1994), SonFall embodies a condition on the diphthongisation of vowel sequences ('sonority must fall between tautosyllabic moras'; p. 42). However, this formulation faces at least two challenges. First, it precludes HV diphthongs ex definitione, contrary to fact in Spanish: cf. *piedra* 'stone', *abuelo* 'grandfather', etc. Rosenthall's formal answer to this challenge is questionable on grounds of complexity and arbitrariness, although we do not have space to argue this through here. Second, Rosenthall's SonFall runs into problems with high vowel sequences, which can indeed form falling diphthongs, as illustrated by *mùy* 'very', or *cùita* 'woe' in some accents,[35] against Rosenthall's explicit assumptions.[36]

In our present tentative proposal, SonFall' imposes tautosyllabicity on tautopodal abutting vowel sequences of falling sonority:

(37) SonFall' "Sonority fall (bis)"
Tautopodal abutting vowel sequences of falling sonority are tautosyllabic

SonFall' is undominated in Spanish:

34. The constraint is foreshadowed by the condition governing the tautosyllabicity of abutting vowels in Roca (1991): "V_1 bears the stress peak and is more sonorous than V_2" (figure (48) on p. 626; cf. also figure (52) on p. 628).

35. It is a fact of life (not always taken account of in the literature) that the syllabification of abutting vowels in Spanish is often subject to dialectal, indeed idiolectal, piecemeal variation. With respect to stressed *ui*, Navarro Tomás (1959: 166, §149b) explicitly states that "la pronunciación antigua de las formas *muy*, *cuita*, *cuida*, *cuide*, etc., con acento sobre la *u* […] es aún corriente en Asturias y en algunos otros puntos del Norte de España […] Bello la indicó asimismo como conservada en Chile" [the traditional pronunciation of the forms *muy*, *cuita*, *cuida*, *cuide*, etc., with stress on the *u* […] is still common in Asturias and in a number of other spots in Northern Spain […] Bello also identified it as maintained in Chile]. One cannot help wondering in how many other places and individuals such traditional pronunciation is still in existence, whether or not it has been recorded by the (small) army of field researchers.

36. Rosenthall's data, remarkably parallel to Dunlap's (1991), are not always empirically true, a fact that renders the analysis partly orthogonal to real-life Spanish.

(38) *a<h>í* 'there'

.i*	SonFall'	¬Al-Σ]**	FtBin$^{\mu}$min*	Max-Pk	Onset	Al-Σ]	Al-V́]
a.(í)]			*		*!		
☞ (ái)]				*			*
(á.i)]	*				*!		*
(á.)i]			*		*!	*!	*

While the winner (ài) does not match the word for 'there' *a<h>í*, it is a possible Spanish form (*¡ay!* 'ouch!', *hay* 'there is'): *a<h>í* emerges on a lexical representation /.i/, not /.i*/. In the longer *àire* 'air', the /.i/ of hypothetical /.i*/ survives in a.(ir]e), illegitimate *(à.i)r]e also prevented by SonFall', decisively ranked above Al-Σ]:

(39) *aire* 'air'

.i*	SonFall'	¬Al-Σ]**	FtBin$^{\mu}$min*	Max-Pk	Onset	Al-Σ]	Al-V́]
☞ a.(ír]e)					*	*	
(ái)r]e				*!			*
(á.i)r]e	*!				*		*
a.(í)r]e			*!		*		

The winner *a.íre* does not match *àire*, but the pattern is legitimate: cf. *A.ída* 'Aida', its lexical representation reduced to /.i/ on lexicon optimisation. For *àire* it will be /*/.

2.3 HV-induced window narrowing

Having examined VH vowel sequences, we now turn to their converse, HV, already referred to in (21) above. The sequence HV can also induce stress window narrowing, with an unexpected twist, as we will see in §2.4.1.

Some relevant data including HV are now provided:

(40) a. *paròdia*, *famìlia*, *vagància*, *sinonìmia*, *parsimònia*, *magnèsia*, *sàvia*, *acèq<u>ia*
'parody, family, laziness, synonymy, parsimony, magnesia, sap, irrigation ditch'
b. *melodí.a*, *homilí.a*, *mercancí.a*, *economí.a*, *hegemoní.a*, *cortesí.a*, *braví.a*, *seq<u>í.a*
'melody, homily, goods, economy, hegemony, courtesy, wild-fem, draught'

As with VH, HV tautosyllabicity is unmarked, indeed as encapsulated in the standard norms of orthographic accentuation (cf. *paròdia* vs. *melodía*),[37] reflecting speaker intuition (cf. Harris's 1975:60 remark on the naturalness of the Spanish orthographic accent conventions referred to in §1.1 above). Such markedness differential falls out from our model, in which it is the intuitively (and orthographically) marked pattern that requires encoding as a lexical peak, even though this pattern scores better on Al-V́]:

(41) *parodia* 'parody'

	¬Al-Σ]**	FtBin$^{\mu}$min*	Max-Pk	Onset	Al-Σ]	Al-V́]
☞ pa(ròdi)]a						*
paro(dí.)]a				*!		

37. Remember that only our acute accent has representation in Spanish orthography.

(42) *melodía* ‘melody’

i.	¬Al-Σ]**	FtBin-$^{\mu}$min*	Max-Pk	Onset	Al-Σ]	Al-V́]
☞ melo(dí.)]a				*		
me(lòdi)]a			*!			*

A similar situation obtains word-internally:[38]

(43) *persiana* ‘window blind’

	¬Al-Σ]**	FtBin$^{\mu}$min*	Max-Pk	Onset	Al-Σ]	Al-V́]
☞ persi(à)n]a						
persi.(à)n]a				*!		

(44) *arriana* ‘Ar(r)ian-fem’

i.	¬Al-Σ]**	FtBin$^{\mu}$min*	Max-Pk	Onset	Al-Σ]	Al-V́]
☞ arri.(à)n]a				*		
arri(à)n]a			*!			

Likewise in forms with * lexical marking:

(45) *piélago* ‘ocean’

*	¬Al-Σ]**	FtBin$^{\mu}$min*	Max-Pk	Onset	Al-Σ]	Al-V́]
☞ pi(éla)g]o						*
pie(lá)g]o		*!				
pi.(éla)g]o				*!		*

(46) *Niágara* ‘Niagara’

i.*	¬Al-Σ]**	FtBin$^{\mu}$min*	Max-Pk	Onset	Al-Σ]	Al-V́]
☞ Ni.(ága)r]a				*		*
Ni(ága)r]a			*!			*
(Ní.a)gar]a				*		**!

An additional pattern exemplified in *perí.odo* (also *etí.ope* ‘Ethiopian’, *policí.aco* ‘police-related’, *egipcí.aco* ‘Egyptian’, etc.) warrants attention. Like *Niágara* in (46), this pattern involves double lexical marking: (1) *, to activate FtBin$^{\mu}$min* (cf. candidate c in (47) below); (2) *i* syllable peakness, to enforce hiatus (cf. candidate d):

(47) *período* ‘period’

i.*	¬Al-Σ]**	FtBin$^{\mu}$min*	Max-Pk	Onset	Al-Σ]	Al-V́]
☞ pe(rí.o)d]o				*		*
peri.(òd]o)				*	*!	
peri.(ò)d]o		*!		*		
peri(òd]o)			*!		*	
peri(ò)d]o		*!	*!			

38. An additional candidate *per(sià)n]a* is ruled out by undominated Troch, systematically omitted from our tableaux in the interest of graphic parsimony.

An alternative, increasingly common, diphthongal realisation *peridodo* (possibly helped along by the related form *periódico*, whose lexical allomorphy with *perí.odo* is obviated with *periòdo*) formally implies loss of both lexical markings:

(48) *periodo* 'period'

	¬AL-Σ]**	FTBIN^μmin*	MAX-PK	ONSET	AL-Σ]	AL-V́]
pe(rí.o)d]o				*!		*
peri.(òd]o)				*!	*!	
peri.(ò)d]o				*!		
peri(òd]o)					*!	
☞ peri(ò)d]o						

The success of the present procedure extends to shorter words like *rí.o* 'river', where *-o* is a desinence: cf. ***ria**chuelo* 'river-PEJ', ***ri.ì**to* 'river-DIM', etc. This success is irrespective of whether or not *i* is marked as a lexical nucleus:

(49) *río* 'river'

i.	¬AL-Σ]**	FTBIN^μmin*	MAX-PK	ONSET	AL-Σ]	AL-V́]
☞ (rí.)]o				*		
ri.](ó)				*	*!	*
(rí.]o)				*	*!	
ri](ó)			*!		*	*

(50) *río* 'river'

	¬AL-Σ]**	FTBIN^μmin*	MAX-PK	ONSET	AL-Σ]	AL-V́]
☞ (rí.)]o				*		
ri.](ó)				*	*!	*
(rí.]o)				*	*!	
ri](ó)					*	*!

In (49), with underlying *i.*, AL-Σ] is decisive to the victory of the correct candidate *(rí.)]o*, while in (50), with no such lexical marking, the same candidate wins through the intervention of AL-V́], low ranking but still crucially active: (rí.)]o ≻ *ri](ó).

The correct output is also attained on a hypothetical lexical marking * inducing a minimal bisyllabic foot:

(51) *río* 'river'

*	¬AL-Σ]**	FTBIN^μmin*	MAX-PK	ONSET	AL-Σ]	AL-V́]
(rí.)]o		*!		*		
ri.](ó)		*!		*	*	*
☞ (rí.]o)				*	*	
ri](ó)		*!			*	*

The outcome is not altered if the lexical peak *i.* cooccurs with the metrical mark *:

(52) *río* 'river'

i.*	¬Al-Σ]**	FtBin$^{\mu}$min*	Max-Pk	Onset	Al-Σ]	Al-V́]
(rí.)]o		*!		*		
ri.](ó)		*!		*	*	*
☞ (rí.]o)				*	*	
ri](ó)		*!	*!		*	*

These positive results obviously add strong motivation to the procedure. Note that, of the four alternative derivations explored for *rí.o*, the one in (50), with the simplest, indeed maximally unmarked, underlying representation is of course preferred on lexicon optimisation.

2.4 The role of WSP

2.4.1 *QS diphthongs*

The twist referred to above comes up at this point. We have seen that the Spanish feet can contain three vowels (in two syllables), in the interest of Al-Σ] satisfaction: *náufrago* parses *(náufra)g]o*, thus preventing victory of **nau(fràg*]*o)*, in the mould of *omi(cròn*]*es)*, mutatis mutandis. Given this, **(pério)d*]*o* ought to be legitimate, on a lexical marking * (NB no lexical syllable peak; ☹ identifies unselected surface true candidates):

(53) *período* 'period'

*	¬Al-Σ]**	FtBinmin*	Max-Pk	Onset	Al-Σ]	Al-V́]
☹ peri(ò)d]o		*!				
☹ peri(òd]o)					*!	
(péri)od]o					*!	**
☞*(pério)d]o						**

The winning pattern **périodo* does not occur, indeed it is counterintuitive. Richness of the Base therefore demands that it be ruled out in the evaluation itself.

The situation points in the direction of quantity sensitivity, with high-ranking WSP (54) blocking the undesired surface form **périodo*, as shown in (55):

(54) WSP "Weight-to-stress principle"
Polymoraic footed syllables bear stress

(55) *período* 'period'

*	¬Al-Σ]**	FtBinmin*	Max-Pk	WSP	Onset	Al-Σ]	Al-V́]
peri(ò)d]o		*!					
☞ peri(òd]o)						*	
(péri)od]o						*	*!*
(pério)d]o				*!			**
pe(rí.o)d]o					*		*!

WSP thus brings on a rightward stress shift paralleling *omicrònes* in (19) above.[39] In turn, we can assume that the output *periòdo* undergoes loss of lexical * through lexicon optimisation, leading to the more direct unmarked evaluation in (48) above.

2.4.2 *Consonant-induced weight?*

The obvious next question is whether C-closed syllables also count as heavy. The answer is less clear, and the issue in any event marginal within the overall fabric of Spanish non-verb stress, contrary to much previous opinion.

The general lack of PPO# (native) forms with a C-closed penult has often been attributed to quantity sensitivity (QS), hence C QS. However, the gap actually falls out from the Law of Stressed Syllable Constancy,[40] and therefore no special provision is in principle needed for its enforcement in the present-day language. Still, Richness of the Base requires that ungrammatical patterns, as the present one is commonly taken to be, be excluded through constraint ranking. This said, at least one native item (if a proper noun) breaches the generalisation: *Fró.mis.ta*, the name of a Castilian village (in Palencia province) boasting a celebrated early medieval church.[41] The survival of this pattern through the centuries would be truly bizarre if Spanish QS indeed paralleled Latin's, with the pattern in question thus formally banned. In addition, words of Germanic flavour currently in use happily accept (indeed, in effect require) PPO# stress, even when the penult is C-ending, the usual situation: *Wàshington* (Sp [ˈgu̯asinton]), *Mànchester*, *Àmsterdam*, *Dùsseldorf*, *Pàrkinson*, *bádminton*, etc. Note that appeal to simple mimicry is contradicted by fact: cf. Spanish pronunciations like *Àmsterdam* or *Ròtterdam* (Dutch *Amsterdàm*, *Rotterdàm*), *Àberdeen* or (V-ending) *McNàmara* (English *Aberdèen*, *McNamàra*), etc. And so on: the evidence against mimicry is indeed overwhelming (further discussion in Roca 2005c).

The strongest argument available for Spanish C QS involves hypercorrection of coda *s* in Dominican dialects (Núñez Cedeño 1988, 1989, 1994): hypercorrected coda *s* fails to turn up precisely in penultimate position of PPO# forms (e.g. *e<s>túpido* → *estúpido*, *etúspido*, *etúpidos*, but crucially not **etúpisdo*).[42] However, while these

39. Santiago Alcoba (pc) kindly confirms the outcome predicted by our procedure with the systematic pluralisation of *júnior* 'junior' as *juniòres* (NB not **júniores*), denoting the pupils in a certain form in a particular Spanish secondary education institution with which he reports to have been familiar. Likewise for the feminine *juniòra(s)*.

40. Remember that heavy penults, whether intrinsic or by position, invariably attracted stress in Latin: cf. *amò*[ː]*.rem*, and, relevantly here, *ornamèn.tum* 'equipment'.

41. *Frómista* used to be kept company by the now obsolete common noun *límiste* 'lemster' (a type of cloth from the English town of Leominster). The problem posed by these two forms for C QS is pointedly remarked on already in Larramendi (1729:344–45).

42. *Frómista* is therefore incompatible with the Dominican hypercorrecting grammar. The Dominican situation has a diachronic precedent in the handful of historical leftward stress shifts that took place historically in Spanish, in contravention of the Law of Stressed Syllable Constancy (e.g. *médula* < *medùla* 'marrow'; cf. patrimonial *meòllo* 'gist'): the shift systematically failed to take place in forms with heavy penults. Note, however, that the relevance of this fact to the contemporary synchronic grammar cannot facts are unquestionably suggestive, it is not obvious that they suffice to outweigh the contrary evidence just adduced. Indeed, Núñez Cedeño & Morales-Front (1999:224) express a similar view: “Los datos del dominicano no deberían, por sí solos, tomarse como prueba irrefutable de que en español las codas contribuyen al peso silábico.” [The Dominican data should not by themselves be taken as an irrefutable proof that codas contribute to syllable weight in Spanish].

Moreover, the introduction of C QS in Spanish would create problems for C-ending PO#’s: *caníbal*, *alcázar*, etc., with a stressless word-final heavy syllable. This difficulty is typically overcome by resort to final -C extrametricality (general review and assessment of this practice in Roca 1992). In OT, we could equivalently appeal to Non-Finality (cf. e.g. Morales-Front 1994), hence *ca(**níba)l***, etc. However, this analysis renders SM forms unobtainable (**o(**mìcro)n***, **re(**gìme)n***, etc.), a fatal result if we are truly interested in the full stress grammar of the Spanish speaker. Alternatively, we could revert to FtBin$^{\sigma}$min*, in effect cancelling off WSP, which presupposes moraic stress computation, as will be confirmed in §3.2 below. However, all our findings so far favour precisely FtBin$^{\mu}$min* (cf. **cóloide*, **cáray*, etc.). In addition, FtBin$^{\sigma}$min* would let through PPO#’s with a C-closed penult (**(**cáram)b]a***’oh dear!’, etc.), thus taking us back where we started:

(56) *caramba* ‘oh dear!’

*	¬Al-Σ]**	FtBin$^{\sigma}$min*	Max-Pk	WSP	Onset	Al-Σ]	Al-V́]
☹ ca(ràm)b]a		*!					
☹ ca(ràmb]a)						*!	
☞*(cáram)b]a							*

Faced with such problems and with lack of decisive evidence, we shall conclude that the matter of Spanish C QS is best left undecided.[43] Importantly, the remainder of the analysis goes through unimpaired, as we have abundantly seen.

3. English inroads

3.1 V-final SM forms?

The introduction of WSP would seem to make problematic the pattern of *hòckey*, an English word regularly realised as [ˈxokei̯] by Spanish speakers:

be taken for granted, the more so in view of the systematic present-day contradiction of WSP in Germanic-flavoured forms. Interestingly, the Dominican data run head-on against mimicry generally.

43. The bulk of the literature has through the years favoured C QS (Roca 1988 et seq. is a dissenting voice), but recent work is turning away from it, cf. e.g. Lipski (1997), Roca (1997a, 2005c), Bárkány (2002b) and Alvord (2003), the latter two experimentally.

(57) *hockey* 'hockey'

*	SonFall'	FtBin$^{\mu}$min*	Max-Pk	WSP	Onset	Al-Σ]	Al-V́]
☞*hoc(kèi)]							*
☹ (hòckei)]				*!			**
☹ (hòcke)i]						*!	**
hocke.(í)]		*!			*		
hock(é.i)]	*!				*		*

The difficulty is readily overcome by allotting *hockey* to the SM class,[44] alongside *régimen* and *Wàshington*, thus opening this class to vowel-ending words from the foreign set (*hockey*'s foreignness is explicit in both the spelling *ck* and the pronunciation of <h> as [x]: <h> is silent in native Spanish words). The proposed procedure is illustrated in (58):

(58) *hockey* 'hockey'

**	SonFall'	¬Al-Σ]**	FtBin$^{\mu}$min*	Max-Pk	WSP	Onset	Al-Σ]	Al-V́]
hoc(kèi)]		*!						*
(hòckei)]		*!			*!			**
☞(hòcke)i]							*	**
hocke.(í)]		*!	*!			*		
hock(é.i)]	*!	*!				*		*

It will be instructive to compare the pattern of *hòckey* to that of nativised forms like standard colloquial *jersèy* [xersˈei̯] 'pullover' or formerly popular *orsày* [orˈsai̯] 'offside (in football)'.[45] In this context, the shift from traditional *Disnèy* to more up to date *Dìsney* is readily interpretable as 'foreignisation' of the word's stress (** marking formally, i.e. not mimicry), brought on by pressure from English. Likewise for other stress shifts recently materialised, at least in the Spanish media, e.g. *Lìverpool* (traditionally *Liverpùl*) or *Àrsenal*, for the London football club, in spite of the actual Spanish O *arsenàl* 'arsenal'.

3.2 Syllable-based FtBin

We have seen that the unified model being advanced correctly bans forms in the shape of **périodo*, **Marácaibo* or **g<u>írigay*, while allowing *hòckey* and *régimen*, alongside *Wàshington*. The contrast between the two sets is evident to native speakers, and correspondingly shows up in their (spontaneous) behaviour. Some further facts, still in the periphery but nonetheless real, now need to be considered, to complete the picture.

The name of the greater Buenos Aires train station *Temperley*, commonly spelled without an accent in keeping with its foreign origin, is spontaneously and systematically

44. Similarly for *Dìsney* or *cònvoy* in dialects or speakers that exhibit this stress pattern.

45. 3σW violations will of course be prevented in the way shown for *Kalevala* in §2.5 above. Note that the classification of *hockey* as foreign would seem to rule out an alternative analysis with *-y* as D, consistent with a M stress pattern: *(hòcke)]y*. Against *-y* as D also militates the fact that nonce derivatives like *hockeicito* 'hockey-DIM' or *hockeyero* 'hockey fan' seem preferable to ?*hockeíto* and ??*hock(e)ero*.

rendered [ˈtemperlei̯] in the area in question. Similarly, the English borrowing *volleyball* can be stressed [ˈbolei̯bol], in spite of the falling diphthong in the penult.[46] These patterns are manifestly unobtainable on the present procedure:

(59) *Tèmperley*, *vòleibol* ‘volleyball’

**	Son-Fall’	¬Al-Σ]**	FtBin$^{\mu}$ min*	Max-Pk	WSP	Onset	Al-Σ]	Al-V́]
☹ (Tèmper)lei]							**!	***
Tem(pèrlei)]		*!			*!			**
☞*Tem(pèrle)i]							*	**
Tem(pèr)lei]			*!				**	**
Temper(lèi)]		*!						*
☹ (vòlei)bol]					*!		*	***
vo(lèibol)]		*!						**
☞*vo(lèi)bol]							*	**
volei(bòl)]		*!	*!					

In particular, the present high ranking of FtBin$^{\mu}$min* and FtBin$^{\sigma}$max does not allow stress further left than the antepenultimate stem vowel, as shown. However, in forms like these, stress targets the word’s antepenultimate syllable, in this and similar varieties. This suggests activity of FtBin$^{\sigma}$min* in the ‘foreign’ set, rather than of FtBin$^{\mu}$min*, in addition of course to ¬Al-Σ]** with Al-V́] reinterpreted as Al-σ́]:

(60) *Tèmperley*, *vóleibol*

**	¬Al-Σ]**	FtBin$^{\sigma}$ min*	Max-Pk	WSP	Onset	Al-Σ]	Al-σ́]
☞ (Tèmper)lei]						*	**
Tem(pèrlei)]	*!						*
Tem(pèr)lei]		*!				*	*
Temper(lèi)]	*!	*!					
☞ (vòlei)bol]						*	**
vo(lèibol)]	*!						*
vo(lèi)bol]		*!				*	*
volei(bòl)]	*!	*!					

Note that *Tem(pèrle)i*] is not a possible alternative to (failed) candidate b. *Tem(pèrlei)*] in (60), with which it would draw, since FtBin$^{\sigma}$min* by definition operates on syllables, and *le* is not a syllable in *Temperley*: *ley* is. Note also that FtBin$^{\sigma}$min* renders WSP irrelevant, given that the syllable weight underpinning WSP is obviously computed on moras (= rime vowels in Spanish), not on syllables.

This new grammar also brings into line the pattern of *Sàmuelson*, the surname of the economics Nobel Prize winner author of a celebrated textbook. In my sus-

46. I owe this information to María Ohannesian, a stress specialist (cf. Ohannesian 2004) and a native of Buenos Aires.

tained experience, Spanish speakers (including speakers without an active knowledge of English, the practical totality of Spain's population at the time of the observation) show no tendency to place stress further to the right, as in **Samuelsón*, **Samuèlson* or **Samu.èlson* (despite the *Samuèl* or *Samu.èl* of the Spanish base), **Samú.elson*:

(61) *Samuelson*

**	¬Al-Σ]**	FtBin$^{\sigma}$ min*	Max-Pk	WSP	Onset	Al-Σ]	Al-σ́]
☞ (Sàmuel)son]						*	**
Samu(èl)son]		*!				*	*
Samu(èlson)]	*!						*
Sa(mú.el)son]					*!	*	**
Samuel(són)]	*!	*!					

On the μ setting of FtBinmin* the surface untrue pattern *Samú.elson* would emerge instead, because of the effect of WSP:

(62) *Samuelson*

**	¬Al-Σ]**	FtBin$^{\mu}$ min*	Max-Pk	WSP	Onset	Al-Σ]	Al-V́]
☹ (Sàmuel)son]				*!		*	***
Samu(èlson)]	*!						*
Samu(èl)son]		*!				*	*
☞*Sa(mú.el)son]					*	*	**

Tèmperley, *vòleibol* and *Sàmuelson* thus reveal prevalence of FtBin$^{\sigma}$min* over FtBin$^{\mu}$min* in Germanic-felt forms.[47] The respective identity of the two contrasting sets is accordingly established on a principled basis, membership of the FtBin$^{\sigma}$min* set being confined to words we can assume are transparently foreign (English or, more generally, Germanic) to the average speaker. The replacement of the more restrictive FtBin$^{\mu}$min* by FtBin$^{\sigma}$min* in this set clearly serves to maximise a 'leftmost stress' target, presumably the interpretation of Germanic stress by Spanish speakers. This target, however, crucially remains checked by the set of Spanish ranked constraints, with the concomitant preservation of the 3σW: cf. e.g. maximal *Schevèningen* for Dutch *Schèveningen*, or *Cantèrbury* for English *Cànterbury*.[48]

47. Seemingly only Germanic: cf. by contrast Japanese *Toyòta, Subàru*, *samurài*, *sayonàra*, *kimòno*, *kamikàze* (although *kárate*); Arabic *Hassàn, Mohamèd*, *Alí*, *Yasèr*, *Omàr*, *Nassèr*, *Sa(d)dà*[n] (and household Arabic names from Spanish history: *Tarìk*, *Abderramán*, *Almanzòr*, etc.); Russian *Kruschèv*, *Gorvachòv*, *kalasnikòf*, *Lenín*, *Rasputín*, *Bakunín* (although [e]*Stàlin*, *Yèlsin*, *Pùtin*); and so on.

48. Empirical evidence for the *Canterbury* shift is readily available from nature, in the not uncommon phrase *arzobispo de Canterbury* 'archbishop of C.', for instance. For *Scheveningen*, in an informal experiment referred to in Roca (1997b:243, fn 6) a handful of Spanish speakers pronounced the word under two conditions: reading aloud and mimicking a (presumably) Dutch speaker. The test consistently yielded PO# stress, crucially not the Dutch PPPO#.

The FtBin$^{\sigma}$min* analysis could in principle be extended to *hòckey*, with this word thus taken out of our SM set, once more reserved to C-ending learnèd forms. However, while *hòckey* is, to the best of my knowledge, general throughout the Spanish-speaking world, *Tèmperley* and *vòleibol* are not:[49] the latter, in particular, is *voleibòl* at least in Spain, with *vòleibol* quite vigorously rejected by speakers. All the facts considered thus point to change in progress, substitution of FtBin$^{\mu}$min* by FtBin$^{\sigma}$min* making its way through the foreign set.

4. Summary and conclusions

This paper has advanced a successful, substantially innovative formalisation of the various patterns of Spanish non-verb stress.[50] The situation has been seen to be more complex than most existing analyses allow for, because of the co-existence of several native or nativised patterns with additional patterns induced by incoming English (indeed Germanic) words. Of particular interest is the effect of abutting vowels on stress positioning, with the ordinary 3σW narrowing to a 2σW or even a 1σW: cf. *co.lòi.de* and *ca.rày*, respectively. Previous analyses have tended to occult such effects under the formal construct 'glide', amounting to wholesale lexicalisation of (high) vowel parse, a brute force approach that misses on a number of principled interactions between stress and syllables. We have instead seen that the syllabification of high vowels is guided by Onset, with exceptions entered with a lexical peak, protected by MaxPk from Onset. Moreover, rime high vowels remain vowels, phonetically and phonologically, whatever their parse.[51] We have consequently judged the construct 'glide' unnecessary, indeed unreal. To the best of my knowledge, the coverage of the present analysis has no match in the available literature.[52] This fact and the degree of cohesion and simplicity achieved strongly vouch for its correctness.

A summary of the paper now follows. The basic constraint ranking relevant to Spanish non-verb stress is displayed in the tree diagram in (63). The letters labelling

---

49. A revealing anecdote in this connection arose in the course of my (informal) probing of intuitions with a handful of Madrid speakers. One of these speakers (fluent in English, and very active in the conversation), referring precisely to the persistence of English stress in English words used in Spanish discourse, quoted as PPO the name *Manderley* in the Spanish dubbed version of Hitchcock's film "Rebecca": *Mànderl*[ei̯]. The interest of the matter lies in the fact that, after pronouncing the name thus once or twice, he repeated it several more times as *Manderlèy*, obviously unaware that his Spanish pattern was slipping through and winning the day. I have observed an analogous outcome in the Spanish media with the similar name *Vanderley*, of Real Madrid's former Brazilian coach Vanderley Luxemburgo: *Vànderley* in careful mode, with lapses to *Vanderlèy* (and occasionally *Vandèrley*!) when attention is relaxed.

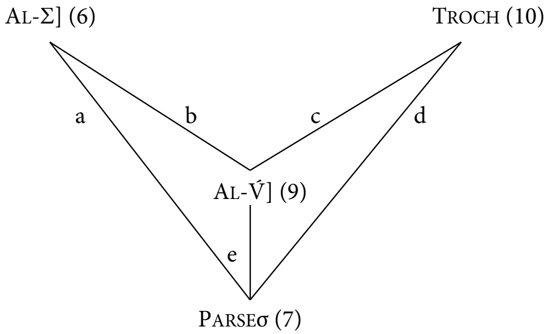
50. Our coverage and results compare favourably with those in the also OT analyses in Hammond (1995), Garrett (1996) and Kikuchi (2000), in any event only partially overlapping.

51. High vowels parsed in the onset syllable-initially consonantalise: see Roca (2005a) for discussion.

52. The patterns instantiated in *Tèmperley*, *vòleibol* or *Sàmuelson* are not generally discussed in the literature. In Roca (1991) and Harris (1995) they are explicitly considered ungrammatical.

the branches refer to the examples listed at the bottom, where the material relevant to the ranking is given in bold:

(63)

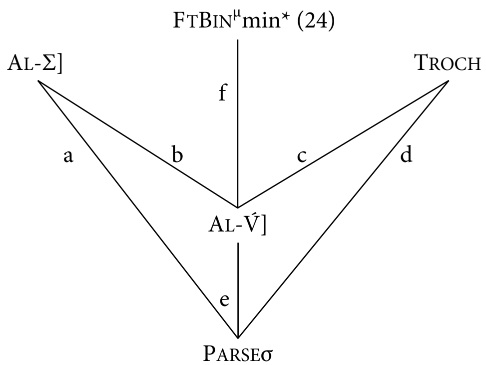


a. Al-Σ] >> Parseσ pis(tòl]a) ≺ pis(tò)l]**a**
b. Al-Σ] >> Al-V́] *epis(tòl]a) ≺ e(píst**o**)l]a, *nau(fràg]o) ≺ (ná**u**fr**a**)g]o
c. Troch >> Al-V́] *e(pistò)l]a ≺ e(píst**o**)l]a, *(regì)men] ≺ (rég**i**)men]
d. Troch >> Parseσ a(nimàl)] ≺ an**i**(màl)], (pistò)l]a ≺ p**i**s(tò)l]a, (menú) ≺ m**e**(nú)
e. Al-V́] >> Parseσ *(písto)l]a ≺ p**i**s(tò)l]a, *a(nímal)] ≺ an**i**(màl)], *(mènu)] ≺ m**e**(nú)]

These rankings yield the stem-final stress of *me(nú)*, *ani(màl)* and *pis(tò)l*]*a*, formally encoded as a stem right-aligned degenerate foot. In particular, such a foot complies with all the constraints in (63) but lowest ranking Parseσ, relevantly violated in *pis(tò)l-a*.[53] This representation, divergent from the commonly favoured ones word-final binary trochee or stem-final unbounded iamb, is amply backed up by the remainder of the data.

Stem paroxytones necessitate a dominant FtBin$^{\mu}$min* diacritically bound to the corresponding lexical class:

(64)



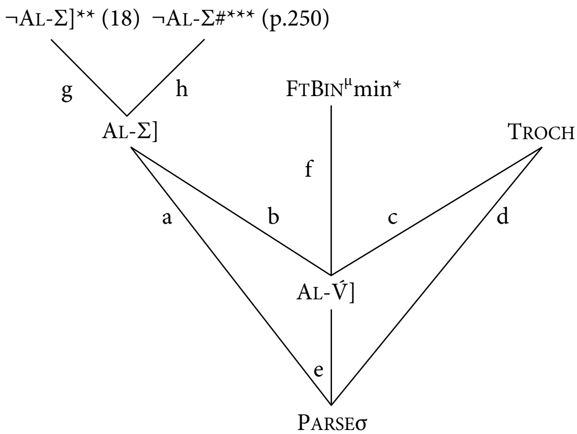
f. FtBin$^{\mu}$min* >> Al-V́] *epis(tò)l]a ≺ e(píst**o**)l]a, *re(gì)men] ≺ (rég**i**)men]

53. 'Relevantly' in the sense that the Parseσ violation affects the head foot. Syllables outside the head foot violate Parseσ across the board, given the ban on additional feet imposed by the ranking Al-Σ] >> Parseσ.

Historically, such forms are 'learnèd', i.e. originating in written Latin. However, synchronically they are on a par with their 'patrimonial' counterparts in all but stress,[54] and consequently idiosyncratic lexical marking * is needed. This marking activates high-ranking FtBin$^{\mu}$min* to correctly assign stem penultimate stress in *ca(nìbal)* and *e(písto)l*]*a*, for instance. The rankings in (64) above are justified by this result, hence the inviability of the word-final binary trochee frequently assumed elsewhere.

The subset of data summed up so far is still compatible with a stem-final unbounded iamb. However, the supermarked set instantiated in *ómicron* isn't. The existence of this set leads to the incorporation of the anti-alignment constraint ¬Al-Σ]**, to enforce location of the right boundary of the (maximal) foot one position away from the right stem boundary: before it in the singular *(ómi)cron*] and after it in the plural *omi(cròn*]*es)*. This is the default pattern for this type of items, also Latinate (or Greek), but making up an additional lexical class '**' distinct at least with regard to stress. The more common word *régimen* pluralises as *regímenes*, however, seemingly out of prescriptive pressure. Formally, the small *régimen* class (perhaps also containing *espécimen*) can be associated with a further high-ranking constraint ¬Al-Σ#***, also outranking Al-Σ]: this approach seems preferable to simple brute force stress lexical allomorphy, technically also feasible. The resulting enriched ranking is as follows:

(65)



g. ¬Al-Σ]** >> Al-Σ] *o(mìcron)] ≺ (ómi)cron], *o(mícro)n]es ≺ omi(cròn]es)
h. ¬Al-Σ#*** >> Al-Σ] *re(gìmen)]# ≺ (régi)men]#; but *(régi)men]es# ≺ re(gíme)n]es#

The minimality of the proposed machinery is worth noting: it accounts for all and only the existing patterns in the simplest possible way, in contrast with previous analyses. There remains to incorporate the four syllable-related constraints that interact with stress: SonFall', Max-Pk, Onset and WSP.

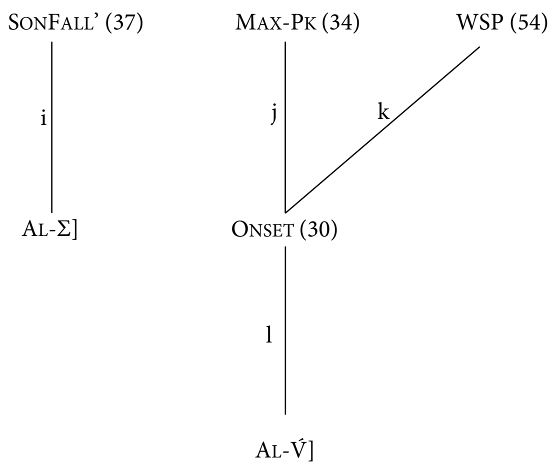
54. Harris (1969) analyses learnèd forms as also systematically distinct from patrimonial forms in certain segmental respects. However, the synchronic status of these differences is not clear, with a high likelihood they have simply become lexicalised (cf. Morin 1997).

Onset militates against onsetless syllables, inducing tautosyllabicity of a vowel with a preceding consonant or, crucially for us here, with an abutting high vowel: cf. *(náufra)g-o* ≻ **na.(úfra)g-o*, or *persiàna* ≻ **persi.àna*, for instance. Lexicalised syllable heads are, however, protected from Onset by higher ranking Max-Pk: cf. e.g. *a.<h>í*, not **ài* (otherwise grammatical), given lexical /.i/.

The correct foot in *(náufra)g-o* contains three vowels (crucially, parsed in two syllables), rather than the expected two: the latter parse *(náu)frag-o* would lose to empirically untrue **nau(fràg-o)*, as we saw in (32) above. The footed extra vowel is, however, only licensed in a stressed syllable, the foot head, as enforced by WSP: compare **(pério)d-o* with correct *peri(ò)d-o*. In turn, abutting vowels with a sonority fall are obligatorily tautosyllabic, as determined by SonFall', which rules out, e.g. *á.i* for correct *a.<h>í* or *¡ày!*

The tree in (66) shows the ranking of these four constraints with respect to each other and to the purely stress-relevant Al-V́]:

(66)

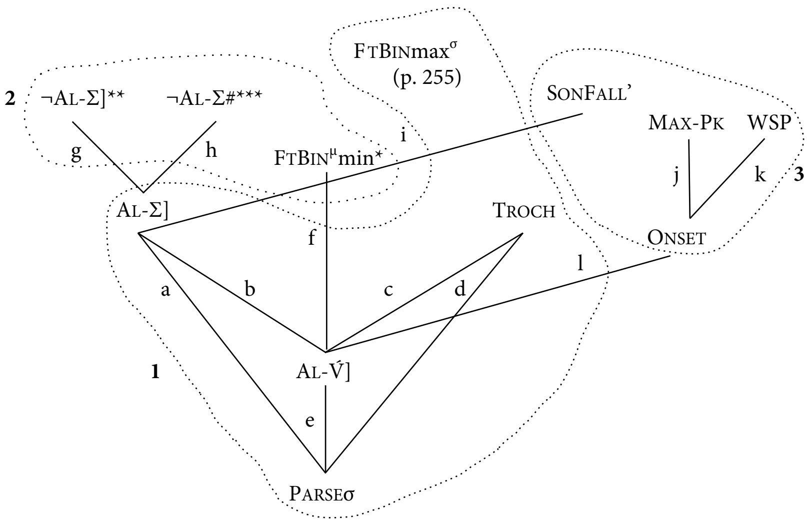


i.	SonFall' >> Al-Σ]	*(á.i)r]e (≺ *a.(ír]e)* ≺ *A.(í)d]a)*
j.	Max-Pk >> Onset	*(ài) ≺ a.(**í**), *me(lòdi)]a ≺ melo(dí.)]**a**, *Ni(ága)r]a ≺ Ni.(**á**gara), etc.
k.	WSP >> Onset	*(pério)d]o ≺ pe(rí.**o**)d]o
l.	Onset >> Al-V́]	*na.(úfra)g]o ≺ (ná**u**fra)g]o, *colo.(í)d]e ≺ co(lò**i**)d]e, *cara.(í)] ≺ ca(rà**i**)]

A last element active in the Spanish non-verb stress grammar is FtBinmax$^{\sigma}$, which we have assumed to be part of GEN throughout the analysis, in harmony with Hyde (2002). The ranking tree in (67) makes explicit the full machinery pertinent to non-verb stress we have adopted.[55] The constraints cluster in three families, each enclosed in a dotted bubble and numbered for ease of reference:

55. The ongoing change from FtBin$^{\mu}$min* to FtBin$^{\sigma}$min* in foreign forms obviously needs to be borne in mind.

(67)



a.	Al-Σ] >> Parseσ	pis(tòl]a) ≺ pis(tò)l]**a**
b.	Al-Σ] >> Al-V́]	*epis(tòl]a) ≺ e(píst**o**)l]a, *nau(fràg]o) ≺ (ná**u**fr**a**)g]o
c.	Troch >> Al-V́]	*e(pistò)l]a ≺ e(píst**o**)l]a, *(regì)men] ≺ (rég**i**)men]
d.	Troch >> Parseσ	a(nimàl)] ≺ an**i**(màl)], (pistò)l]a ≺ p**i**s(tò)l]a, (menú) ≺ m**e**(nú)
e.	Al-V̀] >> Parseσ	*(písto)l]a ≺ p**i**s(tò)l]a, *a(nímal)] ≺ an**i**(màl)], *(mènu)] ≺ m**e**(nú)]
f.	FtBin^μmin* >> Al-V́]	*epis(tò)l]a ≺ e(píst**o**)l]a, *re(gì)men] ≺ (rég**i**)men]
g.	¬Al-Σ]** >> Al-Σ]	*o(mìcron)] ≺ (ómi)cr**o**n], *o(mícro)n]es ≺ omi(cròn]**e**s)
h.	¬Al-Σ#*** >> Al-Σ]	*re(gìmen)]# ≺ (régi)m**e**n]#; but *(régi)m**e**n]es# ≺ re(gíme)n]es#
i.	SonFall' >> Al-Σ]	(á.i)r]e (≺ *a.(ír]e) ≺ A.(í)d]a)
j.	Max-Pk >> Onset	*(ài) ≺ a.(**í**), *me(lòdi)]a ≺ melo(dí.)]**a**, *Ni(ága)r]a ≺ Ni.(**á**gara), etc.
k.	WSP >> Onset	*(pério)d]o ≺ pe(rí.**o**)d]o
l.	Onset >> Al-V́]	*na.(úfra)g]o ≺ (ná**u**fra)g]o, *colo.(í)d]e ≺ co(lò**i**)d]e, *cara.(í) ≺ ca(rà**i**)

Cluster 1 contains the constraints responsible for the basic metrical structure of Spanish non-verbs, and basically corresponds to the tree in (63) above. Cluster 2 contains the metrical constraints responsible for (various degrees of) markedness, as developed in (64) and (65) above. Finally, cluster 3 contains the syllable-related constraints that additionally affect the distribution of stress (cf. (66) above).

Our conclusions, before closing the paper, are as follows:

1. the Spanish non-verb stress bearers are vowels generally, but can be syllables (i.e. syllable heads) in incoming foreign vocabulary
2. the maximum three syllable window on the right edge of the word, invariably obeyed by Spanish non-verbs whatever their historical origin, is not a metrical primitive, but an epiphenomenon

3. the traditional construct 'glide' is unhelpful, indeed spurious: vowels are vowels irrespective of syllabic constituency
4. abutting high vowels are impelled by ONSET to tautosyllabicity, but surface heterosyllabic where lexically marked as peak
5. the presence of abutting vowels, whatever their parse, can narrow the window to two or even one syllable, in native or nativised words
6. the unmarked Spanish foot has both the foot's right edge and the (foot leftmost) head aligned with the stem's right edge, and is consequently degenerate
7. the marked Spanish foot is a binary trochee, either right-aligned with the stem's right edge ('marked' stress) or minimally misaligned with it ('supermarked')
8. quantity sensitivity is active on vowels: WSP requires that footed diphthongs be stressed
9. the relevance of consonants to quantity sensitivity ('weight by position') is unclear, and in any event marginal to the current Spanish stress system

References

Alderete, J. 2001. *Morphologically Governed Accent in Optimality Theory*. London: Routledge.

Alvord, S. 2003. The psychological unreality of quantity sensitivity in Spanish. *Southwest Journal of Linguistics* 22: 1–12.

Apoussidou, D. and Boersma, P. 2003. The learnability of Latin stress. In *Proceedings* 25: 101–48. Amsterdam: Institute of Phonetic Sciences, University of Amsterdam.

Bárkány, S. 2002a. Primary stress in Spanish. In *Current Issues in Romance Languages*, T. Satterfield, C. Tortora and D. Cresti (eds), 17–31. Amsterdam: John Benjamins.

Bárkány, S. 2002b. A fresh look at Spanish quantity sensitivity. *Linguistics* 40: 375–94.

Booij, G. 1997. Non derivational phonology meets lexical phonology. In *Derivations and Constraints in Phonology*, I. Roca (ed.), 261–88, Oxford: Clarendon Press.

Carreira, M. 1990. The Diphthongs of Spanish: Stress, syllabification, and alternations. PhD dissertation, University of Illinois, Urbana-Champaign.

Chomsky, N. 1986. *Knowledge of Language: Its nature, origin and use.* New York NY: Praeger.

Clements, G.N. and Hume, E. 1995. The internal organization of speech sounds. In *The Handbook of Phonological Theory*, J. Goldsmith (ed.), 245–306. Oxford: Blackwell.

Cohn, A. and McCarthy, J. 1994. Alignment and parallelism in Indonesian phonology. ROA–25.

Colina, S. 1996. Spanish noun truncation: The emergence of the unmarked. *Linguistics* 34: 1199–1218.

Colina, S. 1999. Reexamining Spanish glides: Analogically conditioned variation in vocoid sequences in Spanish dialects. In *Advances in Hispanic Linguistics*, J. Gutiérrez-Rexach and F. Martínez-Gil (eds), 121–34, Somerville MA: Cascadilla.

Colina, S. 2003a. The status of word-final [e] in Spanish. *Southwestern Journal of Linguistics* 22: 87–107.

Colina, S. 2003b. Diminutives in Spanish: A morpho-phonological account. *Southwestern Journal of Linguistics* 22: 45–88.

Crowhurst, M. 1992. Diminutives and augmentatives in Mexican Spanish: A prosodic account. *Phonology* 9: 221–53.

Davis, S. and Hammond, M. 1995. Onglides in American English. *Phonology* 12: 159–82.

Díaz-Campos, M. 2000. The phonetic manifestation of secondary stress in Spanish. In *Hispanic Linguistics at the Turn of the Millennium*, H. Campos, E. Herburger, A. Morales-Front and T. Walsh (eds), 49–65. Somerville MA: Cascadilla.

Dunlap, E. 1991. Issues in the Moraic Structure of Spanish. PhD University of Massachusetts, Amherst MA.

Felíu, E. 2001. Output constraints on two Spanish word-creation processes. *Linguistics* 39: 871–91.

Garrett, S. 1996. Another look at Spanish stress and syllable structure. *Chicago Linguistic Society* 32: 61–75.

Halle, M. 1990. Respecting metrical structure. *Natural Language and Linguistic Theory* 8: 149–76.

Halle, M. and Vergnaud, J.-R. 1987. *An Essay on Stress*, Cambridge MA: The MIT Press.

Halle, M. and Kenstowicz, M. 1991. The free element condition and cyclic versus noncyclic stress. *Linguistic Inquiry* 22: 457–501.

Halle, M. and Idsardi, W. 1995. General properties of stress and metrical structure. In *The Handbook of Phonological Theory*, J. Goldsmith (ed.), 403–43, Oxford: Blackwell.

Halle, M., Vaux, B. and Wolfe, A. 2000. On feature spreading and the representation of place of articulation. *Linguistic Inquiry* 31: 387–444.

Hammond, M. 1995. There is no Lexicon! ROA–43.

Harris, J.W. 1969. *Spanish Phonology*. Cambridge MA: The MIT Press.

Harris, J.W. 1975. Stress assignment in Spanish. In *1974 Colloquium in Spanish and Portuguese Linguistics*, W.G. Milán, J.J. Staczek and J.C. Zamora (eds), 56–83. Washington DC: Georgetown University Press.

Harris, J.W. 1980. Non-concatenative morphology and Spanish plurals. *Journal of Linguistic Research* 1: 14–31.

Harris, J.W. 1983. *Syllable Structure and Stress in Spanish*. Cambridge MA: The MIT Press.

Harris, J.W. 1985. Spanish word markers. In *Current Issues in Spanish Phonology and Morphology*. F.W. Nuessel (ed.), 34–54, Bloomington IN: IULC.

Harris, J.W. 1989. How different is verb stress in Spanish? *Probus* 1: 241–58.

Harris, J.W. 1991a. The exponence of gender in Spanish. *Linguistic Inquiry* 22: 27–62.

Harris, J.W. 1991b. With respect to metrical constituents in Spanish. In *Current Studies in Spanish Linguistics*, H. Campos and F. Martínez-Gil (eds), 447–473, Washington DC: Georgetown University Press.

Harris, J.W. 1992. The form classes of Spanish substantives. In *Yearbook of Morphology 1991*, G. Booij and J. van Marle (eds), 65–88. Dordrecht: Kluwer.

Harris, J.W. 1994. The OCP, prosodic morphology and Sonoran Spanish diminutives. *Phonology* 11: 179–90.

Harris, J.W. 1995. Projection and edge marking in the computation of stress in Spanish. In *The Handbook of Phonological Theory*, J. Goldsmith (ed.), 867–87. Oxford: Blackwell.

Harris, J.W. 1999. Nasal depalatalization *no*, morphological well-formedness *sí*; The structure of Spanish word classes. *MIT Working Papers in Linguistics* 33: 47–82.

Harris, J.W. and Kaisse, E. 1999. Palatal vowels, glides and obstruents in Argentinian Spanish. *Phonology* 19: 117–90.

Hayes, B. 1989. Compensatory lengthening in moraic phonology. *Linguistic Inquiry* 20: 253–306.

Hayes, B. 1995. *Metrical Stress Theory*. Chicago IL: The University of Chicago Press.

Hewett, M. 1994. Deconstructing foot binarity. ROA–12.

Hochberg, J. 1988. Learning Spanish stress: Developmental and theoretical perspectives. *Language* 64: 683–706.

Hooper, J. and Terrell, T. 1976. Stress assignment in Spanish: A natural generative approach. *Glossa* 10: 64–110.

Hualde, J. 1999. Patterns in the lexicon: Hiatus with unstressed vowels in Spanish. In *Advances in Hispanic Linguistics*, J. Gutiérrez-Rexach and F. Martínez-Gil (eds), 182–97. Somerville MA: Cascadilla.

Hualde, J. and Prieto, M. 2002. On the diphthong/hiatus contrast in Spanish: Some experimental results. *Linguistics* 40: 217–34

Hyde, B. 2002. A restrictive theory of metrical stress. *Phonology* 19: 313–59.

Hyman, L. 1985. *A Theory of Phonological Weight*. Dordrecht: Foris.

Kikuchi, S. 2000. A sympathetic approach to stress in Spanish ipsiradical sets. In *The Phonological Society of Japan* (*On'in Kenyu*) [Phonological Studies 3], (ed.), 45–52. Tokyo: Kaitakusha.

Kiparsky, P. 2003. Syllables and moras in Arabic. In *The Syllable in Optimality Theory*, C. Féry and R. van de Vejver (eds), 147–82, Cambridge: CUP.

Klein, P. 1989. Spanish 'gender' vowels and lexical representation. *Hispanic Linguistics* 3: 147–63.

Larramendi, M. de. 1729. El imposible vencido: Arte de la lengua bascongada. Salamanca: Joseph Villagordo Alcaraz. (Reprint: Donostia-San Sebastián: Hordago, 1979).

Lipski, J. 1995. Spanish hypochoristics: Towards a unified prosodic analysis. *Hispanic Linguistics* 6/7: 387–434.

Lipski, J. 1997. Spanish word stress: The interaction of moras and minimality. In *Issues in the Phonology and Morphology of the Major Iberian Languages*, F. Martínez-Gil and A. Morales-Front (eds), 559–93. Washington DC: Georgetown University Press.

McCarthy, J. 2002. OT constraints are categorical. *Phonology* 20: 75–138.

Menéndez Pidal, R. 1962. *Manual de gramática histórica española*. Madrid: Espasa-Calpe.

Morales-Front, A. 1994. A Constraint Based Approach to Spanish Phonology. PhD dissertation, University of Illinois, Urbana-Champaign.

Morin, R. 1997. The Non-productivity of Softening Alternations in Spanish. PhD dissertation, Georgetown University.

Morin, R. 1999. Spanish substantives: How many classes? In *Advances in Hispanic Linguistics*, J. Gutiérrez-Rexach and F. Martínez-Gil (eds), 214–30. Somerville MA: Cascadilla.

Navarro Tomás, T. 1959. *Manual de pronunciación española*. Madrid: Publicaciones de la Revista de Filología Española.

Nespor, M. and Vogel, I. 1986. *Prosodic Phonology*. Dordrecht: Foris.

Núñez Cedeño, R. 1988. Structure-preserving principles of an epenthetic rule in Spanish. In *Advances in Romance Linguistics*, D. Birdsong and J.-P. Montreuil (eds), 319–35, Dordrecht: Foris.

Núñez Cedeño, R. 1989. El estado fonémico de la vibrante múltiple española. *Romance Languages Annual* 1: 696–704.

Núñez Cedeño, R. 1994. The alterability of Spanish geminates and its effects on the Uniform Applicability Condition. *Probus* 6: 23–41.

Núñez Cedeño, R. and Morales-Front, A. 1999. *Fonología generativa contemporánea de la lengua española*, chapter IX (El acento y la optimidad). Washington DC: Georgetown University Press

Ohannesian, M. 2004. La asignación del acento en castellano. PhD dissertation, Universitat Autònoma de Barcelona.

Oltra-Massuet, I. and Arregi, K. 2005. Stress-by-structure in Spanish. *Linguistic Inquiry* 36: 43–84.

Piñeros, C.E. 2000a. Prosodic and segmental unmarkedness in Spanish truncation. *Linguistics* 38: 63–98.

Piñeros, C.E. 2000b. Foot-sensitive word minimization in Spanish. *Probus* 12: 291–324.

Piñeros, C.E. 2000c. Vowel weightlessness and stress retraction. ROA–427.

Prieto, P. 1992a. Morphophonology in Spanish diminutive formation: A case for prosodic sensitivity. *Hispanic Linguistics* 5: 169–205.

Prieto, P. 1992b. Truncation processes in Spanish. *Studies in the Linguistic Sciences* 22: 143–58.

Prieto, P. and van Santen, J. 1996. Secondary stress in Spanish: Some experimental evidence. In *Aspects of Romance Linguistics*, C. Parodi, C. Quicoli, M. Saltarelli and M.L. Zubizarreta (eds), 337–56. Washington DC: Georgetown University Press.

Prince, A. and Smolensky, P. 1993. *Optimality Theory: Constraint interaction in generative grammar* [Technical Report 2], Center for Cognitive Science, Rutgers University. (Published by Blackwell, Malden MA, 2004).

RAE (Real Academia Española). 1973. *Esbozo de una gramática de la lengua española*. Madrid: Espasa-Calpe.

Roca, I. 1986. Secondary stress and metrical rhythm. *Phonology Yearbook* 3: 341–70.

Roca, I. 1988. Theoretical implications of Spanish stress. *Linguistic Inquiry* 19: 393–423.

Roca, I. 1989. The organisation of grammatical gender. *Transactions of the Philological Society* 87: 1–32.

Roca, I. 1990. Diachrony and synchrony in word stress. *Journal of Linguistics* 26: 133–64.

Roca, I. 1991. Stress and syllables in Spanish. In *Current Studies in Spanish Linguistics*, H. Campos and F. Martínez-Gil (eds), 599–635. Washington DC: Georgetown University Press.

Roca, I. 1992. Constraining extrametricality. In *Phonologica* 1988, W.U. Dressler, H.C. Luschützky, O.E. Pfeiffer and J.R. Rennison (eds), 239–48. Cambridge: Cambridge University Press.

Roca, I. 1994. *Generative Phonology*. London: Routledge

Roca, I. 1997a. On the role of accent in stress systems: Spanish evidence. In *Issues in the Phonology and Morphology of the Major Iberian Languages*, F. Martínez-Gil and A. Morales-Front (eds), 619–64. Washington DC: Georgetown University Press.

Roca, I. 1997b. There are no glides, at least in Spanish. *Probus* 9: 233–65.

Roca, I. 1999. Stress in the Romance languages. In *Word Prosodic Systems in the Languages of Europe*, H. van der Hulst (ed.), 659–811. Berlin: Mouton de Gruyter.

Roca, I. 2005a. Strata, yes; structure preservation, no. Evidence from Spanish. In *Romance Languages and Linguistic Theory* 2003, T. Geerts, I. van Ginneken and H. Jacobs (eds), 197–218, Amsterdam: John Benjamins.

Roca, I. 2005b. La gramática y la biología en el género del español. *Revista Española de Lingüística* 35.1: 17–44; 35.2: 397–432.

Roca, I. 2005c. Saturation of parameter settings in Spanish stress. *Phonology* 22: 345–94.

Roca, I. and Felíu, E. 2003. Morphology in truncation: The role of the Spanish desinence. In *Yearbook of Morphology 2002*, G. Booij and J. van Marle (eds), 187–243, Dordrecht: Kluwer.

Rosenthall, S. 1994. Vowel-glide alternations in a theory of constraint interaction. PhD dissertation, University of Massachusetts, Amherst MA.

Rubach, J. 1997. Extrasyllabic consonants in Polish: Derivational optimality theory. In *Derivations and Constraints in Phonology*, I. Roca (ed.), 551–82, Oxford: Clarendon Press.

Rubach, J. 2000. Glide and glottal stop insertion in Slavic languages: A DOT analysis. *Linguistic Inquiry* 31: 271–317.

Rubach, J. 2005. Mid vowel fronting in Ukranian. *Phonology* 22: 1–36.

Saltarelli, M. 1997. Stress in Spanish and Latin: Where morphology meets prosody. In *Issues in the Phonology and Morphology of the Major Iberian Languages*, F. Martínez-Gil and A. Morales-Front (eds), 665–94. Washington DC: Georgetown University Press.

Saporta, S. 1959. Morpheme alternants in Spanish. In *Structural Studies in Spanish Themes*, H. Kahane and A.M. Pietrangeli (eds), 15–162. Salamanca: Acta Salmanticiensia.

Saporta, S. 1962. On the expression of gender in Spanish. *Romance Philology* XV(3): 279–84.

Scharf, G., Henrich, I., Roca, I. and Dogil, G. 1995a. Articulatory correlates of secondary stress in Polish and Spanish. *AIMS [Arbeitspapiere des Instituts für Maschinelle Sprachverarbeitung]* 2(2): 243–64. Universität Stuttgart.

Scharf, G., Henrich, I., Roca, I. and Dogil, G. 1995b. Articulatory correlates of secondary stress in Polish and Spanish. In *Proceedings of the XIIIth International Congress of Phonetic Sciences*, K. Elenius and P. Branderud (eds), Vol. 4, 634–37. Stockholm.

Selkirk, E. 1995. The prosodic structure of function words. In *Papers in Optimality Theory*, J. Beckman, L. Walsh Dickey and Z. Urbanczyk (eds), 439–69. Amherst MA: GLSA.

Smith, J. 2001. Lexical category and phonological contrast. In *PETLE 6: Proceedings of the workshop on the lexicon, phonetics and phonology*, R. Kirchner, J. Pater and W. Wikely (eds), 61–72. Edmonton: University of Alberta.

Vachon, E. 1996. Optimizing Russian Stress. *University of Pennsylvania Working Papers in Linguistics* 3(2): 95–120.

Waltermire, M. 2004. The effect of syllable weight in the determination of Spanish stress. In *Laboratory Approaches to Spanish Phonology*, T. Face (ed.), 171–91, Berlin: Mouton de Gruyter.

Whitley, S. 1976. Stress in Spanish: Two approaches. *Lingua* 39: 301–33.

Morphological structure and phonological domains in Spanish denominal derivation*

Ricardo Bermúdez-Otero
University of Manchester

In Spanish denominal derivation, the stem formative of the base typically disappears before the derivational suffix: e.g. *man-**o*** 'hand', *man-az-a* 'hand.AUG', **man-**o**-az-a*. This pattern can be analysed in two ways: as driven by a morphotactic restriction, or as created by a morphophonological process of stem-final vowel deletion. Following James Harris, most generative linguists have consistently assumed the former; Stratal Optimality Theory, however, requires the latter, for otherwise the interaction between diphthongization and depalatalization gives rise to a stratification paradox. This paper adduces independent morphological evidence to confirm the existence of stem-final vowel deletion in Spanish, as predicted by Stratal Optimality Theory. Our data reveal a previously unrecognized contrast between pseudoplural nouns and nouns with athematic stems ending in /s/, and cast light on the relative rôles of suffixes and infixes in diminutive formation.

Keywords: Stratal Optimality Theory, morphophonology, phonological domain, derivation, stem, inflection class, syntax-morphology mismatch, diminutive, infix

0. Introduction

In Spanish, nominal words fall into a number of inflectional classes, each characterized by a particular stem formative:[1] thus, *o*-stems bear the formative /-o/, *a*-stems bear the

* This paper has benefited from comments, suggestions, and criticism from Eulàlia Bonet, Sonia Colina, Martin Durrell, James Harris, Richard Hogg, Fernando Martínez-Gil, Fabio Montermini, John Payne, Iggy Roca, Anna Thornton, Nigel Vincent, two anonymous reviewers, and the participants of the conference *Deponency and morphological mismatches* organized by the Surrey Morphology Group at the British Academy in London on 16 and 17 January 2006. None of them necessarily agrees with the views expressed here. I alone am responsible for any remaining flaws.

1. Bosque and Demonte (1999: Fifth Part) provide a wealth of information about Spanish morphology. For a survey of theoretical proposals on Spanish noun and adjective inflection, see Ambadiang (1993: First Part). Spanish adverbs are not inflected, but on the basis of their formal properties they

formative /-a/, and *e*-stems bear the formative /-{e,Ø}/ (less frequently, /-e/).[2] Together, these three core classes comprise the vast majority of Spanish nouns and adjectives; athematic stems, which lack stem formatives altogether, are comparatively rare.

(1)		SG	PL	gender	gloss
a.	*o*-stems	*libr-**o***	*libr-**o**-s*	M	'book'
		*niñ-**o***	*niñ-**o**-s*	M	'boy'
		*tont-**o***	*tont-**o**-s*	M	'silly'
		*re-**o***	*re-**o**-s*	M/F	'convict'
		*man-**o***	*man-**o**-s*	F	'hand'
b.	*a*-stems	*libr-**a***	*libr-**a**-s*	F	'pound'
		*niñ-**a***	*niñ-**a**-s*	F	'girl'
		*tont-**a***	*tont-**a**-s*	F	'silly'
		*ingles-**a***	*ingles-**a**-s*	F	'English'
		*pianist-**a***	*pianist-**a**-s*	M/F	'pianist'
		*problem-**a***	*problem-**a**-s*	M	'problem'
c.	*e*-stems	*libr-**e***	*libr-**e**-s*	M/F	'free'
		lápiz-Ø	*lápic-**e**-s*	M	'pencil'
		cruz-Ø	*cruc-**e**-s*	F	'cross'
		*cruc-**e***	*cruc-**e**-s*	M	'crossing'
		inglés-Ø	*ingles-**e**-s*	M	'English'
		común-Ø	*comun-**e**-s*	M/F	'common'
		*inmun-**e***	*inmun-**e**-s*	M/F	'immune'
		hindú-Ø	*hindú-**e**-s*	M/F	'Hindu'
		rey-Ø	*rey-**e**-s*	M	'king'
d.	athematic stems	*menú*	*menú-s*	M	'menus'
		jersey	*jersey-s*	M	'pullover'
		esnob	*esnob-s*	M/F	'snob'
		clip	*clip-s*	M	'paper clip'
		virus	*virus*	M	'virus'
		brindis	*brindis*	M	'toast'

Establishing the exact inventory and underlying distribution of nominal stem formatives is a key task for Spanish morphophonology, for it is impossible to analyse the phonotactics or the metrical system of the language without making crucial assumptions about the phonological behaviour of these elements. Discussions of Spanish stress assignment illustrating this link include Harris (1983: 114–116, 1992: 75–76), Oltra-Massuet and Arregi (2005: §3.1), and Roca (1988: 416, 1991: note 11, 2005: 357–358), among many others.

may be assigned to the same morphological classes as nouns and adjectives (Harris 1983: §5.1.1 endnote 1, 1985: endnote 2); this point does not affect the argument below.

2. In the literature, these suffixes go under many labels, including 'word marker', 'class marker', 'class vowel', 'form-class morpheme', 'theme vowel', 'thematic suffix', 'terminal element', and 'desinence': see Ambadiang (1993: §2.2), Harris (1999: note 3). As will become apparent below, however, the term 'stem formative' reflects their morphological rôle more transparently: in particular, see (25).

On the surface, nominal stem formatives seem never to occur before derivational suffixes. This is one of their most salient properties.

(2)

base		derivative		
*man-**o***	'hand'	*man-az-a*	**man-**o**-az-a*	'hand.AUG'
*problem-**a***	'problem'	*problem-ón-Ø*	**problem-**a**-ón-Ø*	'problem.AUG'
*nub-**e***	'cloud'	*nub-os-o*	**nub-**e**-os-o*	'cloudy'

In principle, there are two possible approaches to the pattern exemplified in (2). One possibility is to posit some sort of morphotactic restriction preventing nominal stem formatives from occurring inside derivational suffixes, as in (3a). In this view, the stem formative of the base is absent from the underlying phonological representation of the derivative, and the morphological structure of the derivative is faithfully reflected in its surface representation. I shall hereafter refer to analyses of this type as 'purely morphological'.

(3) *Purely morphological analysis of* (2)

a. Morphotactic restriction[3]

* SF ⟧ DER ⟧ where SF = stem formative
DER = derivational suffix

b. Phonological mapping

UR	⟦⟦ man ⟧ o ⟧	⟦⟦⟦ man ⟧ aθ ⟧ a ⟧
SR	[má.no]	[ma.ná.θa]
	'hand'	'hand.AUG'

Alternatively, one can postulate a morphologically sensitive phonological process of deletion applying to unstressed stem-final vowels before vowel-initial suffixes. In (4a) I provide a preliminary statement of this process; the precise conditions listed in the structural description are motivated in §2.1 below; tableau (32) offers an optimality-theoretic implementation. In this analysis, which I shall henceforth describe as 'morphophonological', stem-final vowel deletion masks the underlying morphological structure of stem-based derivatives.

(4) *Morphophonological analysis of* (2)

a. Stem-final vowel deletion

$$\mathrm{V} \rightarrow \varnothing \,/\, \overset{\sigma_w}{\underline{\quad}}\,_{\text{stem}}⟧\ ⟦_{\text{suffix}}\,\mathrm{V} \qquad \text{(noniterative)}$$

b. Phonological mapping

UR	⟦ man-o ⟧	⟦⟦ man-o ⟧ aθ-a ⟧
SR	[má.no]	[ma.ná.θa]
	'hand'	'hand.AUG'

The alternative presented by these two approaches has of course not gone unnoticed in the literature (e.g. Pensado Ruíz 1999: 4461). A similar question arises in Italian (Montermini 2003: §2), where Peperkamp (1995) adopts a purely morphological analysis

3. In this paper, morphological categories and the phonological domains associated with them are enclosed within hollow brackets. I use solid brackets for phonetic transcriptions and to mark the edges of prosodic categories.

along the lines of (3), whereas Scalise (1983: 74–78, 287ff.; 1994: 105, 151ff.) posits a rule of vowel deletion analogous to (4a). It is therefore rather surprising to observe that the choice between (3) and (4) has scarcely been discussed in mainstream generative work on Spanish. Within this tradition, most linguists have followed Harris (1983, 1985, 1991, 1992, 1996, 1999) in assuming that Spanish denominal derivational suffixes attach to bases obligatorily lacking stem formatives: e.g. Oltra-Massuet and Arregi (2005: notes 8, 29, 30, 33, 38, 45), Roca (1990: 135, 1991: 604, 2005: 358).[4] The problem calls for closer scrutiny since, as I pointed out above, one cannot describe Spanish stress or Spanish phonotactics without making crucial assumptions about the behaviour of stem formatives.

In this chapter I examine the issue from the viewpoint of Stratal Optimality Theory (StrOT), a version of Optimality Theory (OT) in which morphology-phonology interactions are modelled by means of cyclicity and level segregation, as in Lexical Phonology and Morphology (LPM): see e.g. Bermúdez-Otero (1999, 2003, forthcoming a), Bermúdez-Otero and McMahon (2006), Booij (1996), Inkelas and Zoll (2005), Kiparsky (1998, 2000, 2003), and Orgun (1996), among others. It turns out that, in a highly constrained version of StrOT allowing no more than three phonological levels, the purely morphological analysis of Spanish nominal stem formatives shown in (3) leads to insurmountable difficulties: it creates a *stratification paradox* involving the two well-known phonological phenomena of diphthongization and depalatalization. In consequence, StrOT forces one to countenance the long-neglected morphophonological hypothesis set out in (4). Gratifyingly, this turns out to be the correct option: morphological arguments independent from diphthongization and depalatalization consistently favour (4) over (3). This result provides strong support for StrOT, which emerges from the trial as an empirically adequate, highly restrictive, and heuristically powerful model of grammar.

The chapter is organized as follows. Section 1 introduces the key principles of StrOT and shows how their application to Spanish requires the postulation of a morphophonological process of stem-final vowel deletion. In Section 2, I examine and refute Harris's arguments for the purely morphological analysis of nominal stem formatives: Section 2.1 shows that stem-final vowel deletion is motivated independently by the behaviour of verb stems; Section 2.2 examines denominal derivation with consonant-initial suffixes; and Section 2.3 adduces new evidence to disprove Harris's claim that, in words such as *virus* 'virus' and *brindis* 'toast', the final /Vs/ string is an exotic 'word marker' (cf. (1d)). Significantly, the data presented in Section 2.3 reveal

4. To be precise, Oltra-Massuet and Arregi (2005: note 8) assert that nominal stem formatives do indeed occur inside derivational suffixes but are phonologically null in that environment. Instead of (3a), therefore, Oltra-Massuet and Arregi would assume an allomorphy rule along the lines of (i), applying specifically to *nominal* stem formatives:

(i) NSF → /-Ø/ / __ ⟧ DER ⟧ where NSF = nominal stem formative

This qualification is immaterial to our purposes: the question is whether or not Spanish denominal derivation involves the deletion of stem-final *vowels* before vowel-initial suffixes.

a previously unrecognized contrast between pseudoplural nouns (e.g. sg. *Sócrat-e-s* 'Socrates', pl. *Sócrat-e-s*, dim.sg. *Socrat-it-o*) and nouns with athematic stems ending in /s/ (e.g. sg. *virus*, pl. *virus*, dim.sg. *virus-it-o*). In addition, the behaviour of pseudoplural bases casts new light on the relative rôles of suffixes and infixes in Spanish diminutive formation. Section 3 comments on the significance of our results.

1. The view from Stratal Optimality Theory

1.1 Principles

StrOT aims to solve the problem of phonological misapplication in OT assuming no correspondence relationships other than input-output faithfulness; it therefore rejects both output-output correspondence (e.g. Benua 1997) and sympathy (McCarthy 1999). In addition, StrOT generates nonparadigmatic opacity by the same means as cyclic effects (Bermúdez-Otero 2003: §8; Bermúdez-Otero and McMahon 2006: §3.2). The theory relies on three basic concepts: those of domain, cycle, and level (Bermúdez-Otero forthcoming a: ch. 2).

Phonology may be thought of as a function $\mathscr{P}$ mapping input representations onto the corresponding outputs. In OT, $\mathscr{P}$ is modelled as a pass through Gen and Eval:

(5) $\mathscr{P}(\mathrm{x}) = \mathscr{Eval}(\mathscr{Gen}(\mathrm{x}))$

In StrOT, however, $\mathscr{P}$ applies recursively: certain constituents in the morphosyntactic structure of a linguistic expression (or, alternatively, certain operations in its morphosyntactic derivation) define domains for $\mathscr{P}$; each such domain provides the input for an application of $\mathscr{P}$. Bermúdez-Otero (forthcoming a: ch. 2) argues that the relationship between grammatical structure and phonological domains is in fact one of simplification: each phonological domain is exactly coextensive with some grammatical constituent, but not every grammatical constituent defines a phonological domain (cf. Inkelas 1990, Orgun 1996).[5] Within the nested hierarchy of phonological domains associated with any linguistic expression, $\mathscr{P}$ applies cyclically in the sense of Chomsky and Halle (1968: 15). However, domains associated with different types of grammatical constituent (or, alternatively, with different types of grammatical operation) may invoke different rankings of Con: it is in this sense that domains are said to belong to different 'levels'. Thus, for example, if a linguistic expression *e* has the domain structure shown in (6a), where the subscript indices denote the level to which each domain belongs, the surface representation of *e* will be specified by the composite function (6b).

(6) a. $e = [_{\mathrm{c}} [_{\mathrm{b}} [_{\mathrm{a}} x]] [_{\mathrm{b}} [_{\mathrm{a}} y] z]]$
b. $\mathscr{P}(e) = \mathscr{Eval}_{\mathrm{c}}(\mathscr{Gen}(\mathscr{Eval}_{\mathrm{b}}(\mathscr{Gen}(\mathscr{Eval}_{\mathrm{a}}(\mathscr{Gen}(x)))), \mathscr{Eval}_{\mathrm{b}}(\mathscr{Gen}(\mathscr{Eval}_{\mathrm{a}}(\mathscr{Gen}(y)), z))))$

5. It is vital not to confuse *phonological domains*, which are arguments of $\mathscr{P}$, with *prosodic units* such as ω, φ, I, or U, which are constituents of phonological representations: see Bermúdez-Otero (forthcoming a: ch. 2). Booij and Rubach (1984) draw the same elementary distinction using the terms 'morphological domain' vs 'prosodic domain'.

In principle, this theoretical programme could be implemented in several ways. Bermúdez-Otero (forthcoming a) is primarily concerned with providing a highly restrictive version of StrOT that will curb the complexity of opacity effects and facilitate the acquisition of opaque interactions. This is best achieved in two ways: by limiting the number of phonological levels within the grammar, and by constraining the ascription of grammatical categories to phonological levels. Therefore, following a long tradition of research both within and outside LPM, Bermúdez-Otero (forthcoming a) adopts the hypothesis that, universally, grammars distinguish just three phonological levels: the stem level (SL), the word level (WL), and the phrase level (PL); see also Kiparsky (1998, 2000, 2003). Within this version of StrOT, the relationship between morphological constructions and phonological levels is regulated by principles that refer to three key morphological categories: root, stem, and word. In brief, a stem is defined as a form that can provide the base for an inflectional operation; roots cannot be inflected without first undergoing root-to-stem conversion (overtly or covertly), whereas words are fully inflected (i.e. syntactically free).

(7) *Morphological categories*

	inflectable?	**fully inflected?**
root		
stem	✓	
word	(✓)	✓

On this basis, the grammar is set up in such a way as to enforce the following correspondences between grammatical constructions and phonological domains (for detailed discussion, see Bermúdez-Otero forthcoming a: ch. 2):

(8) a. Roots do not define phonological domains.
b. A phonological domain associated with an operation of root-to-stem derivation must be stem-level.
c. Every morphological word defines a word-level domain.
d. The highest phrasal category in the linguistic expression defines a phrase-level domain.

At this point, it is important to note that terms such as 'stem-level' and 'stem-based' are not synonymous: the former refers to the *phonological* properties of an affix; the latter, to its *morphological* subcategorization requirements. Thus, an affix is stem-level if it defines phonological domains that invoke the stem-level constraint hierarchy; it is stem-based if it attaches to stems. Thus, an affix may be root-based and stem-level, stem-based and stem-level, stem-based and word-level, etc.; by (8b), however, it cannot be root-based and word-level.

In terms of learnability, the austere implementation of StrOT outlined in this section enjoys significant advantages. First, the phonological domain structure of linguistic expressions remains relatively simple; there is no proliferation of cycles (cf. Orgun

1996).[6] Secondly, learners with access to the grammatical structure of linguistic expressions can easily discover their phonological domain structure.

1.2 A stratification paradox?

However, if scholars like Harris, Roca, and Oltra-Massuet and Arregi are right in their view of Spanish nominal stem formatives, then the StrOT model I have just outlined proves *too* austere: this section will show that, in a system with no more than three phonological levels, positing underlying representations along the lines of (3b) leads to a stratification paradox. The problem arises over the stratal ascription of two well-known phonological phenomena: so-called 'diphthongization' and 'depalatalization'. For the sake of convenience I shall retain these traditional labels here, although, as we shall see presently, in neither case does a phonological process derive surface alternants synchronically from a common underlier.

1.2.1 *Diphthongization*

So-called 'diphthongization' affects a sizable but idiosyncratic set of lexical items that display an alternation between the diphthongs /je, we/ and the mid vowels /e, o/: the diphthongs appear in tonic syllables, the mid vowels elsewhere. See Cole (1995: §6.2) for a survey of LPM analyses, and Eddington (2004: §6.1) for a summary of psycholinguistic approaches.

(9) a. Alternating items

[**ʝé**r-o]	'iron'	[**e**r-éɾ-o]	'blacksmith'
[p**wé**ɾt-a]	'door'	[p**o**ɾt-éɾ-o]	'doorman'
[d**jé**nt-e]	'tooth'	[d**e**nt-ál-Ø]	'dental'
[m**wé**ɾt-e]	'death'	[m**o**ɾt-ál-Ø]	'mortal'
[θ**jé**ɣ-o]	'blind'	[θ**e**ɣ-eðá^{ð}-Ø]	'blindness'
[n**wé**β-o]	'new'	[n**o**β-eðá^{ð}-Ø]	'novelty'

6. Insofar as the complexity of the learner's task increases in proportion to the number of steps in the derivation, the most desirable theory is that which allows the minimum number of cycles compatible with the description of all attested opacity effects. This in no way implies that noncyclic approaches to opacity (e.g. Sympathy Theory) are preferable, for such approaches incur learnability costs of their own, which may well be more onerous than those of StrOT. In fact, Bermúdez-Otero (2003) shows that StrOT facilitates the acquisition of opacity effects, whereas Sympathy Theory makes the task harder.

In addition, it is perfectly possible to allow two or more construction-specific cophonologies within a given level (Anttila 2002; Inkelas 1998; Inkelas, Orgun & Zoll 1997; Inkelas & Zoll 2003, 2005; Orgun 1996) without thereby increasing the number of cycles in each derivation. This is because same-level cophonologies are mutually exclusive. For example, consider a language with two stem-level cophonologies SL*a* and SL*b*. In such a language, the phonological domain structure of a word *x* consisting of a single stem without overt inflection will be either ⟦$_{WL}$ ⟦$_{SLa}$ —⟧⟧ or ⟦$_{WL}$ ⟦$_{SLb}$ —⟧⟧. In other words, *x* will go through cophonology SL*a* or through cophonology SL*b*, but not through both. For an illustration, see the discussion of English stem-level cophonologies in Bermúdez-Otero and McMahon (2006: §4). Inkelas and Orgun (1995) advance a similar idea under the label of 'level economy'.

b. Nonalternating items

[θ**é**st-a]	'basket'	[θ**e**st-éɾ-o]	'basket weaver'
[p**ó**θ-o]	'well'	[p**o**θ-éɾ-o]	'well digger'
[a^{k}θið**é**nt-e]	'accident'	[a^{k}θið**e**nt-ál-Ø]	'accidental'
[k**ó**ɾ-o]	'chorus'	[k**o**ɾ-ál-Ø]	'choral'
[t**é**ɾk-o]	'stubborn'	[t**e**ɾk-eðá^{ð}-Ø]	'stubbornness'
[m**ó**θ-o]	'young'	[m**o**θ-eðá^{ð}-Ø]	'youth'

I assume that alternating items have two lexically listed allomorphs, whereas nonalternating items have a single underlying representation:

(10) a. Alternating items

/p $\left\{\begin{matrix}\text{o}\\ \text{we}\end{matrix}\right\}$ ɾt-a/

'door'

b. Nonalternating items

/poθ-o/

'well'

In this view, diphthongization involves phonological selection between listed allomorphs (e.g. Kager 1996; Mascaró 1996; McCarthy 2002: 152–5, 183–4; Rubach and Booij 2001): the phonological constraint hierarchy preserves the quality of input vowels, but, when given the choice, favours diphthongs in tonic syllables and monophthongs elsewhere. This effect is illustrated in tableau (11), where I use Tonic→Diphthongal as an informal label for whatever context-sensitive markedness constraints favour diphthongs in tonic syllables, whilst *Diphthong is a context-free markedness constraint requiring pure vowels.

(11)

morphology	phonology: input	phonology: output	Ident	Tonic→ Diphthongal	*Diphthong
⟦p{o,we}ɾt-a⟧	/poɾt-a/	[pwéɾ.ta]	*!		*
		[póɾ.ta]		*!	
	☞ /pweɾt-a/	☞ [pwéɾ.ta]			*
		[póɾ.ta]	*!	*	
⟦⟦p{o,we}ɾt-a⟧eɾ-o⟧	☞ /poɾt-a-eɾ-o/	[pweɾ.té.ɾo]	*!	(*)	*
		☞ [poɾ.té.ɾo]		(*)	
	/pweɾt-a-eɾ-o/	[pweɾ.té.ɾo]		(*)	*!
		[poɾ.té.ɾo]	*!	(*)	
⟦poθ-o⟧	/poθ-o/	[pwé.θo]	*!		*
		☞ [pó.θo]		*	
⟦⟦poθ-o⟧eɾ-o⟧	/poθ-o-eɾ-o/	[pwe.θé.ɾo]	*!	(*)	*
		☞ [po.θé.ɾo]		(*)	

For our present purposes, the crucial point is that the selection of the diphthongal allomorph under primary stress overapplies in the presence of certain stress-attracting affixes, such as superlative *-ísim-o* and the so-called 'evaluative' suffixes, i.e. diminutive *-(ec)it-o*, augmentative *-az-o*, *-ón-Ø*, etc.

(12)	a.	Base	[b**wé**n-o]	'good'
	b.	Normal nonapplication	[b**o**n-dá^{ð}-Ø]	'goodness'
	c.	Overapplication	[b**we**n-ísim-o]	'best'
			[b**we**n-áθ-o]	'good.AUG'
			[b**we**n-ón-Ø]	'good.AUG'
			[b**we**n-(eθ)ít-o]	'good.DIM'[7]

In StrOT, the overapplication effect in (12c) shows that the domain of diphthongization excludes superlative *-ísim-o* as well as the evaluative suffixes. Accordingly, we must infer that diphthongization is a stem-level process; that suffixes such as *-er-o*, *-al-Ø*, and *-(i)dad-Ø* are stem-level; and that superlative *-ísim-o* and the evaluative suffixes are word-level.[8]

(13)		*portero*	*puertita*
	domain structure	⟦$_{\text{WL}}$ ⟦$_{\text{SL}}$ p {o / we} ɾt-a-eɾ-o ⟧⟧	⟦$_{\text{WL}}$ ⟦$_{\text{SL}}$ p {o / we} ɾt-a ⟧ it-a ⟧⟧
	SL (Diphthongization)	poɾ.té.ɾo	pwéɾ.ta
	WL	poɾ.té.ɾo	pweɾ.tí.ta
		'doorman'	'door.DIM'

1.2.2 *Depalatalization*

It has long been known that Spanish does not tolerate palatal consonants in domain-final position (Alonso 1945: 96–97). In this chapter the term 'depalatalization' will refer to this phonotactic restriction. The precise nature of the markedness constraint responsible for it need not concern us here; below I shall use *CODA/PAL for convenience.

(14)	a.	Palatal in onset position		b.	Nonpalatal in domain-final position	
		[deş.ðe.**ɲ**áɾ]	'to disdain'		[deş.ðé**n**]	'disdain (N)'
		[don̪.θé.**ʎ**a]	'lass'		[don̪.θé**l**]	'lad'

7. There is variation between *buen-**ecit**-o* and *buen-**it**-o* depending on dialectal and stylistic factors.

8. Certain suffixes, notably *-ist-a*, exhibit symptoms of dual level membership: e.g. [k**wé**nt-o] 'tale' ~ [k**o**nt-á-ɾ] 'to tell' ~ [k**we**nt-íst-a] 'fabulist', vs [d**jé**nt-e] 'tooth' ~ [d**e**nt-ál-Ø] 'dental' ~ [d**e**nt-íst-a] 'dentist'; see Eddington (2004: 104). *Pace* Eddington, however, dual level membership is not a problem for StrOT: a suffix may be able to attach at both the stem level and the word level subject only to constraint (8b), whereby a root cannot be the base of a word-level construction. For further discussion of dual level membership, see Giegerich (1999).

Superlative *-ísim-o* behaves as a stem-level suffix in a few learnèd words typical of highly formal registers: e.g. [b**o**n-ísim-o] 'best', alongside colloquial [b**we**n-ísim-o]; [n**o**β-ísim-o] 'newest', alongside [n**we**β-ísim-o]; etc. In addition, augmentative *-ach-o* is exceptional among the evaluative suffixes by being typically stem-level: e.g. [k**o**ɾp-átʃ-o] 'body.AUG', cf. [k**wé**ɾp-o] 'body'; [f**o**ɾt-atʃ-ón-Ø] 'strong.AUG.AUG', cf. [f**wé**ɾt-e] 'strong'; etc.

The literature on the subject is abundant: for Harris's last statement on the subject, see Harris (1999); for a recent optimality-theoretic treatment, see Lloret and Mascaró (2005).

It should be noted that, synchronically, the alternants shown in (14) are not derived from a common underlier (Hualde 1989: §6; cf. Lloret and Mascaró 2005). Psycholinguistic experimentation indicates that these alternations are unproductive: native speakers fail to extend them to neologisms (Pensado Ruíz 1997; Eddington 2004: §3.4). This conclusion agrees well with the internal evidence. Observe that, as far as their morphology is concerned, *desdén*-Ø and *doncel*-Ø are perfectly ordinary *e*-stem nouns, as shown by their plural forms: *desden-**e**-s*, *doncel-**e**-s*; see (1c). After illegal domain-final sequences, however, singular *e*-stem nouns select the /-e/ allomorph of the stem formative; the /-Ø/ allomorph appears only after permissible domain-final strings (Harris 1999; Bermúdez-Otero forthcoming a: ch. 4).[9] By implication, no singular *e*-stem noun or adjective ends in a sequence that is forbidden domain-finally in the core vocabulary: if the /-e/ formative is absent in that environment, then it is also absent in the plural, showing the stem to be athematic rather than a member of the *e*-class. Examples include partially assimilated loans such as sg. *cli*[p] 'paper clip' ~ pl. *clip-s*, not **clip-e-s*.[10] There is thus an altogether natural and predictable relationship of implication between phonological markedness and morphological structure in Spanish nominal morphology: speakers know tacitly that, if a singular noun or adjective is phonotactically deviant, then it cannot belong to one of the core native stem classes and must consequently be athematic.[11] However, this entails that a hypothetical *e*-stem noun derived from the root /desdeɲ-/ would surface as **desde*[ɲ]-*e*, not *desdé*[n]-Ø: see tableau (15).[12] Synchronically, therefore, the alternation between the verb *desdeñ-a-r* and the noun *desdén*-Ø is suppletive.

9. As we saw in §0, there is a minority of *e*-stem nouns that display the /-e/ allomorph in the singular even after a legal domain-final sequence: e.g. *cru*[θ]-***e***, *inmu*[n]-***e***; see (1c). In these nouns, the underlying representation of the stem formative is /-e/, rather than the more frequent /-{e, Ø}/.

10. *Clip* /klip/ has been nativized segmentally but not phonotactically: Spanish /i/ has been substituted for English /ɪ/, but /p/ is not tolerated word-finally in the native Spanish vocabulary (see Harris 1992: 66, 1999: 57).

11. In Peninsular Spanish the only exception to this generalization is *vals*-Ø ~ *vals-**e**-s* 'waltz', plus a tiny handful of nouns ending in /x/, on which see Alonso (1945: footnote 4). Notoriously, the Real Academia de la Lengua has misunderstood this simple fact and throws its prescriptive authority behind artificial creations such as *álbu*[m]-Ø ~ *álbu*[m]-*e-s*, though without much success: in the playground one consistently hears either *álbu*[n]-Ø ~ *álbu*[n]-*e-s* or *álbu*[m] ~ *álbu*[m]-*s*.

12. The tableau omits the effects of phrase-level allophonic processes. Final-C is the well-known constraint requiring prosodic words to end in a consonant (McCarthy 1993: 176).

(15)

morphology	phonology input	phonology output	Max-V	Dep-V	*Coda/Pal	Ident-Place	Final-C
actual UR ⟦desden-{e,Ø}⟧	/desden-e/	[des.dé.ne]					*!
		[des.déɲ]	*!		*	*	
		[des.dén]	*!				
	☞ /desden-Ø/	[des.dé.ne]		*!			*
		[des.déɲ]			*!	*	
		☞ [des.dén]					
counterfactual UR ⟦desdeɲ-{e,Ø}⟧	💣/desdeɲ-e/	💣 [des.dé.ɲe]					*
		[des.déɲ]	*!		*		
		[des.dén]	*!			*	
	/desdeɲ-Ø/	[des.dé.ɲe]		*!			*
		[des.déɲ]			*!		
		[des.dén]				*!	

Of course, even though the alternations in (14) are lexically listed rather than synchronically derived, depalatalization remains perfectly robust as a principle of allomorph selection and as a static phonotactic restriction, as shown by the evidence of loan adaptation.

In the present context, the interest of depalatalization lies in the fact that it applies not only in phrase-level and word-level domains, but also in sublexical domains which can be proved to be stem-level. The crucial piece of evidence is this: word-final consonants never have palatal alternants before word-level suffixes such as augmentative *-az-o* or diminutive *-(ec)it-o*.

(16)	a.	Base		b.	Word-level derivative	
		[don̪.θé**l**]	'lad'		[don̪.θe.**l**í.to]	*[don̪.θe.**ʎ**í.to]
		[pjé**l**]	'leather'		[pje.**l**(e.θ)í.ta]	*[pje.**ʎ**(e.θ)í.ta][13]

However, if palatals were permitted domain-finally at the stem level, then this type of alternation would be possible. Consider, for example, the derivation of the singular and the diminutive singular forms of a hypothetical *e*-stem noun /kantiʎ-{e,Ø}/.[14] With depalatalization active only at the word level, the result would be an impossible alternation between [kan.tíl] and [kan.ti.ʎí.to].

13. Cf. [peʎ-éx-o] 'hide', [peʎ-íθ-a] 'fleece jacket'. These forms are highly revealing, as the absence of diphthongization in the root-vowel independently confirms that they are stem-level constructions: see §1.2.1.

14. Richness of the Base prevents us from stipulating that such nouns do not exist.

(17)			SG	DIM.SG
	a.	*Incorrect derivation*		
		domain structure	⟦$_{WL}$ ⟦$_{SL}$ kantiʎ-{e,Ø}⟧⟧	⟦$_{WL}$ ⟦$_{SL}$ kantiʎ-{e,Ø }⟧ it-o ⟧
		SL (*Coda/Pal ranked **low**)	kan.tíʎ	kan.tíʎ
		WL (*Coda/Pal ranked high)	kan.tí**l**	kan.ti.**ʎ**í.to
	b.	*Correct derivation*		
		domain structure	⟦$_{WL}$ ⟦$_{SL}$ kantiʎ-{e,Ø}⟧⟧	⟦$_{WL}$ ⟦$_{SL}$ kantiʎ-{e,Ø}⟧ it-o ⟧
		SL (*Coda/Pal ranked high)	kan.tí.ʎe	kan.tí.ʎe
		WL (*Coda/Pal ranked high)	kan.tí.**ʎ**e	kan.ti.**ʎ**í.to

We must conclude that palatals are banned domain-finally already at the stem level.

Note that our analysis correctly predicts that depalatalization cannot cause alternations between the singular and plural forms of *e*-stem nouns. As noted by Harris (1999: 69) and Bermúdez-Otero (forthcoming a: ch. 4), Spanish has a morphological rule, stated informally in (18) below, which requires *e*-stem nominals to take the nonnull allomorph of their stem formative before the plural suffix. The presence of -*e*- in plurals such as [indú-**e**-s] 'Hindus' and [ré̯j-**e**-s] 'kings' fulfils a morphological requirement, not a phonotactic one: *[indú-Ø-s] and *[rej-Ø-s] are phonotactically impeccable; cf. [aw.to.βús] 'bus', [xe.sús] 'Jesus', [sejs] 'six', [bejs] 'beige'. In the same way, constrasts such as [indú-**e**-s] 'Hindus' vs [menú-s] 'menus' or [ré̯j-**e**-s] 'kings' vs [xeɾséj-s] 'pullovers' are symptomatic of a morphological distinction (that between *e*-stems and athematic stems) rather than the operation of a phonological process. See further Bonet (this volume) and Colina (2003a, 2003b).

(18)

NSF

-{e,Ø} → -e / __ ⟧ -s ⟧

Accordingly, plural *e*-stem nouns and adjectives take the /-e/ formative regardless of the shape of the root. However, if the root ends in a palatal, then the singular form will also select the /-e/ allomorph in order to satisfy *Coda/Pal: see tableau (15).

(19)			SG	PL
	a.	*Palatal-final root*: 'street'		
		domain structure	⟦$_{WL}$ ⟦$_{SL}$ kaʎ-{e,Ø }⟧⟧	⟦$_{WL}$ ⟦$_{SL}$ kaʎ-e ⟧ s ⟧
		SL	ká.ʎe	ká.ʎe
		WL	ká.**ʎ**e	ká.**ʎ**es
	b.	*Non-palatal-final root*: 'lime'		
		domain structure	⟦$_{WL}$ ⟦$_{SL}$ kal-{e,Ø}⟧⟧	⟦$_{WL}$ ⟦$_{SL}$ kal-e ⟧ s ⟧
		SL	kal	ká.le
		WL	ka**l**	ká.**l**es

In this sense, depalatalization does *not* overapply in plural *e*-stems. Although one can use output-output correspondence to account for the absence of alternations such as *[kan.tí**l** ~ kan.tí.**ʎ**es], such a solution relies on a misrepresentation of the morphological facts (*pace* Lloret and Mascaró 2005).[15]

15. Although the analysis proposed in Bermúdez-Otero (1999: §3.3.2) did not appeal to output-output correspondence, it too relied on an imperfect understanding on the morphological facts.

1.2.3 *The paradox and its solution*

So far, this section has established the following points:

1. diphthongization applies at the stem level;
2. palatal consonants in domain-final position are prohibited at all levels;
3. superlative *-ísim-o* and the evaluative suffixes are word-level.

In this light, consider now the following data:

(20)	a.	Base	b.	Stem-level derivative	c.	Word-level derivative
		[kwéʎ-o]		[koʎ-áɾ-Ø]		[kweʎ-áθ-o]
		'neck'		'collar, necklace'		'neck.AUG'

Paradigms of this type are interesting because they show three phenomena occurring simultaneously:

1. the root ends in a palatal consonant;
2. the root is subject to the diphthongization alternation;
3. as per (2) above, the stem formative of the base fails to surface in derivationally related forms.

For our purposes, the crucial datum is augmentative *cuell-az-o*: (20c). It shows overapplication of diphthongization, which is entirely expected since the suffix *-az-o* is word-level. The question is: how should we account for the fact that the root-final consonant fails to depalatalize?

Let us first assume that the purely morphological approach outlined in (3) gives us the correct analysis of the behaviour of Spanish nominal stem formatives. If so, the morphological structure of *cuell-az-o* will be the following:

(21) ⟦⟦⟦ k{o,we}ʎ ⟧ aθ ⟧ o ⟧

This underlying representation creates a dilemma. If *-az-o* is indeed a word-level suffix, then the underlying /ʎ/ will be domain-final in the stem-level cycle and incorrectly undergo depalatalization: see (22a). If, in contrast, *-az-o* is already visible to the phonology in the stem-level cycle, then the palatal will be syllabified in onset position and escape depalatalization, but the root-vowel will incorrectly fail to diphthongize: see (22b). In other words, we have a *stratification paradox*: the augmentative construction can be neither stem-level nor word-level, yet it must be one of the two.

(22)	a.	*-az-o* is word-level		b.	*-az-o* is stem-level
		domain structure	$⟦_{WL}$ $⟦_{SL}$ k{o,we}ʎ ⟧ aθ-o⟧		$⟦_{WL}$ $⟦_{SL}$ k{o,we}ʎ-aθ-o⟧⟧
		SL	kwél		ko.ʎá.θo
		WL	*kwe.lá.θo		*ko.ʎá.θo[16]

16. Of course, [ko.ʎá.θo] exists, but only as a derivationally opaque surname, not as the augmentative of [kwé.ʎo].

And, recall, we cannot solve the problem by turning depalatalization off at the stem level because that would give rise to unattested alternations such as *[kan.tíl ~ kan. ti.ʎí.to]; see (17).

The alternative hypothesis is that, in the output of the morphology, *cuell-az-o* has the structure shown in (23); the disappearance of the stem formative of the base is caused by the phonological process of stem-final vowel deletion described in (4a).

(23) ⟦⟦ k{o,we}ʎ-o ⟧ aθ-o ⟧

If we take this view, the stratification paradox evaporates. In the stem-level cycle, the stem formative of the base provides an onset position for the root-final consonant, which accordingly evades depalatalization. In the word-level cycle, the palatal remains in the onset despite stem-final vowel deletion, but stress migrates to the augmentative suffix, causing diphthongization to overapply.

(24) domain structure ⟦$_{WL}$ ⟦$_{SL}$ k{o,we}ʎ-o ⟧ aθ-o ⟧
SL kwé.ʎo
WL kwe.ʎá.θo

We must conclude that nominal stem formatives do occur inside derivational suffixation. Thus, the internal logic of StrOT drives one inexorably to reject the view of Spanish nominal morphology assumed by Harris, Roca, and Oltra-Massuet and Arregi. Insofar as the endings /-o/, /-a/, and /-e/ can precede derivational suffixes, they cannot be 'word markers' in the sense of Harris (1985), but must be genuine stem formatives: i.e. meaningless morphs added to the root in order to satisfy a 'morphomic' constraint on stem well-formedness (Aronoff 1994). Logically, if a denominal derivative is stem-based (as opposed to root-based), the derivational affix will attach outside the stem formative of the base. More generally, nouns and adjectives belonging to the three core classes (i.e. *o*-stems, *a*-stems, and *e*-stems) turn out to have exactly the same tripartite morphological structure as verbs:

(25) *Morphological structure of major-category words (*modulo *athematic nominals)*
a. ⟦$_{Word}$ ⟦$_{Stem}$ ⟦$_{Root}$ —— ⟧ SF ⟧ INFL ⟧ where SF = stem formative
INFL = inflectional affixes
b. verbs *amábamos*
⟦$_{Word}$ ⟦$_{Stem}$ ⟦$_{Root}$ am ⟧ -á ⟧ -ba -mos ⟧
love -SF -PRET.IPFV.IND -1PL
'we loved'
c. nouns *niños*
⟦$_{Word}$ ⟦$_{Stem}$ ⟦$_{Root}$ níɲ ⟧ -o ⟧ -s ⟧
boy -SF -PL
'boys'

In sum, the austere implementation of StrOT outlined in §1.1 makes very precise predictions about denominal word-formation in Spanish: in particular, it predicts that stem-based denominal derivatives are subject to the phonological process of stem-final vowel deletion formulated in (4a). In the remainder of this chapter I demonstrate that this prediction is, in fact, correct.

2. The morphological evidence

Over the years, Harris has grounded his rejection of stem-final vowel deletion on three claims:

1. stem-final vowel deletion has no independent motivation (Harris 1991: footnote 9);
2. stem-final vowel deletion cannot account for the absence of nominal stem formatives before derivational suffixes beginning with a consonant (Harris 1983: 92, 147; 1996: 104);
3. stem-final vowel deletion cannot account for the behaviour of exotic 'word markers' such as *-us* in *vir-us*, or *-is* in *brind-is* (e.g. Harris 1992: 66, 75).

In this section I show that each of these three claims is false (see also Bermúdez-Otero forthcoming a: ch. 4).

2.1 Stem-final vowel deletion in verb stems

Discussing the contrast between the noun [éɾo-**e**] 'hero' and its derivatives [eɾo-ín-a] 'heroine', [eɾo-íș̬m-o] 'heroism', Harris (1991: footnote 9) asserts that the final vowel of the base "is not an integral part of the stem" because "there is no independently motivated rule that would delete such a stem-final vowel". This claim can be easily disproved, for the process of stem-final vowel deletion required to describe denominal derivation operates in exactly the same way in deverbal derivation and verbal inflection.

As is well-known, Spanish verbs fall into three inflectional classes ('conjugations'), characterized by the stem formatives /-a/, /-e/, and /-i/; these are subject to allomorphic patterns of gradation whose details need not concern us here (see e.g. Harris 1997: 547). The data in (26) show that verb stem formatives surface before consonant-initial derivational suffixes. Thus, Harris must stipulate that verb stems are exempt from the putative morphotactic restriction in (3a).[17]

(26)	a. infinitive		b. *nomen agentis*	c. participle
	*caz-**a**-r*	'hunt'	*caz-**a**-dor-Ø*	*caz-**a**-d-o*
	*habl-**a**-r*	'talk'	*habl-**a**-dor-Ø*	*habl-**a**-d-o*
	*com-**e**-r*	'eat'	*com-**e**-dor-Ø*	*com-**i**-d-o*
	*beb-**e**-r*	'drink'	*beb-**e**-dor-Ø*	*beb-**i**-d-o*
	*hac-**e**-r*	'do'	*hac-**e**-dor-Ø*	*hech-o*
	*pon-**e**-r*	'put'	*pon-**e**-dor-Ø*	*puest-o*
	*abr-**i**-r*	'open'	*abr-**i**-dor-Ø*	*abiert-o*
	*dec-**i**-r*	'say'	*dec-**i**-dor-Ø*	*dich-o*

17. Similarly, Oltra-Massuet and Arregi (2005) require a special allomorphy rule specific to nominal bases: see note 4 above.

Observe that the derived *nomina agentis* in (26b) cannot be analysed as departicipial formations in *-or-Ø* because they do not preserve the gradation and suppletion patterns of the corresponding participles. Needless to say, they are not deinfinitival either: rather, they are based on the verb stem. For example, *caz-a-dor-Ø* 'hunter' (pl. *caz-a-dor-e-s*) has the underlying representation shown in (27).

(27) ⟦$_N$ ⟦$_V$ kaθ-a ⟧ doɾ-{e,Ø} ⟧

Consider now the augmentative suffix *-ón-Ø*. This can be added not only to nominal stems, but also to verb stems, from which it derives *nomina agentis* with jocular or derogatory connotations. By principle (8b), these constructions must be stem-based rather than root-based, since *-ón-Ø* is a word-level suffix: see §1.2.1, particularly (12). Moreover, the examples in (28b) are unambiguously deverbal, since they differ morphologically and/or semantically from the corresponding *nomina actionis* (Lázaro Mora 1999: 4673). Crucially, however, the augmentative *nomina agentis* lose the stem formative of the base before the initial vowel of the suffix.

(28)	a.	infinitive		b.	*nomen agentis* (AUG)	c.	*nomen actionis*
		*acus-**a**-r*	'accuse'		*acus-ón-Ø*		*acuse, acusación*
		*fisg-**a**-r*	'pry'		*fisg-ón-Ø*		*fisgoneo*
		*trag-**a**-r*	'swallow'		*trag-ón-Ø*		*trago*
		*respond-**e**-r*	'answer'		*respond-ón-Ø*		*respuesta*

The contrast between (26b) and (28b) indicates that, in deverbal derivation, the stem formative of the base surfaces before consonant-initial suffixes but is deleted before vowel-initial suffixes, exactly as predicted by (4a).

In fact, stem-final vowel deletion applies in precisely the same way regardless of the syntactic category of the base. First, it does not iterate:

(29)	a.	Denominal derivation			
		base		derivative	
		*héro-**e***	'hero'	*hero-ín-a*, **her-in-a*	'heroine'
		*bacala-**o***	'cod'	*bacala-ít-o*, **bacal-it-o*[18]	'cod.DIM'
	b.	Deverbal derivation			
		base		derivative	
		*pele-**a**-(r)*	'fight'	*pele-ón-Ø*, **pel-ón-Ø*	'quarrelsome'
		*mare-**a**-(r)*	'make dizzy'	*mare-ón-Ø*, **mar-ón-Ø*	'dizzying'

Secondly, stem-final vowel deletion does not aply to underlyingly accented vowels. In (30) I provide two examples from denominal derivation. Note that the bases *café* and *papá* are athematic stems, not *e*-stems, since their respective plurals are *café-s* and *papá-s*.[19] In both, the final vowel must be underlyingly accented because final stress is a marked pattern for CVCV nouns (see e.g. Roca 1988: 398).

18. There also exists a suppletive diminutive *bacala**d**-it-o*, which has arisen from *bacala-ít-o* through hypercorrection of intervocalic *-d-* loss.

19. There formerly existed an *e*-stem plural *cafe-**e**-s*, now fallen into desuetude. It occurs, for example, in *El Duende de los Cafees* 'The Goblin of the Cafés', the title of a nineteenth-century Spanish newspaper.

(30)	a.	base		b.	derivative	
				UR	SR	
		café	'coffee'	⟦⟦ kafé ⟧ in-a ⟧	[ka.fe.í.na], *[ka.fí.na]	'caffeine'
		papá	'Dad'	⟦⟦ papá ⟧ it-o ⟧	[pa.pa.í.to][20]	'Dad.DIM'

The same phenomenon can be observed in verbal inflection. In the preterite imperfective indicative, for example, stress falls consistently on the stem formative. This pattern gives rise to prosodic configurations that are otherwise unattested in the native vocabulary. Notably, second-person plural forms have penultimate stress despite containing a falling diphthong in their final syllable: see (31b). This metrical pattern is impossible in nonverbal forms: e.g. [kom.bój] 'convoy', not *[kóm.boj] (Harris 1983: §4.4.2, 1995: 870; Roca 1988: 398). This contrast indicates that the stress pattern of the preterite imperfective indicative is controlled by the morphology rather than the phonology: more specifically, an allomorphy rule assigns an underlying foot-head to the stem formative.[21] As expected, the underlyingly accented stem formative fails to delete before the vowel of the tense, aspect, and mood marker.

(31) *partíais*

a. UR $⟦_{\text{Word}}⟦_{\text{Stem}}⟦_{\text{Root}}$ paɾt ⟧ -í ⟧ -a -js ⟧
part -SF -PRET.IPFV.IND -2PL

b. SR [paɾ.tí.ajs]
'part.2PL.PRET.IPFV.IND'

In sum, we cannot concur with Harris (1991: footnote 9) when he asserts that there is no independent motivation for stem-final vowel deletion in Spanish denominal derivation: the same process, subject to identical restrictions, is at work in deverbal derivation and verb inflection. The following tableau provides a possible optimality-theoretic analysis; see Bermúdez-Otero (forthcoming a: ch. 4) for technical discussion.

---

20. *Pap-it-o* exists, but its base is the hypocoristic *papi*, not the full form *papá*.

21. This allomorphy rule applies to other tenses, but crucially *not* to the present indicative or present subjunctive. In the latter, the stem formative is not underlyingly accented and, consequently, a phonologically unmarked stress pattern is allowed to emerge. Thus, stress falls consistently on the penultimate syllable nucleus, whether this belongs to the root (e.g. *am-a-s* [á.mas] 'love.2sg.pres.ind') or to the stem formative (e.g. *am-a-mos* [a.má.mos] 'love.1pl.pres.ind'). The predictable exception is the second person plural, where the presence of a falling diphthong in the final syllable requires final stress (e.g. *am-á-is* [a.májs] 'love.2pl.pres.ind'); cf. *[kóm.boj].

Within the framework of Distributed Morphology, Oltra-Massuet and Arregi (2005) posit a rule that accents the syllable nucleus immediately preceding the morph inserted in T. However, they argue that this rule applies to *all* tense forms, including the present, where, by virtue of a fusion operation, the person and number agreement suffixes realize tense as well (Oltra-Massuet and Arregi 2005: 55). This analysis incorrectly predicts stress on the final syllable of 2sg.pres.ind. verb forms: e.g. *[am-á-s]. To avoid this result, Oltra-Massuet and Arregi (2005: 61) are forced to stipulate an *ad hoc* operation of grid-mark deletion. This approach obscures the contrast between morphologically driven stress in the imperfective and phonologically driven stress in the present, and misses the emergence-of-the-unmarked effects exhibited by the latter.

(32) a. Max-V&$_{\text{AdjSeg}}$Max-V
Assign one violation mark if two or more adjacent input vowels lack an output correspondent.[22]

b. Max-V́
Assign one violation mark for every accented input vowel that lacks an output correspondent.

c. Align(suffix,onset)
If an input vowel V is initial in a suffix attached to a stem, then assign one violation mark for every segment intervening between the output correspondent of V and the nearest preceding onset segment.[23]

d.

		Max-V&$_{\text{AdjSeg}}$Max-V	Max-V́	Align (suffix, onset)	Max-V
man-o $_{\text{Stem}}$⟧ aθ-a	ma.no.á.θa			*!	
	ma.ná.θa ☜				*
bakala-o $_{\text{Stem}}$⟧ it-o	ba.ka.la.o.í.to			**!	
	ba.ka.la.í.to ☜			*	*
	ba.ka.lí.to	*!			**
papá $_{\text{Stem}}$⟧ it-o	pa.pa.í.to ☜			*	
	pa.pí.to		*!		*

2.2 Denominal derivatives with consonant-initial suffixes

Our analysis predicts that nominal stem formatives will be able to surface before derivational suffixes, provided that those suffixes are consonant-initial. Is this true? Harris (1983: 92, 147; 1996: 104) claims that it is not, adducing evidence from *nomina qualitatis* in -*dad*-Ø:

(33) a. base / b. *nomen qualitatis*

*bell-**o***	'beautiful'	*bel-dad-Ø*	**bell-**o**-dad-Ø*
*buen-**o***	'good'	*bon-dad-Ø*	**bon-**o**-dad-Ø*
*herman-**o***	'brother'	*herman-dad-Ø*	**herman-**o**-dad-Ø*

However, these constructions are altogether irrelevant to the matter at hand, since they are root-based rather than stem-based. Thus, the underlying representation of *bon-dad*-Ø is neither (34a) nor (34b), but (34c).

22. For a sequence of adjacent segments as the local domain of a conjunctive constraint, see Łubowicz (2002: 260ff.). In the case of Max-V&$_{\text{AdjSeg}}$Max-V, this is the minimal domain over which both members can be simultaneously evaluated (Łubowicz 2002: footnote 5).

23. McCarthy (2003) denies the existence of gradient constraints such as (32c). The Spanish evidence may be regarded as a counterexample to this claim. Alternatively, Align(suffix,onset) could be 'quantized'; I shall not pursue this option here.

(34)	a.	⟦$_{\text{Stem}}$ ⟦$_{\text{Stem}}$ b{we,o}n-o ⟧ dad-{e,Ø}⟧	✗
	b.	⟦$_{\text{Stem}}$ ⟦$_{\text{Stem}}$ b{we,o}n ⟧ dad-{e,Ø}⟧	✗
	c.	⟦$_{\text{Stem}}$ ⟦$_{\text{Root}}$ b{we,o}n ⟧ dad-{e,Ø }⟧	✓

This is confirmed by three facts:

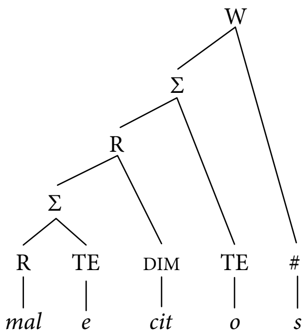
1. The relevant suffix has four allomorphs: *-tad-Ø*, *-dad-Ø*, *-edad-Ø*, and *-idad-Ø*. Of these, only *-idad-Ø* remains productive (Santiago Lacuesta and Bustos Gisbert 1999: 4536). In contrast, *-dad-Ø* is never found in neologisms, but only in words inherited from Latin: e.g. *uēr-itāt-e-m* > *ver-dad-Ø* 'truth', which first underwent intervocalic *-t-* lenition, and then syncope and apocope (Pharies 2002: 163).
2. Many *nomina qualitatis* in *-dad-Ø* have bound bases that do not exist as independent stems: e.g. ***frial**-dad-Ø* 'coldness', ***mortan**-dad-Ø* 'mortality', ***ver**-dad-Ø* 'truth'; note the absence of **ver-o*, **ver-a*, **ver-e*, or **ver-Ø* 'true' in modern Spanish. These constructions can only be root-based.
3. Since the allomorph *-dad-Ø* attaches to roots, StrOT predicts that it will be stem-level, since word-level constructions cannot be root-based: see (8b). This prediction proves correct, for the addition of *-dad-Ø* bleeds diphthongization: e.g. [b**o**n.dá^{ð}], not *[b**we**n.dá^{ð}]; see §1.2.1, particularly (12).

Accordingly, the fact that nominal stem formatives do not surface before derivational suffixes is simply due to the absence of productive *stem-based* denominal constructions with consonant-initial suffixes (Pena 1999: 4337). Since the same is true of Italian (Peperkamp 1995: 210, Montermini 2003: note 3), this state of affairs is likely to represent an inheritance from Latin. However, Spanish does have *root-based* and *word-based* nondeverbal constructions with consonant-initial suffixes. As we have just seen, the unproductive suffixal allomorph *-dad-Ø* is root-based. In contrast, both the deadjectival adverbial suffix *-ment-e* and the denumeral partitive suffix *-av-o* attach to words, i.e. to fully inflected bases; see (7) above. In (35a), for example, we see *-av-o* attaching outside the plural ending *-s* (Pensado 1999: 4461–4462). Interestingly, even though *-av-o* begins with a vowel, it does not induce deletion of an immediately preceding vowel in the base: see (35b). This is exactly what one would expect: the phonological process identified in (4a) and formalized in (32) specifically targets vowel sequences that straddle a stem–suffix boundary.

(35)	a.	*cardinal*		[dos.θjén.tos]	'200'
		partitive	domain structure	⟦$_{\text{Word}}$ ⟦$_{\text{Word}}$ dos-θjent-o-**s**⟧ aβ-o⟧	'200th'
			SR	[dos.θjen.to.sá.βo]	
	b.	*cardinal*		[ón̪θ-e]	'11'
		partitive	domain structure	⟦$_{\text{Word}}$ ⟦$_{\text{Word}}$ on̪θ-e⟧ aβ-o⟧	'11th'
			SR	[on̪.θe.á.βo]	

In Spanish, the only possible case of a consonant-initial derivational suffix attaching to a nominal stem is found among the diminutives of bases of the *e*-class (cf. Peperkamp 1995: 215). Harris (1994: 185) provides the following representation of the morphological structure of *malecitos* 'bad_thing.dim.pl', the diminutive of *mal-e-s*.[24]

(36)



If correct, this parse would once more confirm our predictions, for it shows /-e-/, the stem formative of the base, surfacing before /-θit-/, a consonant-initial allomorph of a derivational suffix. Remarkably, Harris does not comment on the inconsistency of his position.

2.3 Exotic 'word markers' and nouns ending in /s/

Harris's most intriguing argument against stem-final vowel deletion relies on the claim that the set of nominal 'word markers' in Spanish comprises not only the familiar endings -*o*, -*a*, and -*e*/Ø, but also -*i*, -*u* and, crucially, -V-*s* strings (e.g. Harris 1992: 66, 75). These exotic elements appear in loans from Ancient Greek, Latin, English, and other languages (37a), although Harris also provides the same analysis for word-final -V-*s* sequences in certain native items (37b). Harris's views have recently been echoed by Bonet (this volume), Lloret and Mascaró (2005: 13), Oltra-Massuet and Arregi (2005: 66), Roca and Felíu (2003: §8), and Roca (2005: 358).

(37) *Exotic 'word markers' according to Harris*

a.	*trib-**u***	'tribe'	b.	*Carl-**o-s***	'Charles'
	*güisqu-**i***	'whisky'		*lej-**o-s***[25]	'far'
	*vir-**u-s***	'virus'			
	*brind-**i-s***	'toast'			

Harris supports his claim with two arguments: one distributional, the other metrical. I deal with the distributional evidence in §2.3.1, and with the metrical evidence in §2.3.2. The data adduced in §2.3.1 will reveal a three-way morphological contrast among nouns whose singular form ends in /s/: ordinary *e*-stems, athematic stems ending in /s/, and pseudoplural words. The evidence of pseudoplurals casts interesting new light on the incidence of suffixation and infixation in Spanish diminutive formation.

24. R stands for 'root', TE for 'terminal element' (see note 2 above), dim for 'diminutive', # for 'number', and W for 'word'. Harris (1994: 184) glosses Σ as 'uninflected word', but what is an uninflected word, if not a *stem*? See (7) above.

25. This is an adverb, but see note 1.

2.3.1 *The distributional evidence*

Harris's distributional argument for -V-*s* word markers is twofold. First, he notes that the final /Vs/ sequence in words such as *virus* and *Carlos* is absent from derivationally related forms: see (38). Obviously, stem-final vowel deletion cannot explain this fact, since it only applies when vowels are immediately adjacent across a stem–suffix boundary. Suppose, however, that the /Vs/ strings in question are word markers. In that case, the morphotactic restriction in (3a) automatically takes care of the situation.

(38)		base		derivative		
	a.	*vir-**u-s***	'virus'	*vir-al*	**vir-**u-s**-al*	'viral'
				vír-ic-o	**vir-**ú-s**-ic-o*	'viral'
	b.	*brind-**i-s***	'toast'	*brind-a-r*	**brind-**i-s**-a-r*	'to toast'
	c.	*Carl-**o-s***	'Charles'	*carl-ist-a*	**carl-**o-s**-ist-a*	'Carlist'
	d.	*lej-**o-s***	'far'	*lej-an-o*	**lej-**o-s**-an-o*	'distant'
				a-lej-a-r	**a-lej-**o-s**-a-r*	'to distance'

Secondly, Harris observes that, in exactly the same set of words, the plural form is homophonous with the singular:

(39)		SG	PL	e.g.	
	a.	[bí.ɾus]	[bí.ɾus]	*muchos virus*	'many viruses'
	b.	[bɾín.dis]	[bɾín.dis]	*muchos brindis*	'many toasts'
	c.	[káɾ.los]	[káɾ.los]	*muchos Carlos*	'many Charleses'

Harris (1992: §4) accounts for this fact by suggesting that the final *-s* of the word marker occupies the morphological slot allocated to the plural inflection, blocking the insertion of the suffix /-s/. See Harris (1999: footnote 22) for a different statement of the same idea.

However, Harris's distributional argument is invalid because it conflates two heterogeneous word-types. The crucial piece of evidence — which Harris misses — is the contrast between the diminutives of words such as *virus* and *brindis* on the one hand, and *Sócrates* and *crisis* on the other: compare (40b) with (40c). Once this contrast is taken into consideration, there turn out to be precisely *three* different types of /s/-final noun in Spanish. The examples shown in (40) are drawn from my own Northern Peninsular idiolect, but they all occur in both Peninsular and Latin American dialects; see the notes for recorded attestations in spontaneous language use.

(40)		SG	PL	DIM	DIM.PL	
	a.	[íɾis-Ø]	[íɾis-e-s]	[iɾis-ít-o]	[iɾis-ít-o-s]	'iris'[26]

26. A high-frequency noun that behaves like (40a) is *lápiz* 'pencil' in dialects without the phoneme /θ/: i.e. sg. [lápis], pl. [lápis-e-s], dim.sg. [lapis-ít-o], dim.pl. [lapis-ít-o-s]. For some speakers, *iris* patterns like *brindis* in (40b): i.e. sg. [íɾis], pl. [íɾis], dim.sg. [iɾis-ít-o], dim.pl. [iɾis-ít-o-s]. However, the *e*-stem plural *íris-e-s* is widely attested:

> El procedimiento de medida consiste en ajustar **los irises** que permiten el paso de la luz procedente de las fuentes (A), (B), y (C) hasta lograr la igualdad de sensaciones.

b.	[bíɾus]	[bíɾus]	[biɾus-ít-o]	[biɾus-ít-o-s]	'virus'[27]
	[bɾíndis]	[bɾíndis]	[bɾindis-ít-o]	[bɾindis-ít-o-s]	'toast'[28]
c.	[sókɾat-e-s]	[sókɾat-e-s]	[sokɾat-ít-o]	[sokɾat-ít-o-s]	'Socrates'[29]
	[kɾísi-s]	[kɾísi-s]	[kɾis-eθít-a]	[kɾis-eθít-a-s]	'crisis'[30]

The noun in (40a) is an ordinary member of the *e*-class. In the singular, it selects the null allomorph of the stem formative because the root ends in a permissible domain-final sequence: see (15). In the plural, the morphological rule in (18) requires the presence of the *-e* allomorph. Accordingly, the forms in (40a) have the following structures in the output of the morphology:

Bautista Pulido, J.J. 2002. "Generador-monitor de vídeo para televisión." Undergraduate dissertation, Universidad de Huelva, La Rábida. Available at http://www.ugr.es/~amroldan/proyectos/generador_tv/pfc_generador_tv.pdf (accessed on 14 March 2006).

Some Spanish speakers may have acquired the plural *íris-e-s* under the influence of English *irises*, particularly in its orthographic form. This does not alter the fact that *íris-e-s* is a perfectly ordinary *e*-stem plural; cf. [lápis-e-s].

27. A search of the World Wide Web by means of Google on 14 March 2006 returned approximately 956 webpages as being in Spanish and containing one or more tokens of *virus-it-o*: e.g.

> Últimamente algún que otro **virusito** ha aprendido a pillar direcciones de email directamente de los mensajes de news que el usuario tiene en su Outlook.
> http://www.forosmix.net/viewtopic-356150.html

Other variants occurred with significantly lower frequencies. *Virus-cit-o* produced only 10 hits (cf. Ambadiang 1997: 111). There were 327 hits for <virito>, but only a small subset corresponded to a diminutive of *virus*; many pages contained the unrelated surname or nickname *Virito*. There were no hits at all for *vir-ecit-o*. See further note 36.

28. A Google search on 14 March 2006 produced 56 hits for *brindis-it-o*: e.g.

> Aunque sea atrasado, desde aquí te enviamos besos y abrazos y el deseo de que sigas tan bella y alegre como siempre. MUAC! Queda pendiente un **brindisito.**
> http://www.genecapriles.net/modules.php?name=News&file=print&sid=320

On the same date there were 7 hits for *brind-ecit-o* (all of them in copies of the same webpage) and none for *brindis-cit-o* (cf. Ambadiang 1997: 111) or *brind-it-o*. See further note 36.

29. Estoy a-no-na-da-do. Nunca había leído tanta sabiduría como la que derrocha este **Socratito**. Te admiro, Sócrates. Eres tan inteligente y sabes tanto. ¡Imbécil! Y tonto, más encima. E ignorante. Parece que nunca te enseñaron a escribir.
http://www.chile.com/tpl/articulo/detalle/masnotas.tpl?cod_articulo=64119 (accessed on 15 January 2006)

30. Los medios de comunicación regionales, más que preocupados por vender periódicos, dadas las importantes noticias de estos días, ridiculizan la crisis, convirtiéndola en "crisis de opereta" o, como mucho, al igual que a nuestras Cortes autonómicas las denominan por estos lares las cortitas, nuestra crisis autonómica la llamarán la **crisecita**.
Ramón Saura, *El País*, 1 August 1985

(41)	SG	⟦$_W$ ⟦$_S$ iɾis-{e,Ø}⟧⟧	
	PL	⟦$_W$ ⟦$_S$ iɾis-e ⟧ s ⟧	by allomorphy rule (18)
	DIM.SG	⟦$_W$ ⟦$_S$ ⟦$_S$ iɾis-{e,Ø } ⟧ it-o ⟧⟧	
	DIM.PL	⟦$_W$ ⟦$_S$ ⟦$_S$ iɾis-{e,Ø } ⟧ it-o ⟧ s ⟧	

In contrast, the nouns *virus* and *brindis* are athematic: they have no stem formative, and in both the stem is coextensive with the root. The sequences /us/ and /is/ are just part of the root and, by the same token, of the athematic stem. Since both the plural suffix /-s/ and the diminutive suffix /-it-o/ are stem-based, they attach outside the stem-final /Vs/ sequence. The homophony between the nondiminutive singular and plural forms is caused by straightforward degemination of the underlying /s-s/ string in the plural form (Contreras 1977).[31] Thus, words like those shown in (40b) have the following morphological structures:

(42)	SG	⟦$_W$ ⟦$_S$ ⟦$_{\surd}$ biɾus ⟧⟧⟧	
	PL	⟦$_W$ ⟦$_S$ ⟦$_{\surd}$ biɾus ⟧⟧ s ⟧	undergoes degemination in the phonology
	DIM.SG	⟦$_W$ ⟦$_S$ ⟦$_S$ ⟦$_{\surd}$ biɾus ⟧⟧ it-o ⟧⟧	
	DIM.PL	⟦$_W$ ⟦$_S$ ⟦$_S$ ⟦$_{\surd}$ biɾus ⟧⟧ it-o ⟧ s ⟧	

The absence of the string /us/ in derivatives such as *vir-al-Ø* and *vír-ic-o*, noted in (38), poses no particular difficulty for this analysis. Like *nomina qualitatis* in *-dad-Ø* (see §2.2), these are root-based forms, derived from a bound root allomorph ⟦$_{\surd}$ bir-⟧.

(43)	*viral*	⟦$_W$ ⟦$_S$ ⟦$_{\surd}$ biɾ ⟧ al-{e,Ø}⟧⟧
	vírico	⟦$_W$ ⟦$_S$ ⟦$_{\surd}$ biɾ ⟧ ik-o ⟧⟧

This analysis is corroborated by two pieces of evidence:

1. The suffixes *-al-Ø* and *-ic-o* are very commonly found in combination with bound bases: e.g. ***sider**-al-Ø* 'sidereal', ***polém**-ic-o* 'polemical'.
2. If *-al-Ø* and *-ic-o* are root-based suffixes, then they must both be stem-level, since root-to-stem derivation cannot be word-level: see principle (8a). One therefore predicts that the addition of *-al-Ø*, which attracts stress to itself, will bleed diphthongization. This is indeed correct: see (9a).

Significantly, Harris (1992: 76) acknowledges the possibility that derivatives such as *vir-al-Ø* and *vír-ic-o* may be root-based, but chooses not to pursue it.

Finally, the nouns *Sócrat-e-s* and *crisi-s* are pseudoplural. In other words, they are subject to a syntax/morphology mismatch: regardless of their number features in the syntax, in the morphology the stem subcategorizes for the plural suffix /-s/, which occupies the outermost layer of the word.[32] Accordingly, the final /-s/ of *Sócrat-e-s* and *crisi-s* fails to appear inside the diminutive suffix, since the latter attaches to stems, not

31. *Pace* Harris (1992: 76), one does not expect this sequence to be repaired by vowel insertion: it is only initially in the prosodic word that Spanish uses epenthesis to rescue an unsyllabifiable /s/. See Bermúdez-Otero (forthcoming a: ch. 4) for discussion.

32. Spanish pseudoplural words provide an instance of 'extended deponency' in the sense of Baerman et al. (forthcoming). The idea that Spanish has such words is not new (see e.g. Hooper and Terrell to words. [33] Interestingly, the stem of *Sócrat-e-s* belongs to a core native class, namely the *e*-stems, whereas the stem of *crisi-s* is athematic. In the output of the morphology, therefore, the forms in (40c) have the following structure:

(44) a. SG ⟦$_W$ ⟦$_S$ sokɾat-e ⟧ s ⟧ /-s/ mismatched with syntactic features [34]
PL ⟦$_W$ ⟦$_S$ sokɾat-e ⟧ s ⟧
DIM.SG ⟦$_W$ ⟦$_S$ ⟦$_S$ sokɾat-{e,Ø } ⟧ it-o ⟧⟧
DIM.PL ⟦$_W$ ⟦$_S$ ⟦$_S$ sokɾat-{e,Ø} ⟧ it-o ⟧ s ⟧
b. SG ⟦$_W$ ⟦$_S$ kɾisi ⟧ s ⟧ /-s/ mismatched with syntactic features
PL ⟦$_W$ ⟦$_S$ kɾisi ⟧ s ⟧
DIM.SG ⟦$_W$ ⟦$_S$ ⟦$_S$ kɾisi ⟧ eθit-a ⟧⟧
DIM.PL ⟦$_W$ ⟦$_S$ ⟦$_S$ kɾisi ⟧ eθit-a ⟧ s ⟧

Clearly, the existence of diminutive forms such as *virus-it-o* and *brindis-it-o* is fatal to Harris's analysis. Insofar as the sequences /us/ and /is/ occur inside derivational suffixes, they cannot be 'word markers' in his sense. Moreover, by placing these sequences outside the stem in *virus* and *brindis*, Harris leaves himself no way to account for contrasts such as *brindis* ~ *brindis-it-o* vs *crisi-s* ~ *cris-ecit-a*.

A lot depends, therefore, on the evidence of forms such as *virus-it-o* and *brindis-it-o*. However, there are no valid grounds to question the reliability of these data. Lloret and Mascaró (2005: 12–13, 23) claim that forms of this type do not exist, but this is simply false; diminutives like *virus-it-o* and *brindis-it-o* are indisputably attested in records of spontaneous language use by native speakers and, when the pragmatic conditions are right, they occur in high numbers. For example, the relatively high frequency of *virus-it-o* (see note 27) is obviously the result of felicitous pragmatic conditions: when talking or writing about computers, speakers often have occasion to use the word *virus* in emotionally charged situations favouring the addition of evaluative suffixes. Other attested derivatives of *virus* include the augmentatives *virus-ot-e* and *virus-ón-Ø*, all of which are fatal to Harris's analysis. [35] The absence of these forms from

1976, Den Os and Kager 1986, Méndez-Dosuna and Pensado 1990), but so far the distinction between *e*-stems, athematic stems in /s/, and pseudoplurals has never been drawn consistently.

33. Spanish differs from Portuguese, which has two diminutive suffixes: /-iɲ-/, which is stem-based, and /-ziɲ-/, which is word-based. See Rainer (1996: §3), Bachrach and Wagner (2006), Bermúdez-Otero (forthcoming a: ch. 2) .

34. The plural suffix /-s/ triggers allomorphy rule (18) even when mismatched with the syntactic number features of the word.

35. Here are some examples:

Amigas como les va todo??? Bueno a mi pc se le daño la memoria de RAM y bueno en eso y un **virusote** que me enviaron pues ya saben, estuve desconectada del mundo…
http://vindieselfans.com/foro/viewtopic.php?p=19651&sid=bec3af59330c1406ac2605b53856bb9a (accessed on 13 March 2006)

Si algo tiene este antivirus q es notable sobre los demas, es q no t relentiza la pc, tal vez se t puso lenta tu pc por q se puso a vacunar el **VIRUSON** q tienes
http://softonic.es/comment.phtml?id_user=63299 (accessed on 12 March 2005)

corpora like CREA reflects only the limitations of such corpora, not the competence of native speakers of Spanish (cf. Eddington 2002: §5).

Similarly, it cannot be objected that the contrast between *virus* ~ *virus-it-o* and *Sócrat-e-s* ~ *Socrat-it-o* is an artifact of mixing data from disparate dialects. All the diminutive forms listed in (40) occur in my idiolect, in which they are in fact the only possible diminutives of the corresponding bases. In addition, each of these forms can be found in both Peninsular and Latin American dialects.

In sum, the evidence of forms like *virus-it-o* and *brindis-it-o* cannot be ruled out of court; to attempt to do so would be irresponsible and would seriously undermine the empirical underpinnings of any inquiry into Spanish nominal classes. However, one *can* legitimately ask why there is so much variation in the diminutives of paroxytonic singular nouns in /Vs/ with homophonous plurals (see e.g. notes 27 and 28). Bermúdez-Otero (forthcoming b) addresses precisely this question and suggests that this variation is caused by a learnability deficit: the classification of such nouns as athematic stems in /s/ or as pseudoplurals is underdetermined by the evidence of their inflectional paradigms. Bermúdez-Otero (forthcoming b) explores the ways in which learners circumvent this underdetermination effect by relying on other sources of information: phonotactics (see §2.3.2 below), the identification of '*cranberry* morphs', language contact, etc.

The interpretation of the diminutive data raises another question. The existence of words such as those in (45c) indicates that the morph *-it-* can behave infixally (see Jaeggli 1980; Lázaro Mora 1999: §71.6; Méndez-Dosuna and Pensado 1990).

(45)	a.	base	b.	suffixal diminutive	c.	infixal diminutive
		[aθúkaɾ]		[aθukaɾ-(θ)ít-o]		[aθuk<ít>aɾ]
		sugar		sugar-DIM-SF		sugar<DIM>
		[bí^{k}toɾ]		[bi^{k}toɾ-(θ)ít-o]		[bi^{k}t<ít>oɾ]
		Victor		Victor-DIM-SF		Victor<DIM>

In *azuqu<ít>ar*, for example, *-it-* cannot be anything other than an infix, since the string /aɾ/ is not a morph: note that the base *azúcar-Ø* is an ordinary *e*-stem noun, as shown by the plural *azúcar-**e**-s*.

The infixal behaviour of *-it-* does not invalidate the conclusions I have drawn from the evidence in (40), since all the diminutive forms presented there are unambiguously suffixal. In *virus-it-o*, the athematic base *virus-* is found whole inside the diminutive suffix; the same is true of *brindis-it-o*. In the case of *Sócrat-e-s*, infixation would have allowed the pseudoplural *-s* to be retained in the singular diminutive, yielding either **Socrat<it>-e-**s*** or **Socrat<it-o>-**s***; the actual singular form *Socrat-it-o* arises through the suffixation of *-it-o* to the stem *Sócrat-*{*e*,Ø}-. The same argument applies to the singular diminutive *cris-ecit-a*, not **cris<it>i-**s*** or **cris<it-a>-**s*** or **cris<ecit-a>-**s***. Accordingly, the contrast between *virus-it-o* and *Socrat-it-o* cannot be imputed to the alternation between infixal and suffixal strategies in Spanish diminutive formation.

However, the properties of diminutive infixation can explain some intriguing aspects of the behaviour of pseudoplural bases. Consider the following data (cf. Lázaro Mora 1999: §71.6):

(46)		base	gender	gloss	diminutive
	a.	*coch-e*	M	'car'	*coch-*(*ec*)*it-o*, **coch<it>-e*
	b.	*nub-e*	F	'cloud'	*nub-*(*ec*)*it-a*, **nub<it>-e*
	c.	*cur-a*	M	'priest'	*cur<it>-a*, **cur-it-o*
	d.	*mot-o*	F	'motorbike'	*mot<it>-o*, **mot-it-a*

The evidence of *coch-*(*ec*)*it-o* and *nub-*(*ec*)*it-a* shows that suffixal diminutives belong to the *o*-class when masculine, and to the *a*-class when feminine, regardless of the stem class of the base. Moreover, the ungrammaticality of **coch<it>-e* and **nub<it>-e*, coupled with the grammaticality of *cur<it>-a* and *mot<it>-o*, indicates that the infix *-it-* subcategorizes for bases where the final syllable nucleus consists of unstressed /o/ or /a/; this hypothesis suggests an obvious scenario of diachronic reanalysis for the rise of the infix from the suffix, and explains the availability of infixation in *azuqu<ít>ar* and *Vict<ít>or*. [36] We can now account for the fact that diminutives such as *cur<it>-a* and *mot<it>-o* end in the stem formative selected by their bases, instead of the one predicted by their gender (Harris 1999: 76–77): this is because they are the result of the infixation of *-it-*, rather than the suffixation of *-it-*{*o*,*a*}.

Compare now the behaviour of the pseudoplural *e*-stem noun *Sócrat-e-s* with that of the pseudoplural *o*-stem noun *Carl-o-s* 'Charles':

(47)			
	SG	*Sócrat-e-s*	*Carl-o-s*
	PL	*Sócrat-e-s*	*Carl-o-s*
	DIM.SG	*Socrat-it-o*	*Carl<it>-o-**s***
	DIM.PL	*Socrat-it-o-s*	*Carl<it>-o-s*
	AUG.SG	*Socrat-ot-e*	*Carl-ot-e*

Carl-o-s must be a pseudoplural *o*-stem, not an athematic stem in /s/, since the addition of the augmentative suffix *-ot-e* yields *Carl-ot-e*, not **Carlos-ot-e*.[37] However, *Carl-o-s* differs from *Sócrat-e-s* in that its singular diminutive is homophonous with its plural diminutive. In other words, *Carl-o-s* retains its pseudoplural ending *-s* in the diminutive singular (*Carl<it>-o-**s***), whereas *Sócrat-e-s* does not: the singular diminutive is *Socrat-it-o*, not **Socrat-it-o-**s***. Gratifyingly, our hypothesis about the behaviour of the infix *-it-* predicts this contrast. *Sócrat-e-s* does not satisfy the subcategorization requirements of the infix *-it-* because the nucleus of its final syllable is not an unstressed /o/ or /a/. In consequence, the diminutive of *Sócrat-e-s* has to be formed by adding the suffix *-it-o* to the stem *Sócrat-*{*e*,Ø}-, and the pseudoplural ending *-s* is lost. *Carl-o-s*,

36. It seems that, for some speakers, this subcategorization requirement can be relaxed, at least variably. For example, infixal diminutives such as *vir<it>us* and *brind<it>is* are attested, although at very low frequencies. These are strictly ungrammatical in my idiolect.

37. Note the contrast between *Carl-o-s* ~ *Carl-ot-e* and *virus* ~ *virus-ot-e* (note 35). The following example nicely illustrates the behaviour of *Carl-o-s* under evaluative derivation:

> […] para conseguir un anuncio hay que hablar con Mercedes y darle comisión a Mercedes, luego a Luisito, a **Carlitos**, a **Carlote**, al de allá y al de acá […]
> http://www.cedoh.hn2.com/LETICIA.HTML (accessed on 13 March 2006; boldface mine.)

however, does meet the subcategorization requirements of the infix, and the infixation of *-it-* in *Carl<it>-o-s* enables the preservation of the pseudoplural ending.

More generally, this analysis of Spanish diminutive formation predicts that the only pseudoplural nouns that can retain their final /-s/ in the diminutive singular are those belonging to the *o*-class (e.g. *Carl-**o**-s* ~ *Carl<it>-**o**-s*) or to the *a*-class (e.g. *mecen-**a**-s* ~ *mecen<it>-**a**-s* 'patron, sponsor').[38] In contrast, *e*-stems and athematic stems take the diminutive suffix, rather than the infix, and therefore lose the pseudoplural ending: e.g. *Sócrat-**e**-s* ~ *Socrat-it-o*, *crisi-s* ~ *cris-ecit-a*. Forms such as *Merced-it-a-s* (Lázaro Mora 1999: 4661, Méndez-Dosuna and Pensado 1990) turn out to conform with this prediction once their derivational provenance is properly understood. Spanish has an *e*-stem feminine noun *merced-Ø* 'mercy', whose plural form *merced-e-s* has been converted into a pseudoplural feminine name: *Merced-e-s*. The noun *merced-Ø* has an ordinary suffixal diminutive *merced-it-a*, whose plural form *merced-it-a-s* supplies the diminutive of the name *Merced-e-s*: i.e. *Merced-it-a-s*. In this sense, *Merced-it-a-s* is *not* derived from the pseudoplural name *Merced-e-s*, either infixally or suffixally.

(48) *merced-*{*e*,Ø}- (FEM noun stem) → *merced-e-s* (FEM.PL noun)
↓ ↓
*merced-it-**a**-* (FEM.DIM noun stem) *Merced-e-s* (FEM.SG name)
↓
*merced-it-**a**-**s*** (FEM.DIM.PL noun) → *Merced-it-**a**-**s*** (FEM.DIM.SG name)

Support for the account outlined in (48) comes from another pseudoplural feminine name, *Ángel-e-s*, derived by conversion from the plural form of a masculine *e*-stem noun: *ángel-Ø* 'angel'. The most common diminutive of this noun is *angel-it-o* (plural *angel-it-o-s*), with the default stem formative for a masculine noun. Converting the diminutive masculine plural noun *angel-it-o-s* into a diminutive feminine singular name would create a mismatch between the stem formative *-o-* and the name's gender, in addition to the mismatch between the ending *-s* and the name's number. In these circumstances, Spanish speakers opt to avoid the formative/gender mismatch by deriving the diminutive of the name directly from *Ángel-e-s*. As predicted by my analysis, this results in a suffixal diminutive where the pseudoplural *-s* is lost: namely, *Angel-it-a*.[39]

38. Here is an example of the diminutive *mecen<it>-a-s*:

> Don Jesús optó por prescindir de un mecenas opulento porque los hombres ricos o las instituciones poderosas 'suelen ser exigentes e imponen opiniones'. Era mejor recurrir a muchos **mecenitas** y a cada uno pedir nada más que 500 pesos.
> Rodríguez Alcalá, H. 1987. "Al cumplirse los 40 años de *Cuadernos Americanos*". In *La incógnita del Paraguay y otros ensayos*, H. Rodríguez Alcalá, 179–184. Asunción: Arte Nuevo.

39. Although *Angel-it-a* also functions as the diminutive of the name *Ángel-a*, its use as the diminutive of the name *Ángel-e-s* is well attested:

> En abril de 1929, **Ángeles** Santos o **Angelita** expone individualmente en el Ateneo de Valladolid.
> http://antoncastro.blogia.com/2006/032001-el-mundo-y-las-visiones-de-angeles-santos.php (accessed on 10 May 2006)

(49)	*ángel*-{*e*,Ø }- (MASC noun stem)	→	*ángel-e-s* (MASC.PL noun)
	↓		↓
	*angel-it-**o**-* (MASC.DIM noun stem)		*Ángel-e-s* (FEM.SG name)
	↓		↓
	*angel-it-**o**-**s*** (MASC.DIM.PL noun)		*Angel-it-**a*** (FEM.DIM.SG name)

There is independent evidence to confirm that it is the mismatch between the stem formative *-o-* and feminine gender that prevents the noun *angel-it-o-s* from being converted into the diminutive of the feminine singular name *Ángel-e-s*. Note that, alongside *angel-it-o-s*, the noun *ángel-Ø* has an alternative diminutive plural form, *angel-in-e-s*, derived by means of the relatively unproductive diminutive suffix *-ín-Ø* (see Lang 1990: 107–108). Crucially, the stem formative of *angel-in-**e**-s* does not have a default association with masculine gender, and so this noun does undergo conversion into a diminutive feminine singular name: *Angel-in-**e**-s*.

One final observation supports the analysis of *Merced-it-a-s* in (48). James Harris (personal communication) reports that one of his informants has two female relatives whose names are *Merced-e-s* and *Lourd-e-s*. The two sisters refer to each other as *Merced-it-a-**s***, with pseudoplural *-s*, but *Lourd-it-a*, without pseudoplural *-s*. This contrast is explained by the fact that, unlike *Merced-e-s*, the name *Lourd-e-s* is based on a French toponym (*Lourdes*) rather than on a common noun, and so there is no diminutive plural noun **lourd-it-a-s*; cf. (48). The diminutive of *Lourd-e-s* is thus derived directly from the name by adding the suffix *-it-a* to the stem *Lourd*-{*e*,Ø }-, with the result that the pseudoplural *-s* is lost, as in the case of *Socrat-it-o*.

2.3.2 *The metrical evidence*

Let us now consider the metrical evidence adduced by Harris (1992: 75) in support of the existence of exotic word markers in Spanish. Harris's argument rests on the observation that Spanish has a phonotactic constraint agains proparoxytonic nouns and adjectives with a closed ultima (see also Roca 1988: 398). As shown in (50b), the domain of this constraint crucially excludes the plural suffix /-s/; the asterisks mark metrically ill-formed items.[40]

(50)	a.	SG		b.	PL
		[ka.ní.βal], *[ká.ni.βal]	'canibal'		[ka.ní.βa.les]
		[sá.βa.na], *[sá.βa.nal]	'bed sheet'		[sá.βa.nas]

Harris notes that singular nouns such as *Sócrates* and *análisis* 'analysis' appear to violate this constraint, but the anomaly disappears if the final /Vs/ string is treated as a 'word marker'. My analysis allows for a broadly similar treatment: these items are metrically well-formed if they are parsed as pseudoplurals.

40. Among verbs, the metrical constraint against proparoxytones with closed ultimas is violated by 1pl.pret.ipfv.ind. forms like [a.má.βa.mos], but satisfied by 1.pl.pres.ind. forms like [a.má.mos], not *[á.ma.mos]; cf. 2sg.pres.ind. [á.mas]. This observation confirms our claim that stress is governed by the morphology in the imperfective, but is controlled by phonological defaults in the present: see note 21 above.

(51) ⟦$_{Word}$ ⟦$_{Stem}$ só.kɾa.te ⟧ s ⟧
⟦$_{Word}$ ⟦$_{Stem}$ a.ná.li.si ⟧ s ⟧

The previous section provided evidence that *Sócrat-e-s* is indeed a pseudoplural *e*-stem noun: see (40) and (47). Confirmation that *análisi-s* is a pseudoplural word with an athematic stem, like *crisi-s*, is furnished by the suffixal diminutive *analis-it-o*.[41]

The premise of Harris's argument is fairly solid. Admittedly, Spanish does have some proparoxytonic singular nouns with closed ultimas that cannot possibly be analysed as pseudoplural: e.g. [bé.ne.ton] 'Benetton'. However, these exceptional items can generally be shown to be partially assimilated loanwords: in the case of [béneton], for example, the plural form [béneton-s] shows that this item remains in the marginal athematic class and has not joined the native *e*-stems.[42] There appears to be only one genuine exception in the core vocabulary: the *e*-stem noun *régimen* 'diet', pl. *regímen-e-s* (Roca 1988: 406, 418; 1990: 149; 2005: 368).

However, Harris's argument has an obvious flaw: the ban on singular proparoxytonic nouns and adjectives with closed ultimas can explain why native speakers of Spanish treat nouns like *Sócrat-e-s* and *análisi-s* as pseudoplural, but it says absolutely nothing about the morphological structure of paroxytonic words such as *crisi-s*, *virus*, or *brindis*; cf. (40). In other words, Spanish learners are at liberty to treat the final /s/ in these items as part of the stem or as a pseudoplural suffix. Indeed, as we saw in §2.3.1, contrasts such as *brindis-it-o* vs *cris-ecit-a* show that the final /s/ of *brindis* is parsed as the final segment of an athematic stem, whereas the final /s/ of *crisi-s* is treated as a pseudoplural suffix. In sum, the metrical evidence does not support Harris's claim that the final string /is/ in *brindis* is an exotic word marker, and the distributional evidence proves that the claim is, in fact, wrong.

In Bermúdez-Otero (forthcoming b), I turn Harris's metrical argument on its head. I take the contrast between athematic stems ending in /s/ and pseudoplural words as an established empirical fact. The question then arises as to how Spanish learners manage to acquire the distinction between these two morphological classes. Intriguingly, the distinction is not cued within inflectional paradigms, since both noun types have homophonous singular and plural forms; yet the crucial stem-based word-level derivatives that diagnose the distinction (e.g. suffixal diminutives such as *brindis-it-o* vs *cris-ecit-a*) tend to have vanishingly low text-frequencies. Bermúdez-Otero (forthcoming b) argues that, in these circumstances, learners are forced to rely on nonmorphological information. Insofar as proparoxytonic singulars such as *Sócrates* and *análisis* are consistently treated as pseudoplural rather than athematic, this would indicate that

41. This is the only possible diminutive form in my idiolect. Unfortunately, I have not been able to compare my intuitions with evidence from spontaneous language use: despite a diligent search, I have found no tokens of *análisis* in the diminutive.

42. Despues en la zona de atras, pero mas adelante…(xDD se me nota la escasez de palabras lucidas… esto es devido a los carnavales) taran [*scilicet* estarán] sauberes, jaguares y proses y en la mitad pos [*scilicet* pues] los **Benetons** que se jartaran de petar motores renault.
http://foros.ya.com/SForums/$M=readthread$TH=135453$F=26719$ME=1279988 (accessed on 23 August 2005)

speakers are able to use phonotactic information to overcome the lack of morphological cues. However, metrical restrictions are less strict in the case of the paroxytones, and this would account for the high levels of variation found among these forms.

We can now conclude Section 2.3 by stating that there are no such things as exotic word markers in Spanish. The language has precisely four nominal stem classes:

1. *o*-stems;
2. *a*-stems;
3. *e*-stems, with two subclasses: *e*/Ø-stems (e.g. *cruz-Ø* ~ *cruc-e-s*) and *e*-only stems (e.g. *cruc-e* ~ *cruc-e-s*);
4. athematic stems.

All four classes contain a small minority of pseudoplural items:

(52)			SG	DIM/AUG.SG
	a.	*o*-stem	[káɾl-o-s]	[kaɾl-ót-e]
	b.	*a*-stem	[meθén-a-s]	[meθen-áθ-o]
	c.	*e*-stem	[sókɾat-e-s]	[sokɾat-ít-o]
	d.	athematic	[análisi-s]	[analis-ít-o]

Nothing in the behaviour of nouns ending in /s/ raises problems for an analysis of Spanish denominal derivation based on stem-final vowel deletion, as required by StrOT.

3. Conclusion

Scientists and philosophers place high value on theories that make surprising predictions which, unexpectedly, prove correct. This paper has shown that StrOT is such a theory. We have seen that, for over two decades, generative grammarians have espoused a set of tightly interconnected postulates about the behaviour of Spanish nominal stem formatives. They have assumed:

1. that some sort of morphotactic constraint prevents nominal 'word markers' from occurring inside derivational suffixes;
2. that the underlying representation of denominal derivatives such as *man-az-a* 'hand.AUG' is therefore ⟦⟦⟦man⟧aθ⟧a⟧ rather than ⟦⟦man-o⟧aθ-a⟧;
3. that the final /Vs/ sequence in words such as *virus* is absent from derivatives like *viral* because it is a word marker and, therefore, incapable of occurring inside derivational affixes.

These assumptions have been reiterated in work as recent as Bonet (this volume), Lloret and Mascaró (2005), Oltra-Massuet and Arregi (2005), Roca and Felíu (2003), and Roca (2005). Against this background, the austere version of StrOT outlined in §1.1 makes an iconoclastic set of predictions: namely,

1. that nominal stem formatives do in fact occur inside stem-based derivational suffixes;

2. that the correct underlying representation of *man-az-a* is ⟦⟦man-o⟧aθ-a⟧, and that the stem formative of the base is removed by a phonological process of stem-final vowel deletion;
3. that the absence of the sequence /us/ in *viral* is not a reflection of the status of /us/ as a 'word marker', but rather of the fact that *viral* is a root-based derivative.

These predictions follow from the highly constrained way in which morphology and phonology interact in StrOT. Unless one assumes that the morphological structure of *cuell-az-o* 'neck.AUG' is ⟦⟦k{o,we}ʎ-o⟧aθ-o⟧ rather than ⟦⟦⟦k{o,we}ʎ⟧aθ⟧o⟧, one incurs a stratification paradox: it becomes impossible to assign a coherent phonological domain structure to this word.

However iconoclastic, the predictions of StrOT prove correct. The postulation of a morphologically sensitive phonological process of stem-final vowel deletion is corroborated by three pieces of evidence:

1. the process of stem-final vowel deletion required for the analysis of Spanish denominal derivatives in StrOT is found to operate, under exactly identical conditions, in deverbal derivation and verbal inflection;
2. all denominal derivatives in which the 'theme vowel' of the base seems to disappear before a consonant-initial suffix (e.g. *buen-o* ~ *bon-dad-*Ø) prove upon inspection to be root-based rather than stem-based;
3. denominal derivatives in which the base appears to lose its final /Vs/ sequence before a suffix prove to be either root-based (e.g. *vírico* ⟦$_{W}$⟦$_{S}$⟦$_{\surd}$biɾ⟧ik-o⟧⟧; cf. *virusito* ⟦$_{W}$⟦$_{S}$⟦$_{S}$biɾus⟧it-o⟧⟧) or based on a stem from which a pseudoplural ending *-s* is excluded (e.g. *Socratito* ⟦$_{W}$⟦$_{S}$⟦$_{S}$sokɾat-{e,Ø}⟧it-o⟧⟧).

Finally, our discussion of Spanish denominal derivatives has illustrated one of the key advantages of StrOT: its heuristic power. This was specially evident in Section 2.3, as the principles of StrOT enabled us to find our way among the bewildering array of phenomena involved in Spanish diminutive formation. As Harris himself points out in a different connection,

> […T]he problem with this complex set of data — like any other — is that it can be described in a vast number of ways that cannot be immediately rejected on *a priori* grounds. Discussion becomes interesting only when and to the extent that a restrictive theory, supported empirically by (perhaps few but compelling) crucial cases, radically reduces the available descriptive options.
> Harris (1997: 552)

References

Alonso, A. 1945. Una ley fonológica del español. *Hispanic Review* 13:91–101.
Ambadiang, T. 1993. *La morfología flexiva*. Madrid: Taurus.
Ambadiang, T. 1997. Las bases morfológicas de la formación de diminutivos en español. *Verba* 24:99–132.

Anttila, A. 2002. Morphologically conditioned phonological alternations. *Natural Language and Linguistic Theory* 20:1–41.

Aronoff, M. 1994. *Morphology by Itself*. Cambridge MA: The MIT Press.

Bachrach, A. and Wagner, M. 2006. Syntactically driven cyclicity vs. output-output correspondence: The case of adjunction in diminutive morphology. Handout of paper presented at the 29th GLOW Colloquium, Barcelona, 6 April 2006.

Baerman, M., Corbett, G., Brown, D. and Hippisley, A. (eds). Forthcoming. *Deponency and Morphological Mismatches* [Proceedings of the British Academy]. Oxford: OUP.

Benua, L. 1997. Transderivational Identity: Phonological relations between words. PhD dissertation, University of Massachusetts, Amherst. (Available at ROA 259, Rutgers Optimality Archive, http://roa.rutgers.edu/).

Bermúdez-Otero, R. 1999. Constraint Interaction in Language Change [Opacity and Globality in Phonological Change]. PhD dissertation, University of Manchester / Universidad de Santiago de Compostela. (Available at www.bermudez-otero.com/PhD.pdf).

Bermúdez-Otero, R. 2003. The acquisition of phonological opacity. In *Variation within Optimality Theory: Proceedings of the Stockholm Workshop on 'Variation within Optimality Theory'*, J. Spenader, A. Eriksson and Ö. Dahl (eds), 25–36. Stockholm: Department of Linguistics, Stockholm University. (Expanded version available at ROA 593, Rutgers Optimality Archive, http://roa.rutgers.edu/).

Bermúdez-Otero, R. Forthcoming a. *Stratal Optimality Theory*. Oxford: OUP. (Excerpts available at www.bermudez-otero.com/Stratal_Optimality_Theory.htm).

Bermúdez-Otero, R. Forthcoming b. Spanish pseudoplurals: Phonological cues in the acquisition of a syntax/morphology mismatch. In *Deponency and Morphological Mismatches* [Proceedings of the British Academy], M. Baerman, G. Corbett, D. Brown and A. Hippisley (eds). Oxford: OUP.

Bermúdez-Otero, R. and McMahon, A. 2006. English phonology and morphology. In *The Handbook of English Linguistics*, B. Aarts and A. McMahon (eds), 382–410. Oxford: Blackwell.

Booij, G. 1996. Lexical phonology and the derivational residue. In *Current Trends in Phonology: Models and methods*, J. Durand and B. Laks (eds), 69–96. Salford: European Studies Research Institute, University of Salford.

Booij, G. and Rubach, J. 1984. Morphological and prosodic domains in lexical phonology. *Phonology* 1:1–27.

Bosque, I. and Demonte, V. (eds). 1999. *Gramática descriptiva de la lengua española*. Madrid: Espasa Calpe.

Chomsky, N. and Halle, M. 1968. *The Sound Pattern of English*. New York NY: Harper and Row.

Cole, J. 1995. The cycle in phonology. In *The Handbook of Phonological Theory*, J.A. Goldsmith (ed), 70–113. Oxford: Blackwell.

Colina, S. 2003a. The status of word-final [e] in Spanish. *Southwest Journal of Linguistics* 22(1):87–107.

Colina, S. 2003b. Diminutives in Spanish: A morphophonological account. *Southwest Journal of Linguistics* 22(2):45–88.

Contreras, H. 1977. Spanish epenthesis and stress. *University of Washington Working Papers in Linguistics* 3:9–33.

CREA = Real Academia Española. *Corpus de referencia del español actual*. http://corpus.rae.es/creanet.html.

Den Os, E. and Kager, R. 1986. Extrametricality and stress in Spanish and Italian. *Lingua* 69:23–48.

Eddington, D. 2002. Spanish diminutive formation without rules or constraints. *Linguistics* 40:395–419.

Eddington, D. 2004. *Spanish Phonology and Morphology: Experimental and quantitative perspectives*. Amsterdam: John Benjamins.

Giegerich, H.J. 1999. *Lexical Strata in English: Morphological causes, phonological effects*. Cambridge: CUP.

Harris, J.W. 1983. *Syllable Structure and Stress in Spanish: A nonlinear analysis*. Cambridge MA: The MIT Press.

Harris, J.W. 1985. Spanish word markers. In *Current Issues in Hispanic Phonology and Morphology*, F. H. Nuessel (ed), 34–54. Bloomington IN: Indiana University Linguistics Club.

Harris, J.W. 1991. The exponence of gender in Spanish. *Linguistic Inquiry* 22:27–62.

Harris, J.W. 1992. The form classes of Spanish substantives. In *Yearbook of Morphology 1991*, G. Booij and J. van Marle (eds), 65–88. Dordrecht: Kluwer.

Harris, J.W. 1994. The OCP, prosodic morphology, and sonoran Spanish diminutives: A reply to Crowhurst. *Phonology* 11:179–190.

Harris, J.W. 1995. Projection and edge marking in the computation of stress in Spanish. In *The Handbook of Phonological Theory*, J.A. Goldsmith (ed), 867–887. Oxford: Blackwell.

Harris, J.W. 1996. The syntax and morphology of class marker suppression in Spanish. In *Grammatical Theory and Romance Languages: Selected Papers from the 25th Linguistic Symposium of Romance Languages (LSRL XXV), Seattle, 2–4 March 1995*, K. Zagona (ed.), 99–122. Amsterdam: John Benjamins.

Harris, J.W. 1997. There is no imperative paradigm in Spanish. In *Issues in the Phonology and Morphology of the Major Iberian Languages*, F. Martínez-Gil and A. Morales-Front (eds), 537–557. Washington DC: Georgetown University Press.

Harris, J.W. 1999. Nasal depalatalization *no*, morphological wellformedness *sí*; The structure of Spanish word classes. *MIT Working Papers in Linguistics* 33: 47–82.

Hooper, J.B. and Terrell, T. 1976. Stress assignment in Spanish: A natural generative analysis. *Glossa* 10: 64–110.

Hualde, J.I. 1989. Silabeo y estructura morfémica en español. *Hispania* 72: 821–831.

Inkelas, S. 1990. *Prosodic Constituency in the Lexicon*. New York NY: Garland.

Inkelas, S. 1998. The theoretical status of morphologically conditioned phonology: A case study of dominance effects. In *Yearbook of Morphology 1997*, G. Booij and J. van Marle (eds), 121–155. Dordrecht: Kluwer.

Inkelas, S. and Orgun, C.O. 1995. Level ordering and economy in the lexical phonology of Turkish. *Language* 71: 763–793.

Inkelas, S., Orgun, C.O. and Zoll, C. 1997. Implications of lexical exceptions for the nature of grammar. In *Constraints and Derivations in Phonology*, I. Roca (ed), 393–418. Oxford: Clarendon Press.

Inkelas, S. and Zoll, C. 2003. Is grammar dependence real? ROA-587, Rutgers Optimality Archive, http://roa.rutgers.edu/.

Inkelas, S. and Zoll, C. 2005. *Reduplication: Doubling in morphology*. Cambridge: CUP.

Jaeggli, O.A. 1980. Spanish diminutives. In *Contemporary Studies in Romance Languages*, F. H. Nuessel (ed), 142–158. Bloomington IN: Indiana University Linguistics Club.

Kager, R. 1996. On affix allomorphy and syllable counting. In *Interfaces in Phonology*, U. Kleinhenz (ed.), 155–171. Berlin: Akademie Verlag.

Kiparsky, P. 1998. Paradigm Effects and Opacity. Ms., Stanford University. Forthcoming in Stanford: CSLI Publications.

Kiparsky, P. 2000. Opacity and cyclicity. In *A Review of Optimality Theory*, N.A. Ritter (ed.), 351–365. *The Linguistic Review* 17 (2–4).

Kiparsky, P. 2003. Syllables and moras in Arabic. In *The Syllable in Optimality Theory*, C. Féry and R. van der Vijver (eds), 147–182. Cambridge: CUP.

Lang, M.F. 1990. *Spanish Word Formation: Productive derivational morphology in the modern lexis*. London: Routledge.

Lázaro Mora, F.A. 1999. La derivación apreciativa. In *Gramática descriptiva de la lengua española*, I. Bosque and V. Demonte (eds), 4645–4682. Madrid: Espasa Calpe.

Lloret, M.-R. and Mascaró, J. 2005. Depalatalization in Spanish revised. Ms., Universitat de Barcelona and Universitat Autònoma de Barcelona. (Available at ROA 708, Rutgers Optimality Archive, http://roa.rutgers.edu/).

Łubowicz, A. 2002. Derived environment effects in Optimality Theory. *Lingua* 112: 243–280.

Mascaró, J. 1996. External allomorphy as emergence of the unmarked. In *Current Trends in Phonology: Models and methods*, J. Durand and B. Laks (eds), 473–483. Salford: European Studies Research Institute, University of Salford.

McCarthy, J. J. 1993. A case of surface constraint violation. *Canadian Journal of Linguistics* 38: 169–195.

McCarthy, J.J. 1999. Sympathy and phonological opacity. *Phonology* 16: 331–399.

McCarthy, J.J. 2002. *A Thematic Guide to Optimality Theory*. Cambridge: CUP.

McCarthy, J.J. 2003. OT constraints are categorical. *Phonology* 20:75–138.

Méndez-Dosuna, J. and Pensado, C. 1990. How unnatural is Spanish *Víctor* → *Vict-ít-or*? Infixed diminutives in Spanish. In *Naturalists at Krems: Papers from the Workshop on Natural Phonology and Natural Morphology (Krems, 1–7 July 1988)*, J. Méndez-Dosuna and C. Pensado (eds), 89–106. Salamanca: Ediciones Universidad de Salamanca.

Montermini, F. 2003. Appunti sulla cancellazione di vocale in derivazione. In *Scritti di morfologia in onore di Sergio Scalise in occasione del suo 60º compleanno*. A. Bisetto, C. Iacobini, A.M. Thornton (eds), 171–188. Roma: Caissa Italia.

Oltra-Massuet, I. and Arregi, K. 2005. Stress-by-structure in Spanish. *Linguistic Inquiry* 36: 43–84.

Orgun, C.O. 1996. Sign-Based Morphology and Phonology, with Special Attention to Optimality Theory. PhD dissertation, University of California, Berkeley. (Available at ROA 171, Rutgers Optimality Archive, http://roa.rutgers.edu/).

Pena, J. 1999. Partes de la morfología. Las unidades del análisis morfológico. In *Gramática descriptiva de la lengua española*, I. Bosque and V. Demonte (eds), 4305–4366. Madrid: Espasa Calpe.

Pensado Ruíz, C. 1997. On the Spanish depalatalization of /ɲ/ and /ʎ/ in rhymes. In *Issues in the Phonology and Morphology of the Major Iberian Languages*, F. Martínez-Gil and A. Morales-Front (eds), 595–618. Washington DC: Georgetown University Press.

Pensado Ruíz, C. 1999. Morfología y fonología. Fenómenos morfofonológicos. In *Gramática descriptiva de la lengua española*, I. Bosque and V. Demonte (eds), 4423–4504. Madrid: Espasa Calpe.

Peperkamp, S. 1995. Prosodic constraints in the derivational morphology of Italian. In *Yearbook of Morphology 1994*, G. Booij and J. van Marle (eds), 207–244. Dordrecht: Kluwer.

Pharies, D. 2002. *Diccionario etimológico de los sufijos españoles y de otros elementos finales*. Madrid: Gredos.

Rainer, F. 1996. Inflection inside derivation: Evidence from Spanish and Portuguese. In *Yearbook of Morphology 1995*, G. Booij and J. van Marle (eds), 83–91. Dordrecht: Kluwer.

Roca, I. 1988. Theoretical implications of Spanish word stress. *Linguistic Inquiry* 19: 393–423.

Roca, I. 1990. Diachrony and synchrony in word stress. *Journal of Linguistics* 26: 133–164.

Roca, I. 1991. Stress and syllables in Spanish. In *Current Studies in Spanish Linguistics*, H. Campos and F. Martínez-Gil (eds), 599–635. Washington DC: Georgetown University Press.

Roca, I. 2005. Saturation of parameter settings in Spanish stress. *Phonology* 22.345–394.

Roca, I. and Felíu, E. 2003. Morphology in truncation: The role of the Spanish desinence. In *Yearbook of Morphology 2002*, G. Booij and J. van Marle (eds), 187–243. Dordrecht: Kluwer.

Rubach, J. and Booij, G. E. 2001. Allomorphy in Optimality Theory: Polish iotation. *Language* 77:26–60.

Santiago Lacuesta, R. and Bustos Gisbert, E. 1999. La derivación nominal. In *Gramática descriptiva de la lengua española*, I. Bosque and V. Demonte (eds), 4505–4594. Madrid: Espasa Calpe.

Scalise, S. 1983. *Morfologia lessicale*. Padova: Clesp.

Scalise, S. 1994. *Morfologia*. Bologna: il Mulino.

Gender allomorphy and epenthesis in Spanish*

Eulàlia Bonet
Universitat Autònoma de Barcelona

Contrary to most previous approaches, this paper argues that current Spanish does not have final epenthesis or plural epenthesis, based on several types of empirical evidence. As a consequence, former epenthetic vowels have been reinterpreted as "gender" allomorphs or class markers. Only initial and internal epenthesis are possible in the synchronic grammar of Spanish. It is also shown that, contrary to some views, *-o* is not the default class marker. Under this new light, class markers are reanalyzed within Optimality Theory. It is claimed that all allomorphs are present in the input and that the constraint ranking, together with lexical specifications, determine which class marker surfaces and what contexts favor vowel epenthesis. Invariable plural formation follows naturally under this approach. This view is compared with the idea that Spanish does have final epenthesis and plural epenthesis with lexical items divided in two groups, genuine words and loans, which are subject to different constraint rankings.

Keywords: Spanish, class markers, epenthesis, loanwords

0. Introduction

As is well-known, most Spanish masculine nouns and adjectives end in an unstressed vowel, which is not present in derivatives. The most common unstressed vowel is *-o*.

(1) a. Masculines ending in *-o*

pelo	'hair'	(cf. *pelambre* 'thick hair')
potro	'colt'	(cf. *potranca* 'young mare')
lleno	'full'	(cf. *llenísimo* 'very full')
blanco	'white'	(cf. *blancura* 'whiteness')

* I would like to thank Joan Mascaró and two anonymous reviewers for thorough and helpful comments on the first version of this paper. This work has been supported by the Spanish Ministerio de Ciencia y Tecnología and FEDER (BFF2003–06590) and by the Departament d'Universitats, Recerca i Societat de la Informació, Generalitat de Catalunya (Research Groups 2005SGR00753, Modalitat B).

b. Masculines ending in *-e*

pase	'pass'	(cf. *pasar* 'to pass')
hombre	'man'	(cf. *hombruno* 'manlike')
sublime	'sublime'	(cf. *sublimación* 'sublimation')
verde	'green'	(cf. *verdoso* 'greenish')

c. Masculines ending in *-a*

atleta	'athlete'	(cf. *atletismo* 'athletics')
papa	'pope'	(cf. *papista* 'popish')
agrícola	'agricultural'	(cf. *agricultura* 'agriculture')
persa	'Persian'	(cf. *Persia*)

Many other masculine nominals end in a consonant, and some, in a glide or a stressed vowel.[1] In these cases all segments are generally kept in derivatives. In (2a) and other examples below, the letter *z* is pronounced [θ] in most European dialects and [s] in other varieties.

(2) a. Masculines ending in a consonant

mal	'evil'
pez	'fish'
gris	'grey'
holgazán	'lazy'

b. Masculines ending in a glide

buey	'ox'
rey	'king'
guay	'cool (slang)'

c. Masculines ending in a stressed vowel

café	'coffee'
jabalí	'wild boar'
marroquí	'Moroccan'

Feminine nominals can also end in one of the unstressed vowels mentioned in (1), being *-a* the most common, and *-o* extremely rare.

(3) a. Feminines ending in *-a*

casa	'house'	(cf. *caserón* 'large house')
hiedra	'ivy'	(cf. *hiedrita* 'small ivy')
roja	'red'	(cf. *rojiza* 'reddish')
blanca	'white'	(cf. *blancura* 'whiteness')

b. Feminines ending in *-e*

clase	'class'	(cf. *clasificar* 'classify')
fiebre	'fever'	(cf. *febril* 'feverish')
inane	'inane'	(cf. *inanición* 'starvation')
alegre	'happy'	(cf. *alegría* 'happiness')

c. Feminines ending in *-o*

mano	'hand'	(cf. *manita* 'small hand')
modelo	'(fashion) model'	(cf. *modelaza* 'great fashion model')

1. Throughout this paper I use the term *glide* in a descriptive sense. I do not take a stand on the underlying nature of phonetic glides, because this is a highly controversial issue which does not affect the arguments put forward here.

There are also many feminines that end in a consonant, but it is fairly difficult to find feminines that end in a glide or a stressed vowel.

(4) a. Feminines ending in a consonant

pared	'wall'
sien	'temple'
feliz	'happy'
fácil	'easy'

b. Feminines ending in a glide or a stressed vowel

guay	'cool (slang)'
hindú	'Hindu'

Finally, most of the nominals that end in a consonant or a glide, and some of the ones that end in a stressed vowel, surface with an additional *-e* in the plural.[2]

(5) a. Masculine plurals with *-e*

males	'evil (pl.)'	(cf. *mal*)	
peces	'fishes'	(cf. *pez*)	
grises	'grey'	(cf. *gris*)	
bueyes	'oxen'	(cf. *buey*)	
jabalíes	'wild boars'	(cf. *jabalí*)	(more often *jabalís*)

b. Feminine plurals with *-e*

paredes	'walls'	(cf. *pared*)	
sienes	'temples'	(cf. *sien*)	
fáciles	'easy (pl.)'	(cf. *fácil*)	
hindúes	'Hindus'	(cf. *hindú*)	(more often *hindús*)

In spite of the title of this paper, and even though most masculine (and male-related) nominals end in *-o* (e.g. *camarero* 'waiter (masc.)') and most feminine (and female-related) nominals end in *-a* (e.g. *camarera* 'waitress (fem.)'), Roca (1989) and, especially, Harris (1991, 1992) have convincingly shown that these endings are neither gender markers nor are they directly related to sex. They are not directly related to sex because they show up in many nouns referring to objects (e.g. *caso* 'case (masc.)', *armario* 'closet (masc.)'; *idea* 'idea (fem.)', *mesa* 'table (fem.)'), and can also refer to animates without specific reference to their sex (e.g. *leopardo* 'leopard (masc.)', *pantera* 'panther (fem.)'; *buho* 'long-eared owl (masc.)', *lechuza* 'barn owl (fem.)'). And they are not directly related to grammatical gender because they also show up in genderless words, like adverbs: *pronto* 'soon' (cf. *prontito* 'soon (dim.)') *ahora* 'now' (cf. *ahorita* 'now (dim.)'). The endings *-o*, *-a*, *-e*, Ø (the last one, basically for words ending in a consonant or a stressed vowel) are class markers, also called word markers, declensional classes, form-class morphemes, theme vowels or desinences, and are present in all non-verbs

2. This brief description is missing some residual cases in which there is a final unstressed vowel *-i* or *-u* which does not appear in derivatives (*tribu* 'tribe (fem.)', cf. *tribal* 'tribal'; *biquini* 'bikini (masc.)', cf. ?*biquinazo* 'big bikini') or *güisqui* 'whisky', cf. *güisquería* 'whisky bar'. There are also some nominals that end in an unstressed vowel followed by *-s* in the singular (*síntesis* 'synthesis (fem.)', cf. *sintético* 'synthetic'; *lunes* 'Monday', without any clear derivatives). These cases are treated in Section 5. See Ambadiang (1999) for a description of the facts outlined in this section.

of Spanish, including prepositions and adverbs (see Roca 1989 and Harris 1991, 1992 for a more detailed discussion of the differences between sex, grammatical gender and declensional classes).

One of the main questions that have been posed in the literature is the nature of the vowel *-e*. As shown in (1b) and (3b) there are many nominals that end in this vowel (cf. *hombre* 'man' or *clase* 'class'); and we have also seen, in (5), that words that end in a consonant (also a glide or, in some cases, a stressed vowel) in the singular, surface with an additional *-e* in the plural (cf. *paredes* 'walls', with the singular *pared*). Given that [e] is the epenthetic vowel in Spanish, several authors have suggested that many of the *-e* endings are the product of epenthesis caused by syllabification problems (that would be the case in *hombre*), while some of them can be considered class markers (this would be the case in *clase*). With respect to singular-plural asymmetries, like *pared-paredes*, some authors have proposed a deletion analysis in which both the singular and the plural would have an underlying *-e* which would be deleted in the singular, while other authors have interpreted that the *e* that appears in the plural is epenthetic. Section 1 of this paper is devoted to these issues, the conclusion being that current Spanish has initial epenthesis and internal epenthesis, but not final epenthesis. Final *-e* is claimed to be a class marker in all cases (e.g., in *hombre*, *clase* and *paredes*).

Another issue to be discussed, in Section 2, is the marking relations among class markers (mostly in terms of lexical frequency). Contrary to Harris (1999) and other approaches, who claim *-o* to be the default class, it is argued that this is so only for masculine nominals. Marking relations are different for each grammatical gender, masculine and feminine; for adverbs, for instance, the *-o* class is more marked than the Ø class. After some interim conclusions in Section 3, in Section 4 I propose an analysis of class markers in Optimality Theory (OT), within an approach that assumes that no phonological information is introduced through constraints and that all constraints are universal. Section 5 is devoted to some remaining aspects including invariable plurals, and in Section 6 the proposed account, in which loan adaptation is used as an argument against epenthesis, is compared with an approach in which loans are viewed as having a different subgrammar, with a different constraint ranking.

1. The evidence for epenthesis

1.1 Word-initial epenthesis versus word-final epenthesis

One of the most noticeable features of Spanish phonology is that the language does not tolerate word-initial clusters of *s* followed by a consonant and that an [e] is inserted systematically at the beginning of words to avoid those clusters. The examples in (6a) contain native words with initial [e], not present in the English cognates; (6b) contains several recent borrowings from English in which initial epenthesis has taken place. Among the examples in (6b) only *scanner* has been adapted to Spanish orthography by the *Real Academia Española* (RAE): *escáner*.

(6) a. *esfera* 'sphere'
estudio 'study'
escuela 'school'
espacio 'space'
b. [e]*stop*
[e]*stick*
[e]*spray*
[e]*scáner*

It is interesting to note that a word like *spray* has been adapted, in European Spanish, following the spelling, as the pronunciation of the last vowel, [a] instead of [e], suggests ([espɾáj]); however, initial epenthesis is unavoidable in spite of the spelling. Given the type of evidence exemplified in (6), all authors have unanimously accepted that Spanish has a process of initial epenthesis, caused by the impossibility of syllabifying an initial *sC* cluster, and that the epenthetic vowel is [e]. The grammar of Spanish, then, needs some mechanism that generates these word-initial [e]s.

It is a well-known fact that in word-final position the native vocabulary of Spanish tolerates only certain consonants, and generally only one of them. The consonants in (7) are the ones mentioned in Alcina Franch and Blecua (1975), and constitute roughly the set accepted in other work. In (7), [d] is actually pronounced as a fricative or approximant [ð], very often devoiced, and often it is practically absent or completely absent (see Navarro Tomás 1971 for a more detailed description); [θ] is a sound absent in all American varieties and in some European ones ([s] appears instead). The last consonant, the velar or uvular [x], which is most often lenited or deleted (see Navarro Tomás 1971), is excluded by Harris (1999) and by Núñez Cedeño and Morales-Front (1999), among others, from the list of possible final coda consonants mostly because very few native words end in this consonant (it is also the only noncoronal consonant of the list, if we leave aside the fact that in many varieties /n/ is actually pronounced as a velar [ŋ] in word-final position before a vowel or a pause; see Canfield 1981, e.g.).

(7) d: *virtud* 'virtue', *sed* 'thirst', *Madrid*
θ: *pez* 'fish', *feliz* 'happy', *fugaz* 'fleeting'
s: *inglés* 'English', *detrás* 'behind', *casas* 'houses'
n: *canción* 'song', *examen* 'exam', *según* 'according'
l: *pastel* 'cake', *difícil* 'difficult', *final* 'ending'
r: *pastor* 'shepherd', *carácter* 'character', *ayer* 'yesterday'
x: *reloj* 'watch', *carcaj* 'quiver'

The list of possible final consonants may vary depending on the dialects being considered. Final [f] is excluded from the list but it is fairly common in borrowings or acronyms; in some varieties this consonant is lenited (pronounced with a lesser degree of constriction): *chef*, *rosbif* 'roastbeef', *NIF* (*Número de Identificación Fiscal*). Words like *vals* 'waltz' or *golf*, with two coda consonants (a lateral followed by a fricative), are accepted in many varieties, and final stops are accepted in some varieties (e.g. *coñac* 'cognac', *club*, *complot* 'conspiracy'), for instance.

It has been argued that when the language encounters a word with an impermissible consonant (not belonging to the set in (7)) or a consonant cluster in coda position, an epenthetic [e] is inserted in final position (see Harris 1987, 1991, 1992, 1999 and Colina 1995, among others). The words in (8) would all have a final epenthetic [e]. (8a) would have an underlying representation with a final consonant cluster. In (8b) the underlying representation would end in one of the consonants not allowed in coda position (they do not belong to the set in (7)). In order not to distract attention from the relevant issues, all underlying forms of words in this paper are practically identical to their phonetic form except for crucial aspects, in (8) the final vowel.

(8) a. *parte* 'part': /part/
chisme 'gossip': /tʃizm/
solemne 'solemn': /solemn/
peine 'comb': /pejn/
canadiense 'Canadian': /kanadjens/
b. *nube* 'cloud' /nub/
rape 'monkfish' /rap/
mate 'dull' /mat/
pliegue 'fold' /pljeg/
jefe 'boss' /xef/

One striking difference between initial and final epenthesis, noticed by Harris (1987) and stressed by Colina (2003a), for instance, is that while initial epenthesis is systematic and applies to new borrowings, final epenthesis is totally unproductive. As a matter of fact, final epenthesis is *never* used nowadays as a strategy to avoid a syllabication problem (Morin 1999 makes a similar point). The actual strategies are summarized below.

(9) a. Noncoronal sonorants (nasals and laterals): place neutralization
Beckham (English last name): [békan] (*[békame])
imam: [imán] (*[imáme])
Maragall (Catalan last name with a final palatal lateral): [maɾaɣál] (*[maɾaɣáʎe] or *[maɾaɣáje])
detall 'retail' (Catalan borrowing): [detál] (*[detáʎe] or *[detáje])
b. Stops: lenition, often with devoicing, or deletion
input: [ímpuθ̞], [ímpu] (*[ímpute])
bistec 'steak': [bisté] (*[bistéke])
grog (drink): [gɾóɣ] (*[gɾóɣe])
c. Consonant clusters with a final stop: deletion of the stop
Grant (last name): [gɾán] (*[gɾánte])
lord: [lór] (*[lórðe])
comfort: [koɱfór] (*[koɱfórte])
Dirk (proper name): [dír] (*[dírke])
d. Consonant clusters with a stop followed by a fricative: deletion of the stop
bíceps: [bíθes] (*[bíθepse], *[bíθeɸ̞se], *[bíθepes])
ántrax 'anthrax': [án̪tɾas] (*[án̪tɾakse], *[án̪tɾax̞se], *[án̪tɾakes])

e. Consonant clusters with rising sonority: *internal* epenthesis[3]
Al Sadr (proper name): [alsáðer] (*[alsáðɾe])
Lidl (chain of supermarkets): [líðel] (*[líðle], *[líð̥le])
single (applied to records): [síŋgel] (*[síŋgle])

The contexts in (9a–d) do not favor epenthesis; in the varieties where these consonants or consonant clusters are not allowed, lenition of the consonant or plain deletion are the strategies chosen, never epenthesis. The only context where epenthesis takes place is when the last cluster has rising sonority, (9e). Crucially, though, in this case the epenthetic vowel breaks the cluster, it does not appear at the end of the word. Notice especially the case of *single*, in which the spelling would have favored final epenthesis. A word like *Al Sadr* [alsáðer] (*[alsáðɾe]) can be compared to *padre* 'father', a word that would have final epenthesis in many accounts and whose underlying representation would be /padɾ/. It is obvious that no theory will be able to account for final epenthesis in /padɾ/ but internal epenthesis in /al+sadɾ/: the sequences are identical phonologically (the segments involved are the same) and morphologically (there is no morpheme boundary in one of the cases, for example). Resorting to labels like 'xenonym' or [+foreign] for examples like *Al Sadr*, as has been done by several authors (see, for instance, Harris 1999 or Shepherd 2003), has often been just a way of avoiding the problem (especially since sometimes they do not provide a theory of xenonyms that can predict what is allowed in a xenonym). Within Optimality Theory, it can be argued that xenonyms are subject to a different constraint ranking. This view, not accepted here for Spanish, is discussed in Section 6. The important fact to be kept in mind here is that there is no evidence for final epenthesis (contrary to what has been shown for initial epenthesis).

Consonant clusters not mentioned in (9) are often allowed in the language. Examples like *vals* 'waltz' or *golf* were mentioned earlier. Other examples include words like *surf*, *Lemans* (French proper name). Clusters with a glide followed by a consonant, like *Indurain* [in̪duɾájn] (Basque proper name), are also allowed without any problem. Notice that in this example, if the language did not allow this type of cluster, a pronunciation with a vowel instead of a glide, *[in̪duɾáin], would avoid the alleged surface syllabification problem.

The evidence provided in (9), lenition, deletion or internal epenthesis when syllabification problems arise, strongly suggests that the final *-e* present in so many words is not an epenthetic vowel but a class marker, and therefore is present in the underlying representation of the word. Then the underlying representation of *padre* is /padɾ+e/, while the underlying representation of *Al Sadr* is /al+sadɾ/. All authors have acknowledged that there is a class marker *-e*, given the type of data shown in (10), below, where the final *-e* is preceded by one of the consonants allowed in word-final position (see (7)), which means that there is no need for epenthesis.

3. An internal epenthetic [e] can also be heard in Spanish speakers speaking English in words like *little*, pronounced [lítel], *apple* [ápel] (*[áple]).

(10) *jade*, *pirámide* 'pyramid' (cf. *pared* 'wall')
doce 'twelve', *cómplice* 'accomplice' (cf. *pez* 'fish')
clase 'class', *envase* 'container' (cf. *gris* 'grey')
alucine 'act of hallucinating', *pene* 'penis' (cf. *holgazán* 'lazy')
vale 'voucher', *hule* 'oilcloth' (cf. *fácil* 'easy')
títere 'puppet' (cf. *pastor* 'shepherd')
eje 'axle', *encaje* 'lace' (cf. *reloj* 'watch')

In addition, the class marker -*e* is typical of many deverbal nouns independently of the syllabic status of the stem final consonants (less often other deverbal nouns are formed with the class marker -*a*, like *escucha* 'listening', from the verb *escuchar* 'to listen', or the class marker -*o*, like *vuelo* 'flight', from *volar* 'to fly'). This word-formation process is very productive in Spanish.

(11)

toque 'touch'	from *tocar* 'to touch'
pase 'pass'	from *pasar* 'to pass'
derrame 'spilling'	from *derramar* 'to spill'
alucine 'act of hallucinating'	from *alucinar* 'to hallucinate'
despeje 'clearance'	from *despejar* 'to clear'
desaire 'snub'	from *desairar* 'to snub'
ligue 'flirtation'	from *ligar* '(aprox.) to flirt'

According to Lapesa 1959 or Menéndez Pidal 1968, for instance, at some point Old Spanish lost most of its final -*e* (mostly in the 12th and 13th centuries), even when they appeared after consonant clusters or consonants later not allowed in final position (cf. *ardiment* 'daring', *tost* 'immediately', *recib* 'receives'). Later final -*e* was recovered except in the contexts given in (7). Some borrowings, like *cognac*, from French, were often pronounced with final *e*, [koɲáke], in the 19th century and first half of the 20th century (the CORDE database from the RAE records seven tokens written *coñaque*, starting in 1853, the last one being from 1953; at the beginning of the 20th century most of the tokens are already written as *coñac* or *coñá*).[4] This type of data suggests that final epenthesis might indeed have been a strategy for solving syllabification problems in Spanish until fairly recently. The claim in this section is that what at some point might have been final epenthetic vowels were reinterpreted as class markers, a reinterpretation that would have been favored by the position of the vowel (after the stem) and the fact that there was a class marker -*e*. Nowadays epenthesis is restricted to initial position and to internal position for unsyllabified consonants with rising sonority. Harris (1999) proposes an intermediate account of final *e* in which the vowel is epenthetic but it is dependent on a class marker position (in his terms a thematic position, or $\mathfrak{I}$). Colina (2003a,b) reaches the same conclusion presented in this section.

4. At several points in this paper I mention the CORDE and the CREA databases of the RAE. The CORDE (*Corpus Diacrónico del Español*: http://corpus.rae.es/cordenet.html) contains all types of texts of all periods up to 1975; the CREA (*Corpus de Referencia del Español Actual*: http://corpus.rae.es/creanet.html) contains all types of texts, including transcriptions from oral language, starting in 1976.

1.2 Plurals

The plural of words ending in an unstressed vowel is realized with the addition of an -*s* suffix (cf. *casa* 'house', *casas* 'houses'; *pato* 'duck', *patos* 'ducks'). As was exemplified in (5), the plurals of "native" nominals ending in a consonant or a glide surface with the ending -*es*; this ending can also appear in words ending in a stressed vowel. (5) is repeated below as (12).

(12)	a.	Masculine plurals with -*e*			
		males	'evil (pl.)'	(cf. *mal*)	
		peces	'fishes'	(cf. *pez*)	
		grises	'grey'	(cf. *gris*)	
		bueyes	'oxen'	(cf. *buey*)	
		jabalíes	'wild boars'	(cf. *jabalí*)	(more often *jabalís*)
	b.	Feminine plurals with -*e*			
		paredes	'walls'	(cf. *pared*)	
		sienes	'temples'	(cf. *sien*)	
		fáciles	'easy (pl.)'	(cf. *fácil*)	
		hindúes	'Hindis'	(cf. *hindú*)	(more often *hindús*)

There are at least three possible ways to analyze the differences in plural formation. One possibility is to say that the plural suffix has two allomorphs, -*s* and -*es*; then *males* 'evil (pl.)' would have the underlying representation /mal+es/. Another possibility is to say that the *e* found in plurals is epenthetic, the underlying representation of *males* being then /mal+s/. A third possibility is to assume that a word like *mal* has the *e* underlyingly, as a class morpheme, for instance (/mal+e/); this *e* will be preserved in the plural but will be subject to deletion in the singular. The allomorphy analysis, assumed in Saporta (1965), was later abandoned in favor of analyses that need not posit any allomorphy for the plural, which has since then been assumed to be simply /s/. The epenthesis analysis has been assumed or argued for in Saltarelli (1970), Contreras (1977), Harris (1980), (1987), (1992), and, within Optimality Theory, Colina (1995), and Shepherd (2003). The deletion analysis was first proposed in Foley (1967), and is taken up again in Roca (1996) within Optimality Theory. Harris (1999) proposes a fourth possibility, within the framework of Distributed Morphology: he posits a class III which is realized as Ø in the singular (giving as a result words like *mal* or *padre*, the latter with epenthesis), but as *e* in the plural (giving *males* and *padres*).

A fact that weakens the epenthesis analysis is that *e* appears not only in plurals of words ending in a consonant, where there might be some justification for epenthesis (for instance, the need to avoid a complex coda), but it can also appear in words ending in a stressed vowel, like *jabalí-jabalíes* 'wild boar'. In this case there is certainly no syllabic justification for epenthesis, given that *jabalís* contains no complex coda and moreover avoids the hiatus present in *jabalíes*.[5] In these cases it is unavoidable

5. It is true that, even though most prescriptive grammars recommend the use of the ending -*es* (e.g., *jabalíes*), for many speakers those words only have -*s* in the plural (a plural like *jabalís* is much more common than *jabalíes*). However there is a significant number of speakers for whom some of these

to postulate a different source for *e* in the plural, but examples like *jabalíes* have been ignored in practically all approaches defending the epenthesis view. A more important problem is that, if a word like *pan* 'bread' has epenthesis in the plural, *panes*, in order to avoid a complex coda (*[páns]), it is difficult to explain why this problem does not seem to matter for the plural of a word like *fan* 'fan' (a loan), which is *fans*, if one assumes that both words are subject to the same phonology (see Section 6 for a more detailed discussion of this issue).

The main problem for the deletion alternative is the existence of quasi-minimal pairs like the ones in (13).

(13)	a.	Pl: *-es*, sg: Ø		b.	Pl: *-es*, sg: *-e*
		soles and *sol* 'sun'	but		*hules* and *hule* 'oilcloth'
		peces and *pez* 'fish'	but		*doces* and *doce* 'twelve'
		paredes and *pared* 'wall'	but		*jades* and *jade* 'jade'

Under the deletion analysis a mechanism can be devised for the deletion of *-e* in the singular in (13a), but then it will be impossible to prevent deletion from applying in the cases of (13b), with the same phonological and morphological context. Roca (1996), who argues for a deletion analysis under the containment model of Optimality Theory, tries to get around this problem by positing two underlying types of *e*: the examples in (13b) would have a completely specified *e* in the underlying representation (e.g., *hule* /ule/), while the examples in (13a) would have an underspecified vowel (e.g., *sol* /solV/). One of the problems with this account is that it has to posit optimal candidates that crucially have an underspecified vowel (for the plurals in (13a), like *soles*), without mentioning what type of constraint would rule out fully specified candidates (also provided by Gen). Moreover, the absence of the underspecified vowel in the phonetic form of singular words like *sol* is attributed to an ad hoc constraint called Apoc that penalizes final (only final) underspecified vowels.

The idea to be pursued here is in a way close to Harris's approach and is parallel to the conclusions reached in Section 1.1: regardless of the origins of the *-es* plurals, nowadays the *e* present in examples like *soles* 'suns' or *jabalíes* 'wild boars' is interpreted as a class marker, exactly like the one present in *hules* 'oilclothes'. The only difference between these words is that, in the singular, *hule* has the same class marker *-e*, while *sol* and *jabalí* have a class marker Ø. Advancing the view that will be pursued in Section 4, the stem *hul* (/ul/) subcategorizes for a (marked) class marker *-e*. A stem like *sol* (/sol/) subcategorizes for a (marked) class marker Ø in the singular but for a (marked) class marker *-e* in the plural (a more marked option). It is also possible for a stem to subcategorize for a class marker Ø in the singular and in the plural. This is the case for the speakers of Spanish for whom the plural of *jabalí* or of *hindú* is *jabalís* or *hindús*, respectively, and for other examples to be discussed below.[6] The view defended here gets further support from the evidence to be discussed in what follows.

plurals do end in *-es* and do not accept them without the *-e*. It is for those speakers that the *-e* cannot be said to be epenthetic.

6. The origin of the plural *-s* is the Latin plural accusative (cf. *rosas* 'roses', accusative plural from the

It is true that most native Spanish nominals ending in a consonant or a glide have *e* in the plural. And this is what prescriptive grammars of Spanish teach. However, in spite of normative pressure, plurals in *-es* are fairly rare in loans. In (14) I give the results of a survey of a random set of borrowings in the CREA database of the RAE (Ohannesian 2004 reaches a similar conclusion based on a questionnaire answered by 20 native speakers of different dialects and different ages). The first column (with final stops) in all cases and the second column (with final noncoronal nasals) in (14a) have consonants that do not belong to the set of possible codas listed in (7). The rightmost column in (14a-d) contains possible final consonants (final *-f* has also been included in this column, even though it does not appear in (7)).

(14) a. Plural only with *-s* (21 items)

set	*módem*	*jersey*
input	*medium*	*espray*
debut	*cámping*	*fan*
complot 'conspiracy'	*párquing* 'parking lot'	*sij*
superávit 'surplus'		*terminator*
bistec 'steak'		*tour*
clic		*alien*
clip		*gin*
vermut 'vermouth'		

b. Plural mostly with *-s* (11 items)

bit		*pin*
chalet		*póster*
cabaret		*chef*
frac 'dress coat'		*córner*
mamut 'mammoth'	*pool*	
coñac 'brandy'		

c. Plural mostly with *-es* (3 items)

club		*váter* 'WC'
		convoy

d. Plural only with *-es* (2 items)

		chófer 'driver'
		talibán

In (14) there are 32 items which have the plural only or mostly with *-s*; only 5 items have the plural only or mostly with *-es*. Notice that even when the items of the first column are pronounced with a deleted consonant, sometimes reflected in the spelling,

first declension, or *populos* 'villages, people', accusative plural from the second declension). The origin of the plurals with *-es* lies in the items of the third declension (cf. *leones* 'lions', accusative plural) and some from the fifth declension. The stem of those items ended usually in a consonant. According to Menéndez Pidal (1968), the plurals with *-es* were first extended to words ending in a glide (cf. *bueyes* 'oxen', originally *bueis*), later to words ending in a stressed vowel, especially *i*; at some point even stems ending in stressed *e* could have a plural in *-es* (cf. *cafees* 'coffees'). One possible interpretation of these facts is that at some point in the history of Spanish the plural morph required the presence of a class marker, for some not very clear reason. As shown in what follows in the text, this requirement has been clearly losing strength.

it is never the case that the now final stressed vowel is followed by *-es* (in the CREA database there are no examples like **debúes*, **vermúes*, **comploes* or **coñaes*, even though the singular *debú*, *vermú*, *compló* or *coñá* are found).

When one examines the plural of "native" words ending in a stressed vowel (a very small percentage of the words of the language), one finds a very strong tendency to pronounce them without *e*. For some words like *mamá* 'mum', *papá* 'dad' or *sofá* 'sofa', the plurals *mamás*, *papás* and *sofás* are the only possible ones. For other words, like *jabalí* 'wild boar', *hindú* 'Hindi', *marroquí* 'Moroccan' or *rubí* 'ruby', in many dialects of the language only the plurals with *-s* are found (*jabalís*, *hindús*, *marroquís*, *rubís*). For many speakers, the plurals in *-es* after a stressed vowel (*jabalíes*, *hindúes*, *marroquíes*, *rubíes*) are learned forms, but, as emphasized earlier, for a significant set of speakers this is the only form they would ever say. For this set of speakers it is impossible to predict in which cases the plural will have or lack an *e*, and therefore this information has to be included in the lexical entry. A word like *mamá* will subcategorize for a Ø class marker both in the singular and in the plural for all speakers; a word like *magrebí* will have the same subcategorization for many speakers, but for some it will subactegorize for a Ø class marker in the singular but for an *e* class marker in the plural (similarly to cases like *sol-soles* 'sun').

We have seen two types of cases that challenge the former predictability of the *-s* / *-es* distribution in plurals. First, even though due to historical reasons most of the vocabulary has *-es* in the plural when the stem ends in a consonant and the singular has a class marker Ø, the fact that most new (or not so new) vocabulary lacks this type of plural formation, resorting to plain *-s*, suggests that plural formation with *-es* is not productive any more, and that the choice of class marker Ø in the singular vs. class marker *-e* in the plural is a matter of lexical choice: a word like *jersey* [xerséj] 'sweater' subcategorizes for the same class marker in the singular and in the plural (cf. *jerseys*); *convoy*, a much less common word, has the same type of subcategorization for some speakers (cf. *convoys*), but for some other speakers it subcategorizes for the class marker *-e* in the plural (cf. *convoyes*); a word like *rey* 'king' subcategorizes for the class marker *-e* in the plural for all speakers (cf. *reyes*). In addition, a word like *fan* 'fan', without *e* in the plural (*fans*), is not perceived as foreign or strange by native speakers; it just differs from *pan-panes* 'bread', for instance, in the absence of *e*, but not other properties. We have seen a second case, the presence or absence of *e* in the plurals of words ending in a stressed vowel, where predictability has completely disappeared (as mentioned earlier). In these cases it is unavoidable to have a lexical specification for each item: for the speakers who say *marroquíes*, this word has to have a subcategorization requirement both for the singular (class Ø) and for the plural (class *e*), contrary to some other items. The proposal is then that all words that have *e* in the plural but not in the singular — which includes words ending in a consonant, words ending in a glide and words ending in a stressed vowel — have the same subcategorization frame with respect to class membership. This subcategorization frame (class Ø in the singular, class *e* in the plural) is certainly a marked option, and it is natural that new vocabulary chooses a simpler one (the same subcategorization frame for singular and plural).

2. Marking relations between class markers

Harris (1999) proposes an account of the distribution of class markers in Spanish within the framework of Distributed Morphology (DM). In DM the syntax and the first stages of the morphology operate solely with morphosyntactic material, phonological information being inserted later in the morphology through vocabulary entries. Harris (1999: 56–57) explicitly proposes the following classification, which constitutes "a partial inventory of classes and subclasses of Spanish words, ranked in increasing order of the number of words of each type." The list in (15) reproduces his (13), with the exception that I have included only one example of each case, for reasons of space. His ℑ is what I have been calling class markers.

(15)		Class	ℑ	Examples
	a.	xenonyms	Ø	*coñac(s)*
	b.	I-x	o	feminine: *mano* 'hand'
	c.	II-x	a	masculine: *día* 'day'
				no gender: *cerca* 'near'
	d.	III	Ø/e	masculine: *sol* 'sun'
				feminine: *nube* 'cloud'
				no gender: *delante* 'in front'
	e.	II	a	feminine: *silla* 'chair'
	f.	I	o	masculine: *libro* 'book'
				no gender: *dentro* 'inside'

The classification in (15) together with other considerations lead Harris to propose the vocabulary entries in (16) (Harris 1999: 69 (31)).

(16) *Entries for ℑ (final version)*

$$\mathfrak{I} \longleftrightarrow \text{e} \,/ \left[\begin{array}{l}\text{IV} \\ \text{III} \_\_ \text{[plural]}\end{array}\right]$$

Ø / III __

a / II __

o (default)

The *o* ending is for Harris a default because according to him most of the non-verbs in Spanish end in *-o* (see (15f)). This conclusion, accepted in Roca and Felíu (2003), for instance, is not at all obvious. Notice first that for some mysterious reason, while no-gender words ending in *-o* appear in (15f) (nothing to object), no-gender words ending in *a* appear in the much rarer (15c), instead of appearing in the more common (15e). If no-gender words ending in *-a* are included with the more common feminine words, the default status of *-o* is seriously challenged. Second, it is not true that for no-gender words *-o* is the more common ending. If one goes through the list of prepositions (an easy task because it is a closed and short class), there is only one preposition ending in *o* (*bajo* 'below'), but five ending in *-a* (*a* 'to', *contra* 'against', *hacia* 'towards', *hasta* 'until', *para* 'for'); moreover six of them end in a consonant (that is Ø), and four of them end in *-e* (of which, three would end in Ø under the epenthesis approach that Harris assumes). Adverbs are not so easy to list because they form an open class, and many of them come from masculine adjectives (cf. *rápido* 'fast'). If we exclude those, and check the more common ones, it is true that one finds more adverbs ending in *-o* than in *-a* (17 common ones ending in *-o*: e.g., *pronto* 'soon', *luego* 'later', *despacio* 'slowly'; 13 common ones ending in *-a*: e.g., *ahora* 'now', '*nada* 'at all', *fuera* 'outside'). But the vast majority of adverbs do not end in an unstressed vowel, which means that they have the class marker Ø (28 common ones; e.g. *aquí* 'here', *ayer* 'yesterday', *también* 'also'). So, for no-gender words there is no reason to believe that *-o* is the default or preferred ending. When we move on to gender words the markedness relation between *-o* and *-a* does not hold either. It is true that masculine words ending in *-a* are not very common (*poeta* 'poet', *día* 'day', *estratega* 'strategist', etc.) but feminine words ending in *-o* are extremely rare (*mano* 'hand' being the only common one).[7] The conclusion of these observations is then that *-o* is an unmarked or preferred ending for masculine words only; *-a* is the unmarked or preferred ending for feminine words. In no-gender words, the unmarked ending is Ø. This conclusion is explicitly stated in (17).

(17) *Unmarked or preferred class markers*
For masculine words: *-o*
For feminine words: *-a*
For no-gender words: Ø

Harris (1999) gives two basic morphological sources for the ending *-e*. It appears in the plural of words belonging to what he calls class III, which includes the items that do not end in an unstressed vowel in the singular, that is words whose stem ends in a consonant, a glide or a stressed vowel. In those cases a vowel *e* can surface also as the product of epenthesis. In words like *madre* 'mother', for instance, the final vowel of the singular is epenthetic, the class marker being Ø; the *e* present in the plural *madres* is a class marker (see Harris 1999 for a more detailed analysis). The ending *-e* can also correspond to what he calls class IV, which for him is extremely marked and includes words like *hule* 'oilcloth', that is words that do not need an epenthetic vowel but nevertheless surface with *e* (see more examples in (10)). However, according to Morin (1999), there are roughly as many words in the alleged class IV as in the alleged class III with the same stem-final consonants (inspection of rhyme dictionaries shows that this observation is essentially correct). In the proposal put forward in this paper, *-e* is considered a fairly common class marker, since final epenthesis and plural epenthesis are rejected. The main difference between this class marker and the class markers *-o* and *-a* is that *-e* is not so bound to gender (similarly to class marker Ø and other much more exotic class markers, like *i* in *güisqui* 'whisky' or *u* in *tribu* 'tribe').

7. One could add, to the set of feminine words ending in *-o*, a word like *radio*, which is originally the first member of a compound (cf. *radiotelefonía* 'radiotelephony'), and which appears without the final *-o* in verbs like *radiar* 'to radiate'. A more controversial example would be *moto*, also the first member of a compound originally (cf. *motocicleta* 'motorcycle'), because there are no related words without the *-o*.

3. Interim conclusions

So far, I have argued that current Spanish has initial epenthesis and internal epenthesis, but not final epenthesis. In all cases a final *-e* is interpreted as a class marker. This is also the case for the *e* that appears in plurals. I have also argued that the class marker *-o* is a default marker only for masculine words; in this type of words, *-e* and Ø are also fairly common, and *-a* is rarer. For feminines, the default marker is *-a*; *-e* and Ø are less common, and *-o* is extremely rare. For no-gender words, Ø (or the absence of a marker) is the default, other class markers being more marked.

In the next section we will see how all these facts can be accounted for within Optimality Theory (OT). The treatment of class markers within OT presented below follows proposals in Mascaró (2005) and Bonet, Lloret and Mascaró (2003, 2005) for certain cases of allomorphy, including the choice of class markers in Catalan.

4. An OT analysis of "gender" allomorphy

4.1 Information present in the input

As argued for above, *-o* is the default class marker for masculines, *-a* is the default class marker for feminines, and Ø is the default class marker for no-gender words (actually nonverbs, [–V]). Therefore this information need not be present in the lexical entry of words like *pelo* 'hair', *casa* 'house' or *aquí* 'here'.

(18) Lexical entries for unmarked cases (examples)

masculine words:	/pel/	*pelo* 'hair'
feminine words:	/kas/	*casa* 'house'
[–V]:	/aki/	*aquí* 'here'

In any account, all words that have a marked class marker must be lexically specified somehow. Here, as mentioned earlier, it is claimed that marked words have a subcategorization requirement, represented in the examples as a subscript. In (19) I include several examples including some with *-e* only in the plural.

(19) Lexical entries for marked cases

Masculine words:	/$\text{fan}_{\varnothing}$/	*fan* 'fan'
	/ombɾ_{e}/	*hombre* 'man'
	/ul_{e}/	*hule* 'oilcloth'
	/poet_{a}/	*poeta* 'poet'
Feminine words:	/$\text{fan}_{\varnothing}$/	*fan* 'fan'
	/madɾ_{e}/	*madre* 'mother'
	/klas_{e}/	*clase* 'class'
	/man_{o}/	*mano* 'hand'
Masculine and feminine words with -e in the plural only		
	/$\text{paɾed}_{\varnothing,\ \text{pl:e}}$/	*pared-paredes* 'wall'
	/$\text{pan}_{\varnothing,\ \text{pl:e}}$/	*pan-panes* 'bread'
	/$\text{aleli}_{\varnothing,\ \text{pl:e}}$/	*alelí-alelíes* 'wallflower'

[–V] words: /dentɾ$_o$/ *dentro* 'inside'
/fweɾ$_a$/ *fuera* 'outside'

The underlying representations, including the subcategorization requirements, appear in the input to the phonology as stems. Morphological features like [–feminine], [+feminine] and [–V] have the lexical entries (or Vocabulary, if one adopts the DM terminology) shown in (20). Even though in (20) I include no-gender words, for simplification I will concentrate on gender words in presenting the analysis. The symbol '>' indicates 'precedence' while the comma indicates equal status. These lexical entries reflect the markedness relations established earlier.

(20) a. [–feminine]: {o > e, Ø > a > …}
b. [+feminine]: {a > e, Ø > o,…}
c. [– V]: {Ø > …}

The input to the phonology for a feminine word will include all the class markers, that is {a > e, Ø > o,…}. Therefore the input for a feminine word like *casa* 'house', with an unmarked stem, will be as shown in (21a); the input for a feminine word like *clase* 'class', with a marked stem, will be as shown in (21b) (see Bermúdez-Otero, this volume, for a different view).[8]

(21) a. input for *casa*: /kas + {a > e, Ø > o,…}/
b. input for *clase*: /klas$_e$ + {a > e, Ø > o,…}/

Some constraint must ensure that a word like *casa* has an optimal output with the class marker *-a* and not others, and that a word like *pelo* surfaces with final *-o*. This constraint, called Priority, is stated in (22a). Moreover, some other constraint, a faithfulness constraint, has to ensure that the subcategorization requirement of words like *clase* are preserved. This constraint, called Respect, is stated in (22b). The ranking relation between these two faithfulness constraints appears in (22c).[9]

(22) a. Priority: Respect lexical priority (ordering) of allomorphs
(Mascaró 2005, Bonet, Lloret and Mascaró 2003, 2005)
b. Respect: Respect idiosyncratic lexical specifications
(Bonet, Lloret and Mascaró 2003, 2005)
c. Ranking: Respect >> Priority

The tableaux in (23) and (24) illustrate the work done by these two constraints. As can be seen, Priority penalizes any feminine that does not end in *-a* (and any masculine that does not end in *-o*). For simplicity I include in the input corresponding to [+feminine] only the most common class markers.

8. The idea that the input corresponding to a morpheme can contain more than one allomorph is not new; it is explicitly argued for in Mascaró (1996a,b) and it is implicit in proposals like Tranel (1996) or Perlmutter (1998), for instance. See also Mascaró (2005) for a discussion of several cases of this type.

9. The constraint Priority is extensively argued for in Mascaró (2005) and Bonet, Lloret and Mascaró (2003, 2005), with evidence from several languages. The faithfulness constraint Respect is used, in Bonet, Lloret and Mascaró (2003, 2005) for a particular case of Catalan that appears summarized at the end of this section.

(23) Tableau corresponding to *casa* 'house (fem)'

/kas + {a > e, Ø}/	Respect	Priority
a. ☞ kása		
b. káse		*!
c. kás		*!

(24) Tableau corresponding to *clase* 'class (fem)'

/klas$_e$ + {a > e, Ø}/	Respect	Priority
a. klása	*!	
b. ☞ kláse		*
c. klás	*!	*

Roca and Felíu (2003), in line with other work, assume that default class markers are introduced through morphemic constraints of the type [+feminine] → *a*. The existence of morphemic constraints is not assumed here, all phonological information being present in the input; and all constraints are assumed to be universal. For a criticism of morphemic constraints, see Bonet (2004) and Kager (in press). In addition, Roca and Felíu (2003) postulate a constraint that has the same effect as Respect, but which has a much narrower scope (sufficient for the data analyzed there and here). Their constraint is called Ident(I-O)-Des(inence) (the desinence of the input corresponds to the desinence of the output). They assume that the input contains idiosyncratic class markers (the desinence, in their terms) as part of the word, not as part of a subcategorization frame, as claimed here.[10]

The fact that the plural of a word like *pan* 'bread' is *panes*, with *e*, while the plural of a word like *fan* 'fan' is *fans*, without *e*, follows simply from the subcategorization requirement of each word, not from any special constraint reranking depending on the specific word, for instance. The tableaux in (25) and (26) show how *panes* and *fans* are obtained, respectively.

(25) Tableau corresponding to *panes* 'bread (pl)'

/pan$_{Ø,\ pl:e}$ + {o > e, Ø} + s/	Respect	Priority
a. pános	*!	
b. ☞ panes		*
c. páns	*!	*

(26) Tableau corresponding to *fans* 'fans'

/fan$_Ø$ + {o > e, Ø} + s/	Respect	Priority
a. fános	*!	
b. fánes	*!	*
c. ☞ fáns		*

10. The claim that membership to a marked class is a subcategorization requirement is based on the idea that this type of information is idiosyncratic, in the same sense that gender for nouns that refer to objects, or category (being a noun, a verb,…), for instance, are idiosyncratic. Like this type of information, class marker information is not visible in derivatives.

4.2 Class markers, epenthesis and other phenomena

As established earlier, current Spanish has only initial epenthesis (see examples like [e]*sfera* in (6a)) and internal epenthesis (cf. *Al-Sadr* [alsáðer] in (9e)), not final epenthesis. These facts have to be captured by the relevant constraints and constraint ranking. Another aspect that must be taken into account is the fact that the choice of a class marker other than Ø is not a possible strategy for solving a syllabification problem (*[alsáðro], for instance). One comment must first be made about loans. When a word is borrowed into Spanish, the shape of the borrowing determines the choice of class marker. For instance, the borrowing *Lego* (a brand of toys) has been interpreted as having the unmarked class marker -*o* (and therefore has the diminutive *legito*), and *pizza* and *lasaña* (from Italian *lasagna*) are considered to have the class marker -*a* (cf. *pizzería* 'pizza restaurant', *lasañita* 'small lasagna'). *Mister*, from English, is assumed to have a Ø class marker. This is also the case for *Al-Sadr*.

Epenthesis in the present proposal is found only due to syllabification problems in consonant clusters. Complex onsets in Spanish not only need to have increasing sonority (towards the nucleus), but there must be some distance between the two consonants involved. The relevant constraint can be Onset Sonority (O. Son), as in Colina (1995). Moreover, consonants can never be syllable nuclei, meaning that *P/C is very highly ranked. Complex codas must generally have decreasing sonority (toward the margin), obeying the constraint Margin Sonority (M. Son) (see Colina 1995). For convenience, I include all these constraints and others under the cover name Syllable-Structure (σ-Struc). I assume that this constraint is very highly ranked in Spanish because it is never violated. The fact that initial epenthesis is in fact initial ([esféɾa], *[seféɾa]) follows from the higher ranking of the constraint O-Contiguity ("The portion of S_2 standing in correspondence forms a contiguous string; No intrusion"; McCarthy and Prince 1995) with respect to Onset and NoCoda. The example *spray* [espɾáj], in (27), illustrates the need for this constraint ranking. In (27), Respect and Priority are omitted for presentation purposes; their ranking with respect to other constraints, like O-Contiguity, is determined later with other examples. I also omit the constraint against epenthesis, Dep, which must obviously be ranked below σ-Struc; its ranking with respect to other constraints will become clearer later on. From now on, I underline all epenthetic vowels.

(27) Tableau corresponding to *spray* [espɾáj]: initial epenthesis

/spɾaj$_{\varnothing}$ + {o > e, Ø}/	σ -Struc	O-Cont	Ons	NoCoda
a. spɾáj	*!			*
b. ☞ espɾáj			*	**
c. sepɾáj		*!		*

Another aspect that has to be addressed is why at the other edge of the word epenthesis is internal, not peripheral, and why the choice of a class marker other than Ø (that is, a vowel) is not a possible option for repairing a syllabification problem. In order to account for these facts, the only constraint that has to be added is the alignment constraint stated in (28), Align-R (see Kager 1999 for the left counterpart of this constraint).

(28) Align-R: Align (MWd, R, PWd, R)
The right edge of the grammatical word has to coincide with the right edge of the prosodic word.

The tableau in (29) illustrates how internal epenthesis is obtained, with the example *Al-Sadr* [alsáðe̲r]. For reasons of space, I omit the first part of the name, the Arabic article. Recall that epenthetic [e] is underlined, and can therefore be distinguished from the class marker *-e*.

(29) Tableau corresponding to *Al-Sadr* [alsáðe̲r]: internal epenthesis

/sadɾ$_{Ø}$ + {o > e, Ø}/	σ -Struc	Align-R	Respect	O-Cont	Priority	Dep
a. sádɾ	*!				*	
b. sáðɾe̲		*!			*	*
c. ☞ sáðe̲r				*	*	*
d. sáðɾe			*!		*	
e. sáðɾo			*!			

Align-R is violated in (29b) but not in (29d): in (29b) the grammatical word is [sáðɾ] while the prosodic word includes the epenthetic vowel, [sáðɾe̲]; in (29d) [sáðɾe] does not violate Align-R because the grammatical word includes the inflective vowel [e], hence the right edge of the grammatical word and the right edge of the prosodic word coincide. Align-R, which penalizes the candidate with peripheral epenthesis, (29b), has to be ranked above O-Contiguity, violated by the optimal candidate, (29c). Moreover, Respect has to be ranked above O-Contiguity; otherwise (29e) would be the optimal candidate (assuming the established ranking Respect >> Priority). Finally, the ranking of Dep below Respect ensures that epenthesis (as in the optimal candidate, (29c)) is favored over the choice of a class marker different from the one in the lexical entry.[11]

As mentioned in (9), internal epenthesis is a strategy chosen only to avoid a final rising coda. In other contexts, deletion of a consonant, lenition or place neutralization are the strategies used to avoid an unwanted coda. Even though it is beyond the scope of this paper to deal with all these cases, I illustrate here how place neutralization, as opposed to epenthesis or the choice of a class marker other than Ø, can be favored. The only additional constraint needed is one constraint banning nasals with a marked place of articulation in coda position (although a more detailed analysis might call for

11. The proposed asymmetry between initial epenthesis and internal epenthesis is not a surprising one. The cases discussed with initial epenthesis involve sibilant+consonant clusters, while the cases with internal epenthesis involve (spirantized) stop+liquid clusters. This pattern is very similar to the pattern in Farsi, according to the description in Fleishhacker (2000). Differences in epenthesis site depending on the cluster involved have been noticed in the literature before (see, for instance, Singh 1985, Broselow 1992, or Fleischhacker 2000). In Fleishhacker (2000) it is argued that these asymmetries are due to context-sensitive Dep constraints that reflect differences in auditory similarity between input and output. Of course, a much deeper study of the adaptation of different types of clusters in Spanish is needed in order to know whether this is an adequate analysis for Spanish.

a different type of constraints).[12] Let us assume that this constraint is CodaCondition (CodaCond), in (30) (see Kager 1999, among others).

(30) CodaCondition: $*\text{Place}]_\sigma$

The tableau in (31) shows how the high ranking of this constraint ensures that a word like *ítem* is pronounced with a final coronal nasal ([íten]), in spite of the fact that an [m] appears in derivatives (like *itemizar* [itemiθár] 'to itemize'); epenthesis and the use of a class marker other than Ø are not possible strategies to avoid the problem. In (31) I abstract away from the question of the plural (in the CREA corpus the plural without *e* is much more frequent than the plural with *e*). O-Contiguity is not included in the tableau because it is not relevant. The constraint Max, not included in (31), would prevent a candidate with deletion (*[íte]) from being the optimal candidate.

(31) Tableau corresponding to *item* [íten]: place neutralization

/item$_Ø$ + {o > e, Ø}/	CodaCond	Align-R	Respect	Priority	Dep
a. ítem	*!			*	
b. íteme		*!		*	*
c. ítemo			*!		
d. ☞ íten				*	

In Spanish, the optimal candidates always contain either a class marker that is subcategorized for (for instance, *clase* in (24)) or the unmarked class markers (*-o* for masculines, *-a* for feminines). There are no cases in which constraints other than Respect force the choice of a marked class marker. Catalan, as shown in Bonet, Lloret and Mascaró (2003, 2005) provides such a case. In Catalan, a language closely related to Spanish, the unmarked masculine class marker is Ø (*cel* 'sky', *nom* 'name', *marc* 'frame'), while *-o* (/u/ in Central Catalan) is marked (*lloro* 'parrot'). In this language, then, the lexical entry corresponding to the masculine is the following (omitting more exotic class markers): [–feminine]: {Ø > u}. The plural is formed by adding a final *-s*: *cels* [sέls] 'skies', nom [nɔ́ms] 'names', *marcs* [márks] 'frames', *lloros* [ʎɔ́ɾus] 'parrots'. However, when a name or an adjective end in a sibilant, as in *gos* 'dog', an OCP problem is created (cf. **gos-s*) and the marked class marker /u/ is used, the result being *gossos* [gósus]. The tableau in (32) shows how the unmarked class marker is obtained in the singular.

(32) Tableau corresponding to *gos* [gós] 'dog' (Catalan)

/gos + {Ø > u}/	OCP	Priority
a. ☞ gós		
b. gósu		*!

12. In a more accurate approach to place neutralization in Spanish it might be better to follow a positional faithfulness approach (see Beckman 1998), which also ensures the regressive character of place assimilation, rather than the positional markedness approach sketched here (see Zoll 1998, for instance). In a positional faithfulness approach some of the relevant constraints would be Ident-Onset(place) and *Labial. The same results would be obtained.

The tableau in (33) shows how the marked class marker is chosen in the plural. The constraint AL(IGN)-MM penalizes epenthesis between morphemes.

(33) Tableau corresponding to *gossos* [gósus] (Catalan)

/gos + {Ø > u} + s/	OCP	AL-MM	PRIORITY	DEP
a. góss	*!			
b. ☞ gósus			*	
c. gósə̠s		*!		*

In Catalan the unmarked class marker Ø cannot prevent the OCP problem and a more marked class marker /u/ has to be chosen instead.

5. Remaining cases

It has been mentioned in footnote 2 that some words have a very unusual class marker. For instance, the word *tribu* 'tribe' ends in a final *-u* which is not present in derivatives (cf. *tribal* 'tribal'); therefore it can be concluded that this final *-u* is a (very marked) class marker. Of course, under the present proposal these words have a lexical entry with a subcategorization frame: /tɾib$_u$/. The constraint RESPECT ensures that the word will surface with this very marked class marker, which has to be included in the lexical entry corresponding to [+feminine]. There is another set of cases in which the part not present in derivatives includes, besides an unstressed vowel, a final consonant. These examples are usually Latin borrowings. Some examples appear in (34). (34a) includes examples that end in a vowel plus the consonant [s]. In (34b) the examples end in *-m* (pronounced [n] in most varieties). The examples in (34c), mostly referring to days of the week, do not have any clear derivatives; therefore it is difficult to determine the nature of the ending, even though one can assume the same structure that will be attributed to the cases in (34a,b). Words like *tórax*, that does not appear in (34), have a final [s], not preceded by an unstressed vowel underlyingly.

(34) a. *virus* (cf. *viral*)
tesis 'thesis' (cf. *tesina* 'project, MA thesis')
dosis 'dose' (cf. *dosificar* 'to dose')
lejos 'far' (cf. *lejano* 'distant')
cosmos (cf. *cósmico* 'cosmic')
b. *currículum* (cf. *curricular*)
quantum (cf. *quántico*; common forms not accepted by the RAE)
referéndum (cf. *refrendar* 'to endorse')
c. *alias*
atlas
lunes 'Monday'
martes 'Tuesday'
miércoles 'Wednesday'
jueves 'Thursday'
viernes 'Friday'

The words ending in -*s* (in (34a) and (34c)) have a plural form which is identical to the singular (e.g. *dosis – dosis* 'dose'), while the plural of the items in (34b) can vary a lot, although it is fairly common to add just -*s* as in other plural forms. For the words in (34a,c), Harris (1980, 1992) and Roca (1996) claim, using different types of formalism, that these words have some kind of template in which there is a slot for the vowel, the class marker, and another slot that can be filled by final -*s*. The fact that the last slot is already filled prevents the -*s* of the plural from occupying it or, alternatively, the filled slot satisfies the requirements of the plural. One problem for those approaches is the existence of the words in (34b), where the final *m* is clearly part of the desinence (not part of the stem) and which can form the plural with the simple addition of -*s*. In those approaches there are not sufficient slots or positions to have both the -*m* (usually pronounced [n]) and the plural -*s* (cf. *referéndum* and *referéndums*, pronounced [refeɾénduns]). It is clear that the difference in behavior between the two types of words (those that end in -*s*, in (34a,c) and those that end in -*m*, in (34b)) with respect to the plural has to be related to the coincidence between word-final -*s* and plural -*s*, vs. the lack of coincidence between word-final -*m* and plural -*s*; it has nothing to do with positions or slots.[13]

In the present proposal the plural is systematically formed by adding the /s/ morph; the endings in (34) are class markers or desinences and, given their marked status, they have to appear as subcategorization frames in the stems. There are several possibilities as to the way these complex class markers are encoded in the input. One possibility, for instance, would be to say that the vowel in a word like *virus* is the same class marker as the one found in *tribu* 'tribe', while the final -*s* (like the final -*m*) is some extra element that can attach to the class marker. However, for simplification, I will assume here that -*us* as a whole is a marked class marker. Then the lexical entry of the stem of *virus* would be /biɾ_{us}/, and the lexical entry corresponding to [–feminine] would include the marker -*us*: {o > e, Ø,…> …, us,…}.

The fact that the plural of the words in (34a,c) surfaces with a single final [s] (the plural of *virus* is the homophonous *virus* [bíɾus]), without epenthesis or any additional class marker, is now easily accounted for. Only two well established constraints need to be added to the analysis. One of them is the markedness constraint OCP referred to sibilants: OCP(s) (see, Yip 1998 or Bonet and Lloret 2002, for instance, for different applications of this type of constraint). The other constraint is Uniformity-IO (Unif: no segment of the output has multiple correspondents in the input; "fusion is prohibited"; McCarthy and Prince 1995). The tableau in (35) illustrates how the plural of *virus* is obtained. The constraints Align-R and O-Cont are omitted because they are irrelevant. The lexical entry corresponding to [–feminine] is simplified for space reasons: {o > …> us}.

13. According to an anonymous reviewer, the ending -*um* might not be a class marker, given the existence of a plural form *referendos*. However, according to Juan Carlos Rubio (p.c.), this plural form is solely used (as the plural of *referéndum*) by the media. Most speakers use the pair in the text (*referendun-referenduns*), and few use forms without the final nasal in the singular and in the plural (*referendu-referendus*).

(35) Tableau corresponding to the plural of *virus* [bíɾus]: homophony

/biɾ$_{us}$ + {o > …> us$_1$} + s$_2$/	OCP(s)	Respect	Priority	Dep	Unif
a. bíɾus$_1$s$_2$	*!		*		
b. bíɾus$_1$e̲s$_2$			*	*!	
c. ☞ bíɾus$_{1,2}$			*		*
d. bíɾos$_2$		*!			

In (35), the crucial ranking Dep >> Unif favors the candidate with fusion, (35c), not the candidate with epenthesis, (35b). There are at least two relevant candidates missing in (35), namely candidates with deletion of one of the sibilants. These candidates, homophonous with the optimal candidate (35c), would violate Max. I have not included them in (35) because they are not problematic candidates and more data would be needed to ascertain the ranking position of Max in Spanish. Notice that the plural of a word like *referéndum* does not pose any problems for the present proposal. The ending *-um* is also a marked class marker of Spanish; when the plural *-s* is added, no OCP problem arises, no fusion is possible, and therefore it is possible to have the plural *referéndums* (with place neutralization of the *-m* for most speakers) as the optimal candidate.

6. Why not have a special phonology for loans?

In the last few years loanword phonology has become the focus of much phonological research, one of the main points of debate being whether or not loans are subject to a special phonology (see, e.g., Broselow, Chen and Wang 1998, and Paradis 1995, for opposite views on the matter). In this paper we have seen that newer words (called xenonyms in the literature on Spanish phonology by some authors) often behave differently from more "genuine" words, but here these differences have not been attributed to different subgrammars. Rather, it has been argued that current Spanish has a single phonological system and that (possibly) former epenthetic vowels have been reinterpreted as class markers. This means that the [e] found in final position in words like *pase* 'pass', *clase* 'class' or *hombre* 'man', and also the [e] found in plurals like *panes* 'bread(pl)' or *paredes* 'walls' is a class marker, not an epenthetic vowel. The difference between pairs like *pan-panes* and *fan-fans* is due to different subcategorization requirements. However, there is an alternative view that was hinted at at several points in the paper, namely that Spanish has two subgrammars, one for native words, one for loans. For Spanish, within Optimality Theory this line of research has been pursued by Colina (1995) for plural formation, and by Shepherd (2003) also for other cases. Even though a thorough discussion of this alternative is beyond the scope of this paper, the following lines contain a brief discussion of some of the issues involved.

Under the view that different types of words (genuine vs. loans) are subject to different subgrammars, one obvious possibility to explain the presence of *-e* in many plurals but not in others is to say that pairs like *pan-panes* are subject to a constraint ranking different from the one needed to obtain pairs like *fan-fans*. The *-e* present in words like *panes* can be the product of epenthesis with the crucial ranking *ComplexC(oda)

>> Dep, as shown by the tableau in (36). Keeping the rest of the account as presented, *pan* subcategorizes for a class marker Ø (both in the singular and the plural). The constraint Respect rules out an output *[pános].

(36) Tableau corresponding to *panes* 'bread (pl)'

/$\text{pan}_{\emptyset}$ + {o > e, Ø} + s/	Respect	Priority	*ComplexC	Dep
a. pános	*!			
b. ☞ panes		*		*
c. páns		*	*!	

Plurals without the -*e*, like *fans*, are subject to the opposite ranking of *ComplexC and Dep, namely Dep >> *ComplexC. The effects of this reranking are shown in (37).

(37) Tableau corresponding to *fans* 'fans'

/$\text{fan}_{\emptyset}$ + {o > e, Ø} + s/	Respect	Priority	Dep	*ComplexC
a. fános	*!			
b. fanes		*	*!	
c. ☞ fáns		*		*

Words with a complex coda like the singular *vals* 'waltz' (originally a loan) will be realized as [báls] regardless of the ranking relations between *ComplexC and Dep, given that these constraints are both low ranked. Align-R and O-Cont (which penalizes internal epenthesis only within morphemes) discard candidates with epenthesis, as shown in (38). For reasons of space I exclude Priority from the tableau (the relevant candidates fare even with respect to this constraint).

(38) Tableau corresponding to *vals* 'waltz'

/$\text{bals}_{\emptyset}$ + {o > e, Ø}/	Respect	Align-R	O-Cont	Dep	*ComplexC
a. bálso	*!				
b. ☞ báls					*
c. bálse		*!		*	
d. báles			*!	*	

Under the view sketched here, plurals like *jabalíes* (for those speakers who do use them) would still have to be the result of a subcategorization requirement (demanding the class marker -*e* in the plural) because no markedness constraint would ever favor a candidate [xa.βa.lí.es] over [xa.βa.lís], while a faithfulness constraint like Respect can.

The question is now why keep the subcategorization hypothesis (the one defended in Section 4, with -*e* as a class marker) instead of adopting the reranking hypothesis just outlined (with -*e* as an epenthetic vowel). The claim behind the reranking hypothesis is that the grammar of Spanish has (at least) two possible partial rankings available (or, in other words, Spanish has, at least, two subgrammars that differ in the following): *ComplexC >> Dep and Dep >> *ComplexC. One of the rankings can be said to hold for the language in general and the other one be specified for a subset of words;

one question is then which one is the general ranking. In favor of *ComplexC >> Dep being the general one is the fact that it applies to the "native" vocabulary, like *panes*, which moreover constitutes a higher percentage of lexical items; under this view *fan* would have some lexical encoding indicating that it has to be subject to the opposite ranking (Dep >> *ComplexC). The alternative view is that the general ranking is Dep >> *ComplexC, given that it applies to the new vocabulary; it is the "new" grammar of Spanish. Under this view *pan* would have the lexical encoding forcing the opposite ranking *ComplexC >> Dep.

Constraint reranking as a way of accounting for the differences between native words and loans becomes a more complex issue when other cases are taken into account. For instance, the difference between pairs like *Al Sadr* [alsáðer] and *padre* [páðɾe] could be attributed to a difference in constraint ranking. Under this view the [e] present in both cases would be epenthetic, and constraint reranking would account for the differences in epenthesis site: *Al Sadr* [al.sá.ðe̠r], a loan, would be obtained through the ranking *ComplexOnset >> O-Cont, while *padre* [pá.ðɾe̠], a native word, would be obtained through the opposite ranking, O-Cont >> *ComplexOnset.

A worrying aspect of the subgrammars view is, then, its potential excessive power. If differences in behavior between lexical items can be attributed to constraint reranking, the number of subgrammars for a given language could become huge, and probably not much would be gained in our understanding of the phonology of that language (constraint reranking becomes a descriptive device). Moreover, it is difficult to imagine how the grammar can be restricted so that only certain constraint rerankings are allowed, but not others. These aspects have to be taken seriously into consideration when pursuing this line of research, as has been done in some interesting and restrictive proposals such as Itô and Mester (1999) or Anttila and Cho (1998), to give a couple of examples.

Under the subcategorization hypothesis defended here there is one single grammar with a fixed ranking, and this ranking excludes epenthesis as an option for the cases under discussion here. A word like *pan* has *-e* in the plural because this information is idiosyncratic and is therefore lexically encoded in a subcategorization frame (/pan$_{\emptyset,\ pl:e}$/). The reason why loans like *fan* do not have *-e* in the plural is precisely because they lack a plural **fanes* that can be learned (as opposed to *panes*), and therefore the simpler option is adopted (/fan$_{\emptyset}$/ instead of /fan$_{\emptyset,\ pl:e}$/). A similar situation arises with native words that have undergone truncation. For instance, the plural of the hypocoristic of *Francisco*, *Fran* is *Frans*, not **Franes*. Again, this is so not because for some reason this word is subject to a different constraint ranking but simply because there is no existing plural and therefore the simpler option is adopted (/fran$_{\emptyset}$/ instead of /fɾan$_{\emptyset,\ pl:e}$/). And finally, with respect to words ending in a stressed vowel, like *jabalí*, the plural *jabalíes* (that is /xaβalí $_{\emptyset,\ pl:e}$/) will be available only if the word has been learned as *jabalíes*; if one has not been exposed to such form, its lexical entry will be the simpler one, /xaβalí $_{\emptyset}$/. Given the very low frequency of words ending in a stressed vowel (both token-wise and type-wise, leaving aside *papá* 'dad' and *mamá* 'mum'), it is not surprising that speakers tend to use them without *e* in the plural.

References

Alcina Franch, J. and Blecua, J.M. 1975. *Gramática española*. Barcelona: Ariel.

Ambadiang, T. 1999. La flexión nominal. Género y número. In *Gramática descriptiva de la lengua española*, I. Bosque and V. Demonte (eds), 4843–4913. Madrid: Real Academia Española.

Anttila, A. and Cho, Y.-M. Y. 1998. Variation and change in optimality theory. *Lingua* 104: 31–56.

Beckman, J.N. 1998. Positional Faithfulness. PhD dissertation, University of Massachusetts, Amherst.

Bermúdez-Otero, R. This volume. Morphological structure and phonological domains in Spanish denominal derivation. In *Optimality-Theoretic Studies in Spanish Phonology*. Martínez-Gil, F. and S. Colina. Amsterdam and Philadelphia: John Benjamins.

Bonet, E. 2004. Morph insertion and allomorphy in optimality theory. In *International Journal of English Studies* 4(2): *Advances in Optimality Theory*, P. Boersma and J. A. Cutillas-Espinosa (eds), 73–104. Murcia: Universidad de Murcia. (ROA #734–0505)

Bonet, E. and Lloret, M.-R. 2002. OCP effects in Catalan cliticization. *Catalan Journal of Linguistics* 1: 19–39.

Bonet, E., Lloret, M.-R. and Mascaró, J. 2003a. Phonology–morphology conflicts in gender allomorphy: A unified approach. Handout of a talk given at *GLOW 26* (Lund, April 9, 2003).

Bonet, E., Lloret, M.-R. and Mascaró, J. 2005. Allomorph selection and lexical preferences: Two case studies. To appear in *Lingua*.

Broselow, E. 1992. Language transfer and universals in second language epenthesis. In *Language Transfer and Language Learning*, S. Gass and L. Selinker (eds), 71–86. Amsterdam: John Benjamins.

Broselow, E., Chen, S.-I.. and Wang, C. 1998. The emergence of the unmarked in second language phonology. *Studies in Second Language Acquisition* 20: 261–20.

Canfield, D.L. 1981. *Spanish Pronunciation in the Americas*. Chicago IL: The University of Chicago Press.

Colina, S. 1995. A Constraint-Based Analysis of Syllabification in Spanish, Catalan, and Galician. PhD dissertation, University of Illinois, Urbana-Champaign.

Colina, S. 2003a. The status of word-final [e] in Spanish. *Southwest Journal of Linguistics* 22(1): 87–107.

Colina, S. 2003b. Diminutives in Spanish: A morphophonological account. *Southwest Journal of Linguistics* 22(2): 45–88.

Contreras, H. 1977. Spanish epenthesis and stress. *Working Papers in Linguistics* 3: 9–33. Seattle, WA: University of Washington.

Fleischhacker, H. 2000. Cluster-dependent epenthesis asymmetries. In *UCLA Working Papers in Linguistics* 7, *Papers in Phonology 5*, A. Albright and T. Cho (eds), 71–116. Los Angeles CA: UCLA.

Foley, J. 1967. Spanish plural formation. *Language* 43: 486–493.

Harris, J. W. 1980. Nonconcatenative morphology and Spanish plurals. *Journal of Linguistic Research* 1: 14–31.

Harris, J.W. 1987. Epenthesis processes in Spanish. In *Studies in Romance Languages*, C. Neidle and R. A. Núñez Cedeño (eds), 107–122. Dordrecht: Foris.

Harris, J.W. 1991. The exponence of gender in Spanish. *Linguistic Inquiry* 22(1): 27–62.

Harris, J.W. 1992. The form classes of Spanish substantives. In *Yearbook of Morphology 1991*, G. Booij and J. van Marle (eds), 65–88. Dordrecht: Kluwer.

Harris, J.W. 1999. Nasal depalatalization *no*, morphological wellformedness *sí*; The structure of Spanish word classes. In *MIT Working Papers in Linguistics* 33: *Papers on Morphology and Syntax, Cycle One*, K. Arregi, B. Bruening, C. Krause and V. Lin (eds), 47–82. Cambridge MA: MITWPL.

Itô, J. and Mester, A. 1999. The phonological lexicon. In *The Handbook of Japanese Linguistics*, N. Tsujimura (ed.). Oxford: Blackwell.

Kager, R. 1999. *Optimality Theory*. Cambridge: CUP.
Kager, R. In press. Lexical irregularity and the typology of contrast. In *The Nature of the Word: Essays in Honor of Paul Kiparsky*, K. Hanson and S. Inkelas (eds). Cambridge MA: The MIT Press
Lapesa, R. 1959. *Historia de la lengua española*. Madrid: Escelicer.
Mascaró, J. 1996a. External allomorphy as emergence of the unmarked. In *Current Trends in Phonology: Models and Methods*, J. Durand and B. Laks (eds), 473–483. Salford: European Studies Research Institute, University of Salford. (Partially reproduced in *Optimality Theory in Phonology*, J. McCarthy (ed), 513–522. Oxford: Blackwell, 2004).
Mascaró, J. 1996b. External allomorphy and contractions in Romance *Probus* 8: 181–206.
Mascaró, J. 2005. External allomorphy and lexical representations. Article submitted for publication, under revision.
McCarthy, J. and Prince, A. 1995. Faithfulness and reduplicative identity. In *Papers in Optimality Theory* [University of Massachusetts Occasional Papers in Linguistics 18], J. Beckman, L. Walsh Dickey and S. Urbanczyk (eds), 249–384. Amherst MA: Graduate Linguistic Student Association.
Menéndez Pidal, R. 1968. *Manual de gramática histórica española*. Madrid: Espasa-Calpe.
Morin, R. 1999. Spanish substantives: How many classes. In *Advances in Hispanic Linguistics*, J. Gutiérrez-Rexach and F. Martínez-Gil (eds), 214–230. Somerville MA: Cascadilla.
Navarro Tomás, T. 1971. *Manual de pronunciación española*. Madrid: Publicaciones de la Revista de Filología Española.
Núñez-Cedeño, R.A. and Morales-Front, A. 1999. *Fonología generativa contemporánea de la lengua española*. Washington DC: Georgetown University Press.
Ohannesian Saboudjan, M. 2004. *La asignación del acento en español*. PhD dissertation, Universitat Autònoma de Barcelona.
Paradis, C. 1995. Derivational constraints in phonology: Evidence from loanwords and implications. In *Proceedings of the Chicago Linguistics Society* 31, A. Dianora et al. (eds). Chicago: BLS.
Perlmutter, D. 1998. Interfaces: Explanation of allomorphy and the architecture of grammars. In *Morphology and Its Relation to Phonology and Syntax*, S.G. Lapointe, D.K. Brentari and P.M. Farrell (eds), 307–338. Stanford CA: CSLI.
Roca, I. 1989. The organisation of grammatical gender. *Transactions of the Philological Society* 87(1): 1–32.
Roca, I. 1996. Phonology–morphology interface in Spanish plural formation: An optimality analysis. In *Interfaces in Phonology*, U. Kleinhenz (ed.), 210–230. Berlin: Akademie Verlag.
Roca, I. and Felíu, E. 2003. Morphology in truncation: The role of the Spanish desinence. In *Yearbook of Morphology 2002*, G. Booij and J. van Marle (eds), 187–243. Dordrecht: Kluwer.
Saltarelli, M. 1970. Spanish plural formation: Apocope or epenthesis? *Language* 46: 89–96.
Saporta, S. 1965. Ordered rules, dialect differences, and historical processes. *Language* 41: 218–224.
Shepherd, M.A. 2003. Constraint Interactions in Spanish Phonotactics: An optimality theory analysis of syllable-level phenomena in the Spanish language. MA thesis, California State University, Northbridge. (ROA #639–0104).
Singh, R. 1985. Prosodic adaptation in interphonology. *Lingua* 67: 269–282.
Tranel, B. 1996. French liaison and elision revisited: a unified account within optimality theory. In *Aspects of Romance Linguistics*, C. Parodi, C. Quicoli, M. Saltarelli and M. L. Zubizarreta (eds). Washingtion DC: Georgetown University Press.
Yip, M. 1998. Identity avoidance in phonology and morphology. In *Morphology and its Relation to Phonology and Syntax*, S.G. Lapointe, D.K. Brentari and P.M. Farrell (eds), 216–246. Stanford CA: CSLI.
Zoll, C. 1998. Positional asymmetries and licensing. Unpublished manuscript, Massachusetts Institute of Technology (ROA #282–0998). (Partially published in *Optimality Theory in Phonology*, J. McCarthy (ed.), 365–378. Oxford: Blackwell, 2004).

A paradigm account of Spanish number

Mario Saltarelli
University of Southern California

This paper assumes that an adequate grammar provides a formal characterization of the sound-meaning relation between the morpho-phonological alternants of a lexical constant, such as in the Number paradigm ⟨*casa,casas*⟩ 'house' of Spanish, as well as in other inflectional languages like Italian ⟨*panino,panini*⟩ 'sandwich' or Latin ⟨*puella/puellae*⟩ 'lass' (section 1). Inflectional languages exhibit intricately complex systems of paradigms meeting legibility requirements at phonological interface through organizational principles such as category hierarchy and markedness. A paradigm account Number of Spanish is developed in a constraint interaction framework inspired by the seminal work of McCarthy (2003). The analysis of Spanish Number proposed in this paper crucially relies on the parallel evaluation of the realization of both values of the paradigm of a single lexical constant, rather than on the evaluation of a single form of the alternation. We argue that the paradigm approach to Spanish Number provides a more uniform account, while shedding light on "exceptional" cases. The proposed analysis has implications for the general constraint based theory of morpho-phonology, with particular attention to the role of the constraint Realize Number.

Keywords: Number, gender, paradigm, syncretism, markedness, Realize Number

1. What's in a paradigm?

What's in a paradigm? Linguists are intensely asking the question as to whether paradigms are simply useful synoptic devices for presenting inflectional morphology or a conceptually necessary property of grammar to be accounted for in a formal theory of language (Bobaljik, 2003).

Paradigms, as lists of complex symbols of minimally distinct sound-meaning expressions related by morpho-syntactic categories, are often associated with Latin manuals (Allen & Greenough's 1983) in the tradition of Word and Paradigm grammar (W&PG). The core component of W&PG is the paradigm, concretely a matrix configuration of words (lexical roots and stems) bound by a word-class exponent and hierarchically linked with inflectional affixes. In Latin a nominal root is concatenated with the values of inflectional categories active in the language, namely the lexical category Gender ⟨*masculine, feminine, neuter*⟩, and the functional categories Number ⟨*singular, plural*⟩, structural Direct Case ⟨*nominative, accusative*⟩ and Oblique Case ⟨*genitive, dative, ablative*⟩.

More specifically, a typical paradigm consists of the enumeration of forms of a single lexeme projecting the values of an active morpho-syntactic category. For example, the Latin Number paradigm of the nominal masculine lexeme *puer* 'boy' relates the paradigm forms $\langle \mathit{puer}_{\text{SG}}, \mathit{pueri}_{\text{PL}} \rangle_{\text{NUM}}$ by virtue of their morphological values singular (un-realized) and plural (realized). Accordingly, the singular form *puer* has a null realization and the plural form *pueri* is phonologically realized by a coronal vowel /-i/), right-aligned to the stem. In addition, the same forms enter in paradigm relation with the values of the morpho-syntactic category Case. Namely, the unmarked or default nominative value of Direct Case and the marked accusative value, respectively $\langle \mathit{puer}_{\text{SG},\text{NM}}, \mathit{puerum}_{\text{SG,ACC}} \rangle_{\text{CASE}}$ and $\langle \mathit{pueri}_{\text{PL,NM}}, \mathit{pueros}_{\text{PL,AC}} \rangle_{\text{CASE}}$. The hierarchical interaction of inflectional categories is central to an understanding of the notion paradigm and its inherent nature.

Similarly, in Latin the third conjugation verbal root lexeme *fer-* 'carry' is realized in the Person paradigm $\langle\langle \mathit{fero}_{1}, \mathit{fers}_{2}, \mathit{fert}_{3} \rangle_{\text{PER}} \rangle_{\text{NUM}}$ by virtue of the three morphological values realized respectively as /*-o*, *-s*, *-t*/. Each form of the Person paradigm is hierarchically identified with the (singular) value of Number as well as other functional categories such as Tense, Aspect and Mood. Moreover, it's relevant to note that the root *fer-* is a phonological realization of the lexeme 'carry', but only one of three functionally selected lexical alternants; namely, *fer-* for the aspectual Infectum paradigm (and for the Infinitive *fer-re*), *tul-i* for the Perfectum,and *lat-um* for the Supine.

In sum, traditional W&PG constructs complex symbols of morphological and phonological representation, in which the role of the paradigm is necessary and sufficient for the generation and interpretation of complex words. Conceptually, paradigms capture perceived surface resemblances among words. This property of language knowledge can, arguably, be formalized by a definition of paradigm membership. If successful, an economy of paradigms is expected to provide a principled foundation for sorting morpho-phonological relations in sets of words like English {*light, lighten, lightens, lightening, etc.}* (McCarthy 2003).

1.1 Goals, assumptions, proposal, and the structure of the paper

The general goal of this paper is to explore to what extent, if any, a characterization of the notion "paradigm" is a primitive conceptual necessity in a grammar, rather than derivable as a function of the architecture of the system and its computational mechanism. The specific object of study is the two-valued Number paradigm of Spanish in the context of contemporary linguistic analysis.

It will be argued that a paradigm perspective offers (a) an empirical re-assessment of the morpho-syntactic, full interpretation of the properties of Number, as well as (b) a unified morpho-phonological mapping in a constraint interaction evaluation of the <singular, plural> pair, hence providing a formal characterization of its members.

The economy of paradigms, it's also claimed, (c) obviates issues of derivational opacity in the case of the palatal alternation [ʎ/l, ɲ/n] observed in {*doncella* 'lass', *doncel* 'lad'} and their plural forms {*doncellas, donceles},* as well as {*desdén* 'disdain', *desdenes* 'disdains', but *desdeño* 'I disdain'}, etc.).

The structure of the paper is as follows. In section 2, the lexical (Gender) 2.1, functional (Number) 2.2 and their hierarchical relation is proposed, with its attendant consequences in limiting paradigms. section 3, deals with general syncretic and markedness properties of paradigms across time (Latin) and language types (Basque), elaborating on the legibility issue of Number. section 4 proposes a classification of Spanish paradigms that will provide the notational foundation for the constraint-based evaluation mechanism 5, it's phonotactic 5.1, and prosodic 5.2, plus the "exceptional" and residual classes 5.3,4. section 6, expounds on the economy of paradigms: it's empirical bases, theoretical assumptions, descriptive advantages and consequences for a parallel computational mechanism of mapping morphological properties to phonetic interface.

2. Hierarchy of inflectional categories: Gender>Number

Although the traditional paradigm relates by juxtaposition complex symbols of morpho-syntactic categories and phonological words in an observationally parsimonious way, it does not explicitly characterize the computational mechanism that maps these categories onto their phonological realization (nor their status in the extended architecture of the linguistic system). This aspect of grammar is central to the explanation of the relation between sound and meaning in complex (inflected) words. Formal issues in paradigm theory concern (a) constraining the generation of morphological complex words and (b) phonological syncretism or portmanteau effects in inflectional morphology (McCarthy 2003, Baerman 2004).

2.1 Limiting paradigms

The combinatorial properties of lexical roots and inflectional affixes are not free, but systematically restricted. We have hinted above (cf. 2.3 below for more discussion) that an account of Spanish morpho-phonology must disqualify as bona fide complex words forms like *{doncelas, doncelles}* which would follow from an unrestricted permutation of the legitimate lexical root *donce*/ʎ,l/- and the relevant inflectional affixes.

The spurious generation of complex words can be further illustrated with respect to the Gender paradigm. Consider that, on the one hand, the Latin adjectival root *bon-* 'good' projects the full set of the possible paradigm forms in the cumulative inflectional paradigms of Gender, Number and Case (*nominative)*: ⟨*bon-us, bon-i*⟩, ⟨*bon-a, bon-ae*⟩, ⟨*bon-um, bon-a*⟩, *etc.*. On the other hand, grammatical masculine vs. feminine noun pairs like *⟨*mūs/mūs-a*⟩$_{\text{GEN}}$ 'mouse/muse' do not enter in a functional paradigm relation, given that the root-stem in the paradigm must remain a lexical constant. Accordingly, lexical Gender pairs like {*filius, filia*} have separate functional projection paths.

The distinct behavior of adjectival vs. nominal lexemes is attributed to the predicate nature of adjectives. The predicate structure of adjectival modifiers includes a variable, which must be extensionally saturated by a syntactically realized head noun. Hence, the meaning of the adjectival lexeme 'good' is scalar, as the contextual meaning of the adjective in 'the good man/earth/time, etc' is compositionally derived from the lexico-semantic properties of the head noun, along with its gender and number (Dumitrescu & Saltarelli 1998). In contrast with adjectives, nouns have a constant lexical meaning and inherent Gender class. Accordingly, in the pair *mūs/mūs-a* Gender plays a lexical role as word-class realized as a theme-vowel. Arguably, Gender is hierarchically ordered with respect to functional categories like Number and Case. The classifying role of Gender in creating new lexemes is vividly captured in the Spanish gender pairs *río/ría* 'river/inlet', *pueblo/puebla* 'town/old part of town', with a clearly distinct reference encountered in northwestern Spain.

This brief discussion of the category Gender and its hierarchical status with respect to Number, leads to a higher order distinction between the categories of inflectional morphology. Namely, Gender is a lexical suffix, hence an exponent of the lexical stem.[1] In this paper we propose that the precise restriction on the generation of morphologically complex words is the hierarchical implication of inflectional categories, namely Gender>Number. The bonus empirical evidence of this system restricting hypothesis is its correlation with the realized morpho-phonological linear order of concatenation as well as the hierarchical morpho-syntactic order that projects distinct paths for each lexeme. Moreover, the role of category hierarchy will turn out to be conceptually necessary for a definition of paradigm membership and a perceptual understanding of 'resemblance' among inflected words. We return later to demonstrate that this parallel approach to morphological overgeneration is higher valued than serial generative approaches stipulating intrinsically ordered rules and opaque morpho-phonological derivations, with its attendant descriptive consequences.

2.2 Functional paradigm projections

As an implementation of the Gender > Number hierarchy, note that in (1) there are two distinct lexical constants on which the Number paradigm of the root-stem *cas-* 'house' can be computed. Namely the feminine base *casa/casas* and the diminutive value of the same lexeme in the derivational category Size: *casita/casitas*. Under the hierarchical relation hypothesis between Gender and Number, the choice of paradigmatic surface relations is uniformly constrained.

We observe in (1) that cross-value surface candidates of nominal Gender classes are excluded as ill-formed Number paradigm expressions, owing to the hierarchical

1. Gender is assumed to be a (nominal) word class, along the understanding of Harris (1991). Regardless of its realization or syntactic agreement properties, gender is hierarchically ordered with respect to Number. Number differs from Gender as to its interpretable property. Harris' (1991:59) value judgment on the nature of "declensional class" is a misinterpretation of tradition. Declensional classes define heuristically paradigm relations among forms, the empirical notion we address in this paper.

implication between the two categories. Conceptually, the paradigm expressions *⟨*cas-**a**, cas-**o**-s*⟩ and *⟨*cas-**o**, cas-**a**-s*⟩ violate the lexical uniqueness of morpho-syntactic path among the members of a Number paradigm, implied in W&PG and a conceptual necessity in a paradigm theory of surface relation among words.

(1) Lexemes and the Hierarchy of Inflectional Categories

	Lexemes				Functional Paradigm Projections
a.	Noun				
	(i)	Gender		>	Number
		cas-a$_{\text{F}}$	‘house’	>	⟨*cas-a-*$_{\text{SIN}}$, *cas-a-s*$_{\text{PL}}$⟩, *⟨*cas-**a**, cas-**o**-s*⟩
		cas-o$_{\text{M}}$	‘case’	>	⟨*caso-*$_{\text{SIN}}$, *cas-o-s*$_{\text{PL}}$⟩, *⟨*cas-**o**, cas-**a**-s*⟩
	(ii)	Size		>	Gender
		cas-it-$_{\text{DIM}}$*-a*$_{\underline{\text{F}}}$		>	⟨*cas-it-a-*$_{\text{SIN}}$, *cas-it-a-*s$_{\text{PL}}$⟩, *⟨*cas-it-**a**, cas-**a**-s*⟩
		cas-it-$_{\text{DIM}}$*-o*$_{\underline{\text{M}}}$		>	⟨*cas-it-o-*$_{\text{SIN}}$, *cas-it-o-*s$_{\text{PL}}$⟩, *⟨*cas-it-**o**, cas-**o**-s*⟩
	(iii)	*doncell-*a$_{\underline{\text{F}}}$	‘lass’	>	⟨*doncella-*$_{\text{SIN}}$, *doncella-*s$_{\text{PL}}$⟩, *⟨*doncell-**a**, doncel-e-s*⟩
		doncel-$_{\text{M}}$	‘lad’	>	⟨*doncel-*$_{\text{SIN}}$, *doncel-e-*s$_{\text{PL}}$⟩, *⟨*doncel, doncell-**a**-s*⟩
	(iv)	*desdén-*$_{\text{M}}$	‘disdain’	>	⟨*desdén-*$_{\text{SIN}}$, *desden-e-s*$_{\text{PL}}$⟩,*⟨*desdén,,* desdeñ-a-s,…*⟩
		**desden-a*$_{\text{F}}$		>	(lexical gap)
b.	Verb			>	Person > Number
	-Conjugation-/a/				⟨*desdeñ-o*$_{1,}$ *desdeñ-a-s*$_{2}$, *desdeñ-a-*$_{3,}$⟩$_{\text{PER}}$
	desdeñ-a-r			>	⟨*desdeñ-o*$_{1}$, *desdeñ-a-mos*$_{1}$⟩$_{\text{NUM}}$
	‘to disdain’				⟨*desdeñ-a-s*$_{2}$, *desdeñ-a-is*$_{2}$⟩$_{\text{NUM}}$
					⟨*desdeñ-a–*$_{3,}$ *desdeñ-a–*$_{3\text{-}}$*n*⟩$_{\text{NUM}}$

2.3 Paradigms and derivations

In the morpho-phonological paradigm account being proposed in this paper the alternation [ʎ/l, ɲ/n] (1ab) is an observation on the historical evolution of the Spanish lexicon, which does not interact with the projection paths of the Number paradigm nor their phonological realization in contemporary Spanish. The coronal/palatal alternation of liquids and nasals is formulated as Root and Gender lexical contrast (*doncel-*$_{\text{M}}$*/doncella-*$_{\text{F}}$ *‘lad/lass’*) and not a phonological variation interacting with Number. Cross-values paradigms like (1a-iii) *⟨*doncell-**a**, doncel-e-s*⟩ fail high ranked OO-faith constraints between Root-form and Gender affixes, but not Number. Individual word evaluation of **doncelles, *doncelas* also fail on the same constraint IO-faith on Root and Gender, but not Number.[2]

In contrast with the paradigm analysis just outlined, the textbook derivational account of the same data (1c) is formulated as a phonological rule of Depalatalization of underlying palatal /ʎ/ in syllable coda position (1d) (Harris 1983; cf. Kenstowicz 1994:222).

2. Note that paradigm relations are the crux of the empirical paradigm approach. Hence, only paired paradigm forms (1) are evaluated. This limitation to the generation of output forms within the paradigm restricts significantly the generative power of the system and, the claim is, increases the predictive power of the empiricially assumed theory of language.

(1) c. (i) don.ce.[ʎ]a 'lass' (iii) don.ce[l] 'lad'
(ii) don.ce.[ʎ]as 'lasses' (iv) don.ce.[lles 'lads'
d. /ʎ/ → [l] / in coda

The non-paradigm rule-based serial analysis assumes an underlying palatal representation for the etymologically related forms (1c), regardless of their status as distinct lexical items. Underlying forms are the centerpiece of phonology in generative grammar enabling a wide range of abstract explanations through access to intermediate (opaque) derivations. We notice that the rule of Depalatization (1d), which applies only in syllable coda position, must be ordered after the rule of Syllabification. Accordingly, the masculine singular *don.cel* is appropriately depalatalized. It's plural affix *-es*, however, *don.ce.les* should prevent Depalatalization, just as the feminine form *don. ce.lla(s)* behaves. The depalatalization hypothesis can be rescued only by relegating depalatalization to a later rule cycle, before Plural Suffixation and Re-syllabification (Kenstowicz 1994:223).

Summarizing section 2, in the proposed economy of paradigms suggested in this paper each lexeme has its own hierarchical path of functional projections, as a systematic result of the hierarchical organization of inflectional categories (2). Cross-lexemic functional paradigm relations are consequently excluded, as illustrated in (1).

(2) a. Noun: Gender (Theme-V) > Number (> Case)
b. Verb: Conjug. (Theme-V) > Person > Number

Under this perspective, the surface resemblance between *desdén* and *desdeño* is alien to the Number category (1a-iv). Hence, the palatal alternation [ʎ/l, ɲ/n] is inert in the functional paradigm phonology of modern Spanish, in contrast with non-paradigmatic approaches that assume an arbitrary selection of underlying representation, either serial (Harris 1983) or parallel (Kikuchi 1999). The paradigm view of the liquid/nasal palatal alternation, which we propose in this paper, constrains the morphology–phononology interface to a principled and more concrete approach. It suggests by implication that the richness of the options available to an adult speaker through his grammar is not as rich when category hierarchies (2) limiting paradigms are taken into consideration. In section 3, it will be shown that intuitions about surface relations among complex words, their computation and phonetic interface legibility are more precisely articulated in a paradigm approach defined by the hierarchy of morphological categories.

3. Syncretism and markedness

In addition to the issue of unconstrained generation of complex symbols, the phonological realization of morphological categories exhibits massive syncretism. The purpose of this section is to flesh out the issue and to suggest a markedness account of this interface phenomenon in the paradigm approach sketched in 2.

Syncretism, construed as an interface legibility issue between morphology and phonology, can be illustrated with respect to the categories Gender, Number and Direct Case in their paradigm projections of Latin morpho-phonology (3).

In Latin, lexical classes of nouns (declensions) are marked by a unique theme (or stem classifying) vowel and by the functional categories Number and Direct Case. In (3) the first three declensions are illustrated. The singular and plural values of Number intersect with the nominative and accusative values of Case. It should also be noted that the thematic vowel for declensions 1, 2 and 3 is transparently realized (-a, -u, -e) only in the accusative singular quadrant of the table. Note, moreover, that of the category Case only the accusative value (-/m/) is realized and only in paradigm with the singular value of Number. In contrast, observe that of the functional category Number is realized only in the plural value; that is, there is no specific morpheme or feature for singulars except the absence of the plural. Plural morphology is realized as coronality: a segment /s/ in declension 3 or as a coronal features merged with the theme vowel [e, i] in paradigm with the nominative Case value in declension 1 and 2 (Saltarelli 2001). In addition to limiting the realization of Number and Case to a single value, respectively plural and accusative, a mutual exclusiveness effect is created. Case is expressed in the singular where Number is not expressed, and Number is expressed in the plural where Case is not expressed.

(3)		Singular		Plural[3]
	Nominative	1.	stell-**a**	stell-**ae** [**e**]
		2.	serv-**us**	serv-**ī**
		3.	juven-**is**	juven-**ē**-**s**
	Accusative	1.	stell-**a**-**m**	stell-**ā**-**s**
		2.	serv-**u**-**m**	serv-**ō**-**s**
		3.	juven-**e**-**m**	juven-**ē**-**s**

This state of affairs reminds us that morphological categories such as Number and Case are inflectionally realized in a typology of ways, among them (4,5) (see Corbett 2000: 143 for Number).

(4)		Case	Subject	Object
	a.	unmarked	marked	Morphologically Accusative (Latin)
	b.	marked	unmarked	Morphologically Ergative (Basque)

(5)		Number	Singular Plural
	a.	unmarked	marked
	b.	marked	unmarked

The mismatch between morphological categories and their realization has been attributed to principles minimizing phonological information (Kenstowicz 1996, Burzio 1999, but see McCarthy 2003). Such principles, however, are not a conceptual necessity in the paradigm framework advocated in 2. Rather, they follow from paradigmaticity,[4] the notion of paradigm membership that is itself derived from the hierarchical nature of inflectional categories (2).

3. We limit the illustration to declensions 1, 2, 3, excluding 4, 5 and neuter gender paradigms.

4. For an enumeration of morpho-phonological complex symbols {α,β} there is a Functional paradigm relation $\langle\alpha,\beta\rangle_F$, if and only if there is a morphological Category C, such that $C \in F$ and {α,β} are in a correspondence relation with the values of C.

Note, in fact, that the paradigm forms of each lexeme are morphologically legible on the basis of minimized phonological forms, given their categorical paradigm membership. Hence, the relation ⟨*stella, stellae*⟩$_{\text{NUM}}$ is defined by the Number category explicitly expressed by the realization of the marked plural value [coronal] in one of the members of the paradigm, namely *stellae*. As a consequence of the Number paradigm relation, the unmarked member *stella* is interpreted as the default value singular. Likewise, the ⟨*stella, stellam*⟩$_{\text{CASE}}$ paradigm relation is defined by the Case category explicitly expressed by the realization of the marked Case value accusative –/m/ on the marked member *stellam*. The unmarked member *stella* is paradigmatically interpreted as nominative.

We can see, then, how paradigm membership defined on the hierarchical system of inflectional categories (2) can account for the mapping of morphological categories onto their minimized phonological representation in a uniform way.

There is another sense of markedness that will be considered in order to account for the mutually exclusive realization of Number and Case in Latin. Recall that Case inflection is realized in singular forms and Number inflection in plural forms. This distribution is an example of conflicting constraints on the realization of morphological categories. Namely, the realization of Case is disfavored over the realization of plural Number, as can be fully appreciated in the third declension: *juven-**ē-s***. In the absence of plural Number the marked accusative form *juven-e-m* is realized (3). The first and second declension also favor plural realizations of Number over Case (Saltarelli 2001).

In sum, syncretism as a legibility issue in the morphology–phonology mapping has a uniform treatment in a paradigm account of inflectional morphology. We have argued that the paradigm is a crucial concept in defining morpho-phonological relations among words. It's not, however, a grammatical primitive. Rather, the concept of paradigm is an epiphenomenon of the hierarchical nature of lexical and functional categories (cf. footnote 2). Under this perspective, the apparent issues of morphological over-generation (2.) and phonological syncretism (3.) receive a fuller understanding when considered in terms of a hierarchical organization of morphological categories and a markedness account of phonological minimization.

4. Spanish paradigms

In this paper I consider an inflectional (functional) system as the pair-wise correspondence relation between any two of a set of paradigm candidates ⟨P_I, (P_J), P_K⟩ that is evaluated by a ranked constraint grammar [[C_1 C_2 C_3]], where C_X is a morpho-phonological constraint MP. This constraint interaction formulation is in the vein of the paradigm hypothesis (McCarthy 2003) of optimality theory (Prince and Smolensky 1993).

My thesis will be developed from the empirical viewpoint of well known data and analyses of the inflectional category Number of Spanish. Specific arguments are built and discussed in the context of a rich contemporary body of literature on this general morpho-phonological issue (Foley 1967; Harris 1969, 1983; Saltarelli 1970, 2001; Roca 1996; Moyna & Wiltshire 2000, to mention only a few scholarly works on the topic).

The general claim is made that a paradigm approach is a closer conceptual approximation to an optimal characterization of the morphology–phonology interface (McCarthy and Prince 1999). A paradigm view of Number allows a new and uniform account of the alternations of singular and plural forms in Spanish, in contrast with non-paradigm analyses conceived as 'plural formation', which focus, not on an account of the whole category Number, but on the directional computation of the realized value only: the plural form. By definition, a paradigm involves at least two phonological alternants of the same lexeme morphologically related by the values of the same inflectional category.

Note that some relevant paradigm enumerations for the Spanish lexeme *árbol* 'tree' (6) are assumed in light of contemporary generative accounts. (6a–c) are asymmetric and (6d) is a symmetric conceptualization of the paradigm. Asymmetric relations among forms are typical of the Post-Bloomfieldian Item-and-Process approach to morpho-phonology (Hockett, 1958) and intrinsic to derivational morpho-phonology. In (6a) *árbol* is the base and *árboles* the range of the relation, where the base lexeme *árbol* is un-effected and the plural morpheme is –/es/. Asymmetric conceptualizations involve a directionality in the derivational process and the identification of a directionally underlying and a surface form (Benua 1997). (6b) includes the non-canonical plural form **árbol-s,* derivationally or implicitly intermediate between the base and the surface form (Saltarelli 1970, 2003; Moyna&Wiltshire 2000). This construal of the number paradigm attributes an epenthetic status to the vowel –e- as a cluster repair strategy. (6c), in contrast, departs from (6b) by selecting an alternate abstract singular form **árbole* as the base and *árbol* and *árboles* as the range. The selection of the abstract base stem in derivational phonology requires a spurious rule of apocope that is not productive in the language (Foley 1967, Harris 1969). In contrast with asymmetric construal of paradigms that must choose an abstract input (I), (6d–e) are more concrete in that they exclude by definition an abstract or random selection of a base, input or underlying representation. Hence, no directionality or hierarchical-linear order is assumed among the output (O) forms of the paradigm (Kenstowicz 1996).

(6)	a.	⟨*árbol, árbol-es*⟩	Asymmetric, I-O
	b.	⟨*árbol, árbol-s, árbole-s*⟩	Asymmetric, Epenthesis, I-O
	c.	⟨*árbol, árbole, árbole-s*⟩	Asymmetric, Apocope, I-O
	d.	⟨*árbol, árbol-s, árbole-s*⟩	Symmetric, O-O
	e.	⟨*árbol, árbol-es*⟩	Symmetric, O-O

In an optimal paradigm theory, the candidates for evaluation are not individual alternant word forms, but whole paradigms. The optimality of the paradigm is evaluated cumulatively of its member forms. As discussed in section 3, the relation between paradigm members is characterized by minimization of phonological realization (licensing syncretism) and maximization of resemblance (lexical faithfulness). The Spanish category Number encompasses a variety of paradigms (a–f), of which there are two major lexeme types: Thematic (7) and (8) A-thematic.

The realization of Number in Spanish is in accordance with the markedness type (5a), where the plural value is minimally realized by the coronal segment -/s/. The singular Number value is un-realized in accordance with the minimization of functional allomorphy (Burzio 1999). Stem thematicity (7a, b) and (8d-ii)) yields maximal surface faithfulness in the realization of the lexeme, in accordance with legibility conditions on the sound-meaning relation. A-thematic stems (8c, d-i) identify a second, less harmonic, type owing to violations of C-contact markedness and faithfulness.

Two additional Number paradigms have puzzled linguists. The phonetically invariable type (8e) *lunes/lunes* and the prosodic head shift (8f) *régimen/regímenes.* On first observation, the invariable type is problematic for the paradigm theory proposed in this paper, since the phonological shape of the alternant forms is expected to be lexically similar and minimally distinct by the projection of functional categories, in keeping with an optimal sound-meaning legibility. In this paper both (8e) and (8f) fall under the same prosodic correspondence hypothesis.

(7)	a.	(i)	⟨*cas-a, cas-a-s*⟩	Thematic V-Stem (Gender distinctive)
		(ii)	⟨*cas-o, cas-o-s*⟩	
	b.	(i)	⟨*fuent-e, fuent-e-s*⟩	Thematic V-stems (Gender non-distinctive)
		(ii)	⟨*puent-e, puent-e-s*⟩	

(8)	c.	(i)	⟨*árbol, árbol-e-s*⟩	A-thematic C-stem (Gender non-distinctive)
		(ii)	⟨*flor, flor-e-s*⟩	
	d.	(i)	⟨*bajá, bajá-e-s*⟩	A-thematic V́-stem
		(ii)	⟨*bajá, baj-á-s*⟩	Thematic V́-stem
	e.	(i)	⟨*lunes, lunes*⟩	A-thematic S-stem (invariable)
		(ii)	⟨*análisis, análisis*⟩	
	f.	(i)	⟨*régimen, regimen-e-s*⟩	Prosodic Head shift
		(ii)	⟨*carácter, caracter-e-s*⟩	

5. A paradigm account of Spanish Number inflection

As the realization of Number in Spanish is of the markedness type (cf. 2a), only the marked plural value of the category surfaces as the coronal segment -/s/, in right-alignment with the stem. The unmarked morphological value (singular) is simply un-realized. Hence, the morpho-phonological mapping of the category Number is characterized by the realization of -/s/ and its absolute absence. This morpho-phonological mapping, heeding to Burzio's general principle of minimization of allomorphy, while minimally defining the morphological Number contrast, follows as a direct consequence of the paradigm framework. Its implementation is in terms of the constraint Realize Number freely adopted from the general debate on Realize Morpheme (Kurisu 2001)). The specific articulation of the constraint relevant to the Number paradigm of Spanish is informally stated in (9). See the Appendix for an index of interacting constrains.

(9) a. Realize Number RN(PL)
The morphological category Number ⟨singular, plural⟩ must have its (marked) value realized in correspondence with the phonological affix –/s/.

b. Realize Number RN
The morphological category Number must be realized.

5.1 Phonotactic effects

The main paradigm type of Spanish nominal inflectional morphology is the thematic Number paradigm (7a). It consists of a lexical stem with a phonological exponent in the form of the vowels /a, o, e/, each identifying a distinct word class, the Theme Vowel. Tableau (10) below illustrates the paradigm for the lexeme *cas-a* 'house' evaluated by ranked markedness and faithfulness constraints (see Appendix). The paradigm relation for the candidate forms (10a–d) is defined by the presence in the grammar of a morpho-phonological markedness constraint on the category Number, generally Realize Number. For Spanish, the realization of the plural value of Number is high ranked (RN(PL)) (9a) and realized as /s/. In contrast, the default value of Number (singular) is low ranked RN (9b) and un-realized. Accordingly, candidate (10a) is the optimal paradigm among (a–d), as indicated by the evaluation. The lexeme is maximally faithful in the paradigm. The suffix –/s/ minimally identifies the plural form of the pair, the singular value being computed by virtue of the absence of (/s/). In sum, the morpho-phonology of the Spanish number paradigm is formulated in the proposed grammar by the high-ranked RN(PL), evaluating the phonetic interface necessity to realize Number, in conflict with the low-ranked RN evaluating the "singular" as the zero-realization of Number in the paradigm pair set.

(10) Thematic V-Stems: *casa, puente,* (see 7a,b)

/cas-a/+(/s/)	RN(PL)	MAX-IO	DEP	RN
☞ a. ⟨casa, casa-s⟩				*
b. ⟨casa, casa⟩	*!			*
c. ⟨cas, casa-s⟩		*!		*
d. ⟨casa, casae-s⟩			*!	*

In (11) below, Spanish a-thematic Number paradigms are identified by their lexical stem form lacking a realized theme vowel. In Spanish, the lexical stem in this paradigm generally ends in a consonantal segment (typically, but not categorically, a single coronal): *árbol, flor, jamón, mes, rey* (7b). The contact between the stems and the realized plural value /s/ of Number creates a phonotactic conflict between paradigm faithfulness of the candidate (11c) and the satisfaction of phonotactic markedness (11a), the latter resulting in the optimal paradigm. As can be seen, (11b,d) fatally violate Realize Number.[5]

5. A word of caution about paradigms. A paradigm involves the paradigmatic ⟨sing,plur⟩ values of a single lexical constant. In contrast with (11), the grammar of s-aspirating dialects in coda position only would differ exactly in the realization of the plural form ⟨casa, casah⟩. Other syllable based variations need adequate adjustments to the grammar.

(11) A-thematic C-Stems: *árbol, flor* (8c)[6]

/árbol/+(s)	*COMPL	RN(PL)	DEP	RN
☞ a. ⟨árbol, árbole-s⟩			*	*
b. ⟨árbol, árbol⟩		*!		*
c. ⟨árbol, árbol-s⟩	*!			*
d. ⟨árbol, árbole⟩		*!	*	**
e. ⟨árbole, árbole-s⟩			**	

As a technical aside, it's important to note that in the pair-wise evaluation of (a–d) (in (7) and (8)) the underlying Input lexical entry */árbol/+(s)* is superfluous and appears to be computationally un-necessary in a paradigm framework. In fact, on a symmetric paradigm assumption (6e) the evaluation is cumulative of the output paradigm members and blind to any underlying input or base directionality; accordingly, the surface forms of the paradigm are linearly unordered. Restricting the computation to Output paradigm forms, in disregard of the Input, would eliminate by definition arbitrary or random selection of an underlying representation of the lexeme. The binary valued nature of Number in Spanish, would, in fact, exclude (6b,c,d) as well-formed paradigms, owing to the hierarchical organization of morpho-syntactic categories. The analytical implication is that in a tableau with an underlying Input form */árbole/+(s)* (in contrast with */árbol/+(s))* the constraint grammar would select the paradigm candidate (11e) as optimal, rather than (a). The selection of (11e), however, yields a spurious evaluation as it is contrary to the facts. These considerations on underlying forms support a constraint evaluation of strictly output forms, which follows directly from the paradigm theory proposed in this paper. Accordingly, the pair-wise correspondence evaluation is computed to an exhaustive permutation of output candidates. I will continue, however, to indicate an underlying input form in the tableau for the time being.[7]

5.2 Stress shift and foot form

Two well known sub-types of the Spanish Number paradigm involve a rightward shift of the stressed syllable, for a reduced subset of the lexicon of Spanish. Prosodic alternations include both penultimate words like *carácter/caracteres* 'character/s' (12) and ante-penultimate words like *régimen/regímenes* 'regimen/s' (13). For the purpose of this paper, our conceptualization of stress is in line with a metrical theory of prosodic

6. To my knowledge, this is the first constraint–based paradigmatic account of both values of Spanish Number. Pluralization accounts mimic either the epenthesis (Moyna &Wiltshire 2000, Saltarelli 2001) or the apocope (Roca 1996) conceptualization of derivational phonology (Saltarelli 1970, Foley 1965). Systemic asymmetry requires stipulation of an arbitrary Input form *árbol+s* or *árbole+s,* respectively. In connection with (11), the theoretical implications of a strictly symmetric paradigm evaluation are discussed with respect to the articulation of the Realize Number (RN) constraint in conflict with Realize Plural (RN(PL)) and its markednes effects on the members of the paradigm.

7. The use of label DEP lends ambiguity as to whether we are operating on an IO or OO system. The analysis tends to favor the latter. But if it it must be IO, let be it. For that reason, my position remains astride.

prominence (Hayes 1995), although not with extrametrical analyses of stress. As for Spanish and Italian, among the Romance languages, I have argued that both binary (trochaic) and ternary (dactylic) feet are well formed, lexically distinctive and subject to catalectic effects (Saltarelli, 1997, 2001).

The analysis of tableaux (12–14) follows from the interaction of phonotactic (cf. 11) and prosodic constraints. Alternating paradigm members respond to prosodic consistency (Burzio 1990), specifically in foot constituency and in the location of the prosodic head in the word. In the three tableaux foot constituency is characterized by the higher ranked Foot-Form constraint. The lower ranked Linearity of prosodic prominence head protects the lexicalized locus of word stress. Hence, crucially, satisfaction of phonotactics in candidate (12d) at the expense of violation of epenthesis in candidate (12b) creates a ternary foot which is in fatal violation of the higher ranked Foot-Form (cf. Appendix). The candidate (12a) is the optimal paradigm, where Foot-Form is satisfied by violating a lower ranked Linearity(H), i.e. by allowing stress shift, thus preserving the trochaic prosody of the lexeme (cf. Appendix).

(12) Penultimate stress (ˈσσ): *carácter* (8f-ii)

/carácter/+(s)	FT-FORM	*COMPL	RN(PL)	LIN(H)	DEP	RN
☞ a. ⟨carácter,caractére-s⟩				*	*	*
b. ⟨carácter,carácteres⟩	*!				*	*
c. ⟨carácter, carácter⟩			*!			*
d. ⟨carácter,carácter-s⟩		*!				*

The same paradigm reasoning accounts for the preservation of the foot form in antepenultimate stressed words like (13), where violation of Linearity satisfies the foot constituency of the word in both output forms of the Spanish Number paradigm.[8]

(13) Antepenultimate stress (ˈσσσ): *régimen* (8f-i)

/régimen/+(s)	FT-FORM	*COMPL	RN(PL)	LIN(H)	DEP	RN
☞ a. ⟨régimen,regímenes⟩				*	*	*
b. ⟨régimen,régimenes⟩	*!				*	*
c. ⟨régimen,regimen⟩			*!			*
d. ⟨régimen,regimen-s⟩		*!				*

The metrical account of stress shift in the set of tableaux (12–13) yields an added heuristic bonus. The evaluation of forms in paradigm relations independently provides the formal basis for identifying the distinctive lexical prosodic stress type of the lexeme, without the need for an arbitrary selection of input form. For example, given the independent forms *árbol* and *carácter* in Spanish we have no prima facie indication of the lexical metrical constituency of each word: syllabic trochee or dactyl? Only in light of

8. The assumed binary (trochee) and ternary(dactyl) as a prosodic lexicalization for Spanish (Saltarelli 2001) allows us to uniformly account for both tableaux (12–13) including stress shift. Such a generalization does not follow directly under a strictly binary metrical conceptualization of Romance prosody (Moyna and Wiltshire 2000:44).

the Number paradigm behavior of each item can we establish that the first is dactylic ⟨*árbol, árboles*⟩ and the second trochaic ⟨*carácter, caracteres*⟩, the singular forms being catalectic realizations of their prosodic type.[9] A comparison with the Latin etymon (prosodically preserved in Italian) confirms the empirical validity of the paradigm approach to inflectional morpho-phonology.

In sum, in this section I have shown that traditionally 'exceptional' plural forms (8f) find a uniform account with 'regular' plurals under a paradigm theory of morpho-phonological inflection. In the next section (5.3) it will be argued that the same paradigm framework makes available a principled understanding of the 'invariable' type, exemplified in *la crisis/las crisis* (**crísises)* "crisis/crises".

5.3 The invariable paradigm and uniformity

Perhaps the most intractable sub-type of the Spanish Number paradigm is the one that has appropriately been termed 'invariable'. In this apparently absurd paradigm the output forms (corresponding to singular and plural) do not vary phonetically, a case of absolute inflectional syncretism of the category Number. An analysis consistent with the phonotactic (11) and prosodic (12,13) hypothesis proposed so far suggests a similar grammar, with one additional constraint violation of Uniformity of correspondence.

The Number invariable paradigm in Spanish involves a reduced set of lexemes which includes both penultimate and ante-penultimate stress: *lunes,* 'Monday'. *miércoles,* 'Wednesday" (8e). Words like *biceps* 'biceps' fall under the same prosodic analysis as *lunes*, with the additional complication of Coda Conditions.[10] They admit neither violation of Realize Number(PL) candidate (14a), Complex coda consonant clusters candidate (14d), Dependence/Foot Form in candidate (14b), nor stress shift candidate (14c). Uniformity of correspondence is the constraint violation which renders the most harmonic paradigm candidate (14e), whereby violation of the low ranked constraint banning coalescence of stem-fimal –/s/ with the inflectional plural affix -/s/ satisfies Foot-Form, *Complex, Realize Number(PL), and Linearity of Prosodic Head.

(14) Penultimate (ˈσσ) : *lunes miércoles* (8e)

/lúnes/+(/s)	FT-FORM	*COMPL	RN(PL)	LIN(H)	UNIF	DEP	RN
a. ⟨lúnes, lúnes⟩			*!				*
b. ⟨lúnes, lúnese-s⟩	*!					*	*
c. ⟨lúnes, lunése-s⟩				*!		*	*
d. ⟨lúnes, lúnes$_1$-s$_2$⟩		*!					*
☞ e. ⟨lúnes, lúnes$_{1,2}$⟩					*		*

There is, however, an aspect of the analysis in tableau (14) which is un-convincing. The use of subscripts to indicate a phonological distinction is a technical device that does

9. An articulation of prosodic catalexis in Spanish is developed in Saltarelli 2001.

10. Moyna &Wiltshire treat *biceps* independently of the invariable set.

not sit well with a concrete understanding of sound-meaning legibility. Uniformity, then, may not be a precise constraint characterization of the issue. As a more grounded constraint alternative in contrast with (14), one might consider an un-dominated ban on identical segments in the phonetic realization of identical sequence of segments in the spirit of the Obligatory Contour Principle (OCP) or better yet a ban on geminates *CC. The latter option would be consistent with the lack of sibilant geminates in this language. We do not, however, explore further this alternative at this time and stay with tableau (14).

5.4 Between prosody and the lexicon: *bajá/bajás~bajáes*

A final subset of mostly non-autochthonous words ending in a stressed vowel like *bajá* 'pasha' appears to alternate, under social conditions, between the basic thematic ⟨*bajá, bajás*⟩ and a-thematic ⟨*bajá, bajáes*⟩ paradigms, suggesting different or co-existing phonologies.[11] It's reasonable to include under this set the paradigm *café/cafés,* with the caveat that in the paradigm *café/cafées* the plural form is excluded by an empirically motivated constraint banning geminate vowels *VV or perhaps the OCP. The null hypothesis within the paradigm framework presented here is to assume that in words ending in a single stressed vowel, that final vowel is the head of a catalectic foot favoring the realization of its full constituency in the plural value of the Number paradigm (Saltarelli 2001). This prosodic conceptualization of the issue would be integrative of the analysis proposed in this paper. The theory has internal merit when we compare the two tableaux (15) and (16), where the inverse ranking of Dependence and Foot-Form precisely accounts for an otherwise curious fact about the inflectional morphology of the language. An alternative to the prosodic hypothesis that assumes distinct constraint ranking would be a lexical account in which the final stressed vowel is alternatively perceived either as thematic, i.e. */baj-á-/*, or as a-thematic, i.e part of the root */bajá-/*. Under this perceptual (lexical) hypothesis, there would be only one grammar, the alternant behavior being consistent with thematicity, hence coherent with either the basic language paradigms (10) ⟨baj-á, baj-á-s⟩ or (11) ⟨bajá, bajáe-s⟩.

(15) V́-Stems: *bajá,* (thematic behavior)

/bajá/+(s)	RN(PL)	DEP	FT-FORM	RN
☞ a. ⟨bajá, bajá-s⟩			*	*
b. ⟨bajá, bajáe-s⟩		*		*

(16) V́-Stems: *bajá,* (a-thematic behavior)

/bajá/+(s)	RN(PL)	FT-FORM	DEP	RN
a. ⟨bajá, bajá-s⟩		*		*
☞ b. ⟨bajá, bajáe-s⟩			*	*

11. Many polysyllabic words ending in *–á, -í, ú* have adopted the plural ending in *–es* rather than *–s.* The former appear to have acquired literary prestige today, in contrast with the latter that is more spontaneous and colloquial (RAE 1986:184–185).

A third analytic hypothesis under the one grammar conception would concern an alternate perception of Rhythm Type. Accordingly in (15), the (a) candidate is perceived as a lexical iambic right-headed foot. In such case, Foot Form protects the binary foot structure and disfavors candidate (b). In contrast, in (16) the lexical Rhythm is perceived as a left-headed catalectic trochee, hence (b) is optimal over (a). The implications of these alternative accounts will not be explored.

6. The economy of paradigms

This paper proposes a characterization of the morpho-phonology of the Spanish category Number that implies neither epenthesis (6b) nor apocope (6c) as phonological hypotheses in a parallel computational system. These two concepts linger on in the literature as intellectual legacy of derivational grammars, denoting an asymmetric computational relation between an underlying/input element in a string S_1 and a correspondent one in S_2.

In contrast, the account developed in section 5 is couched in a symmetric two-valued morpho-phonological paradigm set of the morpho-syntactic inflectional category Number (7,8). The premise of this proposal differs fundamentally from previous analyses. Mainstream analyses deal with only one member of the Number paradigm: the realization of the plural value of the category, without regard for its paradigm relation to the singular value. Because of directional design, asymmetric analyses miss two generalizations that follow from symmetric paradigm theory, namely constraining morphological relations (section 2) and steady state of phonological syncretism (section 3). We indicated that, as a direct consequence of the framework, a paradigm approach offers a principled understanding of cases of opacity in the debated analysis of the palatal [ʎ/l, ɲ/n] alternation (1a,iii-iv). We have suggested that this opacity issue is intrinsic to an asymmetric conceptualization of morpho-phonology.

The constraint interaction account of the distributional set of the Spanish Number paradigm (7, 8) subsumes the inflectional morpho-phonology of Spanish into two basic lexically defined types, namely thematic (10) and a-thematic (11) stems. The cumulative evaluation of (10) is harmonically optimal with the morpho-phonological mapping constraint Realize Number (9), in contrast with (11), which requires further satisfaction of phonotactic violations. This lays the ground for a paradigm characterization of Spanish Number.

On this basis, previously 'exceptional' cases in (12–14) are uniformly characterized in satisfaction of prosodic well-formedness constraints. Specifically, the stress shift in both *carácter/caracteres* in tableau (12) and *regimen/regimens* in tableau (13), finds a unified explanation in the paradigm coherence of their metrical foot form, namely trochaic in the former and dactylic in the latter. Only a symmetric paradigm hypothesis of Number can precisely integrate an otherwise anomalous prosodic alternation.

The same paradigm coherence of the lexicalized metrical foot form accounts for the paradigm invariability (8e) analyzed in tableau (14). It should be noted that the invariable type was considered the 'exceptional' paradigm case par excellence, a diacritically defined zero realization of the number category in the singular as well as in the plural. The original derivational rule of plural formation asymmetrically assigns [-*s*, -*es*, -Ø] to the morphological plural of the singular form.

The paradigm perspective in tableau (14) is in uniformity with the prosody (12, 13) and the phonotactics (11) of the language. It satisfies markedness constraints Foot Form, *Complex and Realize Number(Pl) at the expense of violating lower ranked faithfulness. The invariable type tableau (14) satisfies markedness at the expense of lower ranked Uniformity of segmental correspondence within the paradigm (tableau 14, candidate e).

In sum, the paradigm approach proposed in this paper provides an integrated theory of Spanish Number, without recourse to directionality, abstract representations, or special statements for the 'exceptional' cases.

If substantiated, the paradigm theory of Number that follows from this analysis has implications for the nature of inflectional morphology and its interface with phonology *sensu lato*. sections 1 and 2 argue that the notion paradigm precisely characterizes the speaker's intuition about resemblances among inflected words. Distributional evidence suggests that inflected words are complex symbols of morpho-syntactic categories under the identity of a lexical stem. The relation among complex symbols is formally defined by paradigmaticity (see footnote 4). Accordingly, the notion paradigm, as a set of functionally related inflected surface forms, is not a primitive. Rather it is derived from the hierarchical organization of categories (section 2). Under this formalization, the phonological mapping of morphological categories is effectively constrained at the interface under markedness (section 3) in a strictly symmetric output to output correspondence hypothesis.

In conclusion, this account suggests that the morphology of Number in the architecture of grammar is largely derived. (17) is a concrete illustration of the proposal.

(17) $[\,[\,/\text{kas-a}/]_{\text{N°}}\,(+/\text{s}/)]_{\text{NUM°}}$ = a. $[\,[\,/\text{kas-a}/\,]_{\text{N°}}\,]_{\text{NUM°SG}}$
b. $[\,[\,/\text{kas-a}/\,]_{\text{N°}}\,+/\text{s}/]_{\text{NUM° PL}}$

The surface structure (17) is a terminal complex symbol of morpho-syntactic and phonological elements, arguably derived by syntactic head movement, whereby the head noun N° moves to Num°. The active values of the category Number expand into the paradigmatically related forms (17a) and plural (17b). Accordingly, at phonological form (PF), assuming a single lexeme and phonological transfer of morpho-syntactic values, the functional correspondence relation of inflected words is defined in the Number paradigm $\langle(\text{a}), (\text{b})\rangle_{\text{NUM}}$ (cf. footnote 4) and uniformly realized (section 5).

The formal implications of the paradigm account of Spanish Number are outlined in (18).

(18) a. The mapping at PF is primarily computational. There is no conceptual necessity for intervening morphological levels of representation (cf. Halle & Marantz 1993).
b. Inflectional categories fall into two major types, (i) lexical (Gender) and (ii) functional (Number, Case, etc.). They are hierarchically organized.

c. The phonological realization of morpho-syntactic categories as inflectional word augments is systematically restricted (syncretism) under markedness conditions.
d. Evaluation of paradigms is cumulative and asymmetric in output to output correspondence.

References

Allen & Greenough's. 1983. *New Latin Grammar*. New Rochelle NY: Caratzas.
Baerman, M. 2004. Directionality and (un)natural classes in syncretism. *Language* 80(4): 807–827
Bobaljik, J.D. 2003. What's in a Paradigm. 3rd Mediterranean Meeting on Morphology. Ms.
Benua, L. 1997. Transderivational Identity: Phonological Relations between Words. PhD dissertation, University of Massachusetts.
Burzio, L. 1999. Surface-to-surface morphology. ROA–341.
Corbett, G.G. 2000. *Number*. Cambridge: CUP.
Foley, J. 1967. Spanish plural formation. *Language* 43: 486–493.
Harris. J. 1969. *Spanish Phonology*. Cambridge MA: The MIT Press.
Harris. J. 1983. *Syllable Structure and Stress in Spanish.* Cambridge MA: The MIT Press.
Harris. J. 1991. The exponent of gender in Spanish. *Linguistic Inquiry* 22(1) :27–62
Hayes, B. 1995. *Metrical Stress Theory*. Chicago IL: University of Chicago Press.
Hockett, C. 1958. *A Course in Modern Lingustics.* New York NY: MacMillan.
Kenstowicz, M. 1994. Phonology in generative grammar.Cambridge: Blackwell.
Kenstowicz, M. 1996. Base-identity and uniform exponence. ROA–103.
Kikuchi, S. 1999. Opacity and Transparency in Spanish Plurals: A Sympathetic Approach. Ms.
Kurisu, K. 2001. The Phonology of Morpheme Realization. PhD dissertation, UCSC
McCarthy, J.J. and Prince, A.S. 1999. Faithfulness and identity in prosodic morphology. In The *Prosody Morphology Interface,* Kager, R. et al. (eds), 218–308. Cambridge: CUP.
McCarthy, J.J. 2003. Optimal paradigms. ROA 485.
Moyna, I. and Wiltshire, C. 2000. Spanish plurals: Why [s] isn't always optimal. In *Hispanic Linguistics at the Turn of the Millenniu,.* H. Campos et al. (eds). Somerville MA: Cascadilla.
Prince, A. and Smolensky, P. 1993. *Optimality Theory: Constraint Interaction in Generative Grammar*. Ms. Rutgers University and University of Colorado.
Real Academia Española (RAE) (1986). *Esbozo de una Nueva Gramática de La Lengua Española.* Madrid: Espasa-Calpe.
Roca, I. 1996. Phonology–morphology interface in Spanish plural formation. An Optimality analysis. In *Interfaces in Phonology*, U. Kleinhenz (ed.). Berlin: Akademie Verlag.
Saltarelli, M. 1970. Spanish plural formation: Apocope or epenthesis? *Language* 46(1): 89–96.
Saltarelli, M. 1997. Stress in Spanish and Latin. In *Issues in the Phonology and Morphology of the Major Iberian Languages,* F. Martínez-Gil and A. Morales-Front (eds), 665–694. Washington DC: Georgetown University Press.
Saltarelli, M. 2001. The realization of number in Italian and Spanish. In *Features and Interfaces*, J. Herschensohn, E. Mallén and K. Zagona (eds), 239–254. Amsterdam: John Benjamins.

Appendix

*COMPLEX[coda]
(Codas are simple)

MAX
Every element in S_1 has a correspondent in S_2, Domain=S_1
(No deletion of segments)

DEPENDENCE (DEP)
Every element in S_2, has a correspondent in $S_{1,}$ Range=S_2
(No epenthesis of segments)

LINEARITY (LIN(H))
Every prosodic head syllable in S_2, has the same correspondent head syllable in S_1
(No stress shift)

UNIFORMITY (UNIF)
No elements of S_2 has multiple correspondence in S_1
(No coalescence of segments)

FOOT-FORM (FT-FORM) (Cover Constraint)
Feet are binary (trochee) or ternary (dactyl)
(Degenerate feet are catalectic of trochees (ʹσ.) or dactyls (ʹσσ.)

Prefix boundaries in Spanish varieties

A non-derivational OT account*

Caroline R. Wiltshire
University of Florida

The special phonology of prefixes has often been used to provide arguments for rule ordering or special devices in Optimality Theory. I examine three cases of special behavior in varieties of Spanish: aspiration of /s/ to [h] in Carribean (Harris 1993); velarization of /n/ to [ŋ] in Granadan (Hualde 1992); and the non-fortition of /j/ to [ʒ] in Argentinian, where otherwise expected (Harris and Kaisse 1999). In all three, prefix-final output segments match word-final outputs in those dialects. Therefore, I analyze prefixed words as containing an internal word boundary, as $[\text{pre}[\text{fix}]_{PW}]_{PW}$ (Peperkamp 1997), and propose a constraint (family) which prefers weaker forms of consonants at prosodic boundaries, $\text{Weak}|_{PW}$. "Weak" consonants may undergo debuccalization (Lavoie 2000) or resist fortition (Baker and Wiltshire 2003). The account provides for syllabification and segmental alternations at prefix and word edges in a non-derivational OT.

Keywords: prefix, word, lenitation, fortition, derivation, asperation, dialects, Granadan, Caribbean, Argentinian

0. Introduction

Prefix boundaries require special analysis in the phonology of many languages, and have been used to provide arguments for rule ordering or for special devices in OT for Spanish (e.g., Harris 1993, Kenstowicz 1996, Colina 2002). In this paper, I examine three cases of the special behavior of segments at prefix edges vs. word-internally in monomorphemic words in varieties of Spanish: the realization of /s/ as [h] in Caribbean I Spanish; the realization of /n/ as [ŋ] in Granadan Spanish; and the fortition of high vowels (and lack thereof) in Argentinian Spanish. In all three cases, the output

* I thank Gary Baker for numerous discussions related to the work here, as well as audiences at LSRL 32 in Toronto, SECOL 61 in Knoxville, DGfS in Marburg, and LACUS 27 at Rice, for their helpful comments on various pieces of this work. I also thank the two anonymous reviewers who commented on a previous version of the paper, and I apologize for not addressing all of their concerns here, whether for lack of space, time, data, and/or ability.

forms of the segments prefix-finally match the outputs in word-final position in those dialects.

I propose that the special behavior prefix-finally results from an analysis of prefixed words as containing an internal word boundary in Spanish, as $[\text{pre}[\text{fix}]_{\text{PW}}]_{\text{PW}}$ (Peperkamp 1997), and a new constraint which prefers weaker forms of segments at prosodic boundaries, called here $\text{Weak}|_{\text{PW}}$. This is a cover term for a family of markedness constraints reducing contrasts and increasing sonority in word-final position, parallel to constraints on syllable-final (coda) position. Such constraints find support in both typology and phonetics, as the word-final position is cross-linguistically a position of neutralization. "Weak" consonant may therefore undergo debuccalization (Lavoie 2000) or resist fortition (Baker and Wiltshire 2003).

I show that this account provides for a non-derivational Optimality Theory account of syllabification and segmental alternations at prefix and word edges in Spanish varieties. Furthermore, I discuss alternative analyses within Optimality theory which use Output-Output constraints (e.g., Colina 2002) and argue that such approaches are less optimal in accounting for dialectal variation, in addition to being more complex.

1. Special behavior at prefix boundaries[1]

I begin by discussing examples of special behavior at prefix boundaries in three varieties, where we find the same pattern for prefix-final and word-final allophonic realizations. This is followed by data on syllabification, where the special behavior at prefix boundaries is common to all dialects. Thus, in all four sections, prefix boundaries are shown to be similar to word boundaries in Spanish.

1.1 Aspiration in Caribbean Spanish

The use of [h] for /s/ in some varieties of Spanish has been widely discussed (e.g., Colina 1997, 2002, Guitart 1979, Harris 1983, 1993, Kaisse 1999, Lipski 1994, and many more). Some varieties never aspirate /s/, such as Northern Castillian, while varieties that do aspirate differ in the contexts for aspiration. Kaisse (1999) categorizes aspirating varieties into three basic types, according to which positions cause aspiration. In all such dialects, /s/ is realized as [h] in codas. In the dialect Kaisse calls Caribbean I, aspiration occurs at the ends of words and prefixes, regardless of whether the following segment is a consonant or vowel:

1. The data throughout this paper has come from a variety of sources: Harris (1983, 1993), Hualde (1992, 1999), Colina (1997), Face (2002). Accent marks have been omitted throughout the paper; although relevant to the fortition data, stress does not directly bear on the examples discussed here. In the data that follows, "." is used for syllable boundaries, "#" for word boundaries, and "+" for morpheme boundaries.

(1) Caribbean I /s/ Aspiration

Word-internal:	a.	/kasa/	[ka.sa]	'house'
	b.	/disko/	[dih.ko]	'disk'
Word-final:	c.	/bitʃos#raros/	[bi.tʃoh.ra.roh]	'strange creatures'
	d.	/bitʃos#estraɲos/	[bi.tʃo.heh.tra.ɲoh]	'strange creatures'
Prefix-final:	e.	/des+ kremada/	[deh.kre.ma.ða]	'de-fatted'
	f.	/des+igual/	[de.hi.gwal]	'unequal'
	g.	/des+armado/	[de.har.mao]	'disarmed'

Although word-internal aspiration occurs only before consonants and not before vowels, word finally, /s/ is realized as [h] regardless of the following segment. The prefix-final realization of /s/ patterns with that of word-final rather than morpheme-internal /s/;[2] thus the prefix boundary is like a word boundary in triggering aspiration in these dialects.

1.2 Velar nasals in Granadan Spanish

The same holds true for /n/ velarization in varieties labelled 'velarizing' by Harris (1993). In the Granada dialect, /n/ is realized as [ŋ] both in coda positions word-internally, regardless of the place of the following consonant (2a–c), and also in word- and prefix-final positions, regardless of the nature of the following segment, consonant or vowel (2d–i). Again, the prefix-final position acts distinctly from word-internal positions, and identically with word-final position.

(2) Granada /n/ Velarization

Word-internal:	a.	/fin+s/	[fi.neh]	'ends'
	b.	/enan+o/	[e.na.no]	'dwarf'
	c.	/kanta+n/	[kaŋ.taŋ]	'they sing'
Word-final:	d.	/sin# fin/	[siŋ.fiŋ]	'without end'
	e.	/sin# eso/	[si.ŋe.so]	'without that'
	f.	/bien# esta]	[bje.ŋeh.ta]	'well-being'
Prefix-final:	g.	/en+amora/	[e.ŋa.mo.ra]	'enamors'
	h.	/in+umano/	[i.ŋu.ma.no]	'inhuman'
	i.	/en+kuadrar/	[eŋ.kwa.drar]	'to frame'

1.3 Fortition in Argentinian Spanish

The final case is more complex, apparently involving underapplication of a rule as well as overapplication. In Argentinian Spanish, the high vocoids, symbolized here as /ɪ/ in underlying form, usually appear in stronger form [ʒ][3] prevocalically in onset position, as in (3a–b) (e.g., Harris and Kaisse 1999). When in nuclear position adjacent to a more sonorous vowel, they appear as [j], as in (c–d):

2. There are three attested patterns for the location of aspiration, for details, see Kaisse (1999). The analysis here will handle only two, but see also Wiltshire (2002), which proposes a difference between the strength of the left and right bracket of a word-boundary.

3. I am dealing here only with the underlying /ɪ/, not /ɪ^{N}/, which undergoes fortition to a different degree. See Harris and Kaisse (1999) and Baker and Wiltshire (2003) for details and analysis.

(3) Argentinian Fortition

Word-internal:	a.	/plaɪ+a/	[pla.ʒa]	‘beach’
	b.	/tramoɪ+a/	[tra.mo.ʒa]	‘trick’
	c.	/desɪert+o/	[de.sjer.to]	‘desert’
	d.	/bɪen/	[bjen]	‘well’
Word initial:	e.	/ɪate/	[ʒa.te]	‘yacht’
after a word:	f.	/mas # Ielo/	[mah.ʒe.lo]	‘more ice’
after a prefix:	g.	/des + Iemar/	[deh.ʒe.mar]	‘to de-yolk’

At prefix and word boundaries, high vocoids show two special behaviors. First, the fortition does apply after prefix and word boundaries where it would not word-internally, as in (3f–g) compared to (3c) above. Second, it does not apply before prefix and word boundaries where it would word-internally, compare (3d) above to (4e) below.

(4) Argentinian Lack of Fortition

Word-final:	a.	/reɪ# alto/	[re.jal.to]	‘tall king’
	b.	/aɪ# algo /	[a.jal.ɣo]	‘there is something’
	c.	/ɪetɪ# amigo/	[ʒe.ti.a.mi.ɣo]	‘friendly yeti’[4]
Prefix-final:	d.	/antɪ + asido/	[an.ti.a.si.do]	‘antacid’
	e.	/bɪ+enɪo/	[bi.enjo]	‘biennium’

The high vocoid will strengthen when word-initial, after a consonant-final prefix or word, but it will not strengthen when word or prefix-final itself. Again, the prefix-final position acts identically to word-final position.

All three cases have previously been analyzed in terms of syllable structure, with aspiration and velarization in codas, following Harris (1983) and fortition in onsets, as in Harris and Kaisse (1999). I therefore turn next to the facts of syllabification in Spanish.

1.4 Syllabification in Spanish

Syllabification in Spanish tends to obey two phonological pressures found widely cross-linguistically: syllables prefer onsets over codas, and syllable edges tend to align with word edges. Word-internally, where there is no pressure to align with word edges, the preference for onsets over codas results in the syllabification of single intervocalic consonants in onset position (5a–b), and the maximization of onset clusters, where allowed by the phonotactics (5c–e).

(5) Word-internal Syllabification

a.	/asul/	[a.sul]	*[as.ul]	‘blue’
b.	/komida/	[ko.mi.ða]	*[kom.i.ða]	‘food’
c.	/soplo/	[so.plo]	*[sop.lo]	‘breath’

4. As Hualde (1999) observes, cases of hiatus like (4c–e) can be pronounced with hiatus or further compressed; however, the difference versus a form like (3d) [bjen] is that it is never produced with vowels in hiatus, it is always diphthongal. Hualde furthermore attributes the hiatus in prefixed forms to the presence of a morphological boundary (1999:190), an insight I follow here.

d.	/ablar/	[a.βlar]	*[aβ.lar]	'talk'
e.	/peregrino/	[pe.ɾe.ɣɾi.no]	*[pe.ɾeɣ.ɾi.no]	'pilgrim'

The two pressures conflict, however, when a word-final consonant precedes a word-initial vowel. In such cases, a word-final consonant is syllabified in an onset with the following vowel (6). If the following word is consonant-initial, so that it already has an onset, syllabification aligns with the word boundaries; any word-final consonant appears in the coda (7).

(6) Word-final Consonants Before Vowel-Initial Words

a.	/ojos#asules/	[o.jo.sa.su.les]	'blue eyes'
b.	/asul#oskuro/	[a.su.los.ku.ro]	'dark blue'
c.	/klub#elegante/	[klu.βe.le.ɣan.te]	'elegant club'
d.	/un#elefante/	[u.ne.le.fan.te]	'an elephant'

(7) Word-final Consonants Before Consonant-Initial Words

a.	/klub#lindo/	[kluβ.lin.do]	*[klu.βlin.do]	'beautiful club'
b.	/tʃef#loko/	[tʃef.lo.ko]	*[tʃe.flo.ko]	'craβy chef'
c.	/benid#rapido/	[be.nið.ra.pi.ðo]	*[be.ni.ðra.pi.ðo]	'come (pl.imp.) quickly'

This gives the appearance of different rules of syllabification in phrases than word-internally, since a cluster such as /bl/ is treated as a good onset word-internally ([a.βlar]), but as a coda plus onset in a phrase ([kluβ.lin.do]). However, the generaliβation is that word edges coincide with syllable edges unless a syllable would lack an onset.

The same generaliβation holds at prefix edges. Unless a syllable would lack an onset (8), prefix edges coincide with syllable edges, even when the cluster would be a good onset within a word (9).

(8) Prefix-final Consonants before Vowel-Initial Words

a.	/des+igual/	[de.si.ɣwal]	*[des.i.ɣwal]	'unequal'
b.	/sub+alteɾno/	[su.βal.teɾ.no]	*[suβ.al.teɾ.no]	'subordinate'
c.	/in+espeɾado/	[i.nes.pe.ɾa.ðo]	*[in.es.pe.ɾa.ðo]	'unexpected'

(9) Prefix-final Consonants before Consonant-Initial Words

a.	/sub+lunaɾ/	[suβ.lu.naɾ]	*[su.βlu.naɾ]	'sublunar'
b.	/sub+lingual/	[suβ.liŋ.gwal]	*[su.βliŋ.gwal]	'sublingual'
c.	/ad+risar/	[að.ri.sar]	*[a.ðri.sar]	'to right (nautical)'

Within and across words, single intervocalic consonants syllabify with a following vowel, regardless of word or prefix boundaries. Though two consonants may form an onset word-internally, word and prefix-final consonants do not syllabify into a following consonant-initial word. The prefix boundary again acts like a word-boundary.

2. Theoretical analysis

The syllabification and alternation data show the similarity of prefix-final and word-final positions, which will motivate the treatment of prefixed words as having an internal word boundary, $[\text{pre}[\text{fix}]_{PW}]_{PW}$. In this section, I illustrate how constraints in an Optimality Theory analysis can provide the correct prosodic structure, for both syllabification and word structure, and propose the constraint family WEAK$|_{PW}$. In Section 3, I show how interactions of syllabification, word structure, and WEAK$|_{PW}$ constraints result in the data discussed in Section 1.

2.1 OT account of syllabification

I first analyze syllabification within simple words and across words, which is straightforward in an OT account (Prince and Smolensky 1993). The pressure for syllables to have onsets is called ONSET (10a). The pressure for word edges to align with syllable edges is captured by two alignment constraints (10b,c), parametrized for the left and right edges of the word. Although ultimately a low ranking constraint in Spanish, the constraint against codas, (10d), is present:

(10) a. ONSET — Syllables begin with a consonant.
b. ALIGN-L(PW,σ) — The left edge of the word and syllable coincide (formally: for every PW there must be some syllable such that the left edge of the PW and left edge of the syllable align).
c. ALIGN-R(PW,σ) — The right edge of the word and syllable coincide (formally the same as 10b, *mutatis mutandis*).
d. NOCODA — Syllables end with a vowel.

Within a word, ONSET and NOCODA decide the winner, and any ranking of the two gives the same result: maximization of the onset cluster, as in Tableau 1.[5]

Tableau 1. Maximizing Onsets, word-internally

Input /ablar/	ONSET	NOCODA	ALIGN-R/L(PW,σ)
☞ [.a.βlar.]	*	*	
[.aβ.lar.]	*	**!	
[.aβl.ar.]	**!	**!*	

Across word boundaries, if a word-final consonant is syllabified with a word-initial vowel, the word-syllable alignment constraints of (10b,c) are violated; these must be outranked by either ONSET or NOCODA, as in Tableau 2.

Tableau 2. Providing onsets, phrase-internally

Input /klub#elegante/	ONSET	NOCODA	ALIGN-R/L(PW,σ)
☞ [.klu.β][e.le.ɣan.te.]		*	*(L)*(R)
[.kluβ.][.e.le.ɣan.te.]	*!	**!	

5. There should also be a high ranked constraints which limit the clusters allowed in onsets, but such have already been developed elsewhere (see e.g., Colina 1997) and are beyond the scope of this paper.

As the losing candidate has more violations of both Onset and NoCoda than the candidate that violates word-syllable alignment, we cannot further rank the constraints from this example.

However, when a consonant-final word precedes a consonant-initial word, the ranking becomes clear. Here, word-syllable alignment is satisfied at the expense of a NoCoda violation, as in Tableau 3.

Tableau 3. Don't Maximize Onsets, phrase-internally

Input klub#lindo/	Onset	Align-R/L(PW,σ)	NoCoda
[.klu.β][lin.do.]		*(R)!*(L)!	*
☞ [.kluβ.][lin.do.]			**

Note that the high ranking of Onset will still guarantee that a single intervocalic consonant will syllabify with a following vowel, both within words and across them. Thus the ranking that gives us maximal onsets within words and syllabification across words only in cases in which a word would otherwise be onsetless is given in (11). Though the word alignment constraints are outranked, they assert themselves if Onset is already satisfied.[6]

(11) Onset >> Align-R(PW,σ), Align-L(PW,σ) >> NoCoda

2.2 OT account of word structure

To handle syllabification in prefixed forms, we require an analysis of the structure of prefixed words which is parallel in some sense to that of words in phrases, so that words in phrases and prefixes followed by bases show the same syllabificational behavior. However, prefixes do not stand alone as words, nor show the characteristics of prosodic words, such as stress, and they must therefore be kept structurally distinct from words. Following suggestions in Selkirk (1995) and Peperkamp (1997), I treat the prosodic word (PW) structure of Spanish as different for prefixed and suffixed words. A suffix coheres to the base within a single PW (12a), with no internal prosodic boundaries. A prefix, however, generates a recursive PW structure (12b), so that a PW edge intervenes between a prefix and the base. The base is a PW, and the combination of prefix and base is also a PW, but the prefix alone is not. Words in a phrase are distinct PWs (12c).

(12) Prosodic structure of words in Spanish
  a. morpheme + suffix $[.a.bl+a+r.]_{PW}$, $[.me.s+eh.]_{PW}$
  b. prefix + base $[.de.h[i.gwal.]_{PW}\,]_{PW}$, $[.sub.[lu.nar.]_{PW}]_{PW}$
  c. words in phrases $[.klub.]_{PW}[lin.do]_{PW}$

6. Nuñez-Cedeño and Morales-Front (1999) independently came to a similar description of these facts, though they only sketch the OT principles involved and do not develop the difference between prefixes and suffixes.

Peperkamp (1997) shows that prefixes are not incorporated into the base prosodic word, as suffixes are, based on two rules of Spanish which apply at the left edge of prosodic words: e-epenthesis and r-strengthening. These rules apply regardless of the presence of a prefix before the base, which must therefore begin its own prosodic word.[7] That the prefix is not an entire prosodic word in its own right is supported by its lack of stress.

The structure proposed in (12b) violates the Strict Layer Hypothesis (the SLH: Selkirk 1984), because the category PW dominates itself. The SLH normally requires that each element governs one or more units on the immediately lower category, and each lower category is exhaustively contained in one category on the immediately higher level, with reference to a hierarchy of Prosodic units as in (13a). The violation of the SLH in prefixed words is shown in (13b):

(13) a. Simplified Prosodic Hierarchy (Selkirk 1984)

Prosodic Phrase (Ph)
|
Prosodic Word (PW)
|
σ

b. Violation of SLH

PW
prefix PW

There are other exceptional cases in which prosodic words are seen as recursive; for example, compounds are often analyzed with each word of the compound as a PW and the combination also as a PW. For use in OT, the SLH has been broken into violable subconstraints (Selkirk 1995, Crowhurst 1996, Peperkamp 1997[8]). Selkirk (1995) also argues that the SLH places distinct conditions on lexical words, such as nouns and verbs, and non-lexical words, such as function words and prefixes. Alignment conditions require the edges of lexical words and prosodic words to align with each other, as in (14a,b), while (14c) limits recursivity, so that one element cannot dominate another on the same level of the hierarchy.

(14) a. ALIGN-L(Lex,PW): Align the left edge of every lexical word with the left edge of some prosodic word.
b. ALIGN-L/R(PW,Lex):[9] Align the left/right edge of every PW with the left/right edge of some lexical word.
c. NONRECURSIVITY: No C_i dominates C_j, $j = i$.

7. The reader is referred to her work for details of her arguments.

8. I diverge from Peperkamp's analysis by allowing word and syllable boundaries to be misaligned, a violation of PROPERNESTING (Peperkamp 1997). This constraint forces each lower element on the hierarchy to be properly contained in a higher level, and in particular, she refers to this constraint as requiring the readjustment of prosodic word boundaries so that each PW begins and ends at the end of a PW. In her account, the constraint is inviolable. However, OT proposes that constraints are generally considered violable; see Wiltshire (1999) for arguments that this constraint should be violable too.

9. The constraint combines two constraints, one aligning left edges of PWs and lexical words, and one aligning the right edges. The two need not be ranked independently here, so they have been combined, though I will indicate by the asterisk which edge is responsible for the violation.

The recursive structure in (12b) is motivated by the constraint aligning the left edge of lexical words to PWs (14a); a base word is a lexical word, while a prefix is not. That is, the requirement that a lexical word begins a prosodic word forces a word boundary inside the prefixed word; in Spanish, NonRecursivity must rank below Align-L(Lex, PW) so that recursivity can arise. In a suffixed word, the same constraints and ranking result in a non-recursive word, since the lexical word is aligned already at the left edge with a prosodic word. The ranking of the constraint that requires PWs to end at the end of lexical words prevents prefixes and suffixes from forming PWs themselves (14b). With (14a–b) ranked above (14c), a recursive word structure is preferred to incorporation of a prefix into the PW with the base, as in Tableau 4. Suffixes do not interfere with left edge alignment of a lexical word, and are incorporated into the base, as in Tableau 5.

Tableau 4. Prefixed word structure

Input /sub+lunaɾ/	Align-L(Lex,PW)	Align-L/R(PW,Lex)	NonRec
[.su.βlu.naɾ.]$_{PW}$	*!	*(L)	
[.suβ.]$_{PW}$ [lu.naɾ.]$_{PW}$		*(L)*(R)!	
☞ [.suβ.[lu.naɾ.]$_{PW}$]$_{PW}$		*(L)	*

Tableau 5. Suffixed word structure

Input /mes+es/	Align-L(Lex,PW)	Align-L/R(PW,Lex)	NonRec
☞ [.me.seh.]$_{PW}$		*(R)	
[.me.s]$_{PW}$ [eh.]$_{PW}$		*(R)*(L)!	
[[.me.s]$_{PW}$ eh.]$_{PW}$		*(R)	*!

Given the prosodic structure, the ranking previously used for syllabification within and across words applies in a straightforward way to explain the syllabification of prefixes, using the constraints from 2.1. The constraint forcing the alignment of the left edges of words and syllables, Align-L(PW,σ), accounts for the failure to syllabify across prefix boundaries as well. As Onset outranks Align-L(PW,σ), a consonant does syllabify across a prefix (word) boundary if the following PW is vowel-initial, as in Tableau 6. Before consonant-initial words, Onset is already satisfied, and alignment is obeyed at the expense of a NoCoda violation, as in Tableau 7.

Tableau 6. Provide Onsets, in complex words (cf. Tableau 2)

Input /sub+ordinado/	Onset	Align-L/R(PW,σ)	NoCoda
☞ [.su.β[or.di.na.ðo]$_{PW}$]$_{PW}$		*(L)	*
[.suβ.[or.di.na.ðo]$_{PW}$]$_{PW}$	*!		**

Tableau 7. Don't Maximize Onsets, in complex words (cf. Tab. 3)

Input /sub+lunaɾ/	Onset	Align-L/R(PW,σ)	NoCoda
[.su.β[lu.naɾ.]$_{PW}$]$_{PW}$		*(L)!	*
☞ [.suβ.[lu.naɾ.]$_{PW}$]$_{PW}$			**

In addition to accounting for the parallels of syllabification across word and prefix boundaries, these PW structures enable us to account for the various locations of /s/ aspiration, /n/ velarization, and /ɪ/ fortition in different dialects. All three involve a family of constraints I call Weak$|_{PW}$, to which I now turn.

2.3 Introducing Weak$|_{PW}$

Cross-linguistically, processes of weakening have tended to be of two types: loss of marked features (neutralization) and increase of sonority (lenition) (Vijayakrishnan 1999). Both types of weakening have been found in similar positions, such as intervocalic position, syllable-finally (or in codas), and word-finally (Lavoie 2000). While many accounts have relied on coda position alone for lenition and neutralization, it is possible for coda and word-final position to place independent constraints on their content; thus constraints referring to both prosodic units are necessary (Wiltshire 2003). The constraint family I propose here, Weak$|_{PW}$ is a cover term for a family of markedness constraints reducing contrasts and increasing sonority in word-final position, parallel to constraints on syllable-final (coda) position.

(15) Weak$|_{PW}$: Be weak before word boundaries.[10]

I consider this term to stand for a family of constraints rather than a monolithic force,[11] but use the cover term here to elucidate the similarity in the alternations being discussed. Similarly, we might use Weak$|_{\sigma}$ to stand for constraints weakening coda consonants, whether by increasing their sonority or reducing their featural content. The constraint family should also extend to word-final vowels, which Prince and Smolensky (1993) note "are liable to de-stressing, de-voicing, shortening, truncation, and so on," in final open syllables (1993: 101).

The absence of fortition when otherwise expected in Argentinian Spanish refers to weakness in the sonority sense. The issue of segment strength or weakness as a function of sonority is not controversial: "a consonant strength hierarchy is basically an inverted sonority hierarchy" (Lavoie 2000:213). Such hierarchies consistently rank approximants and vowels as weaker than fricatives (Clements 1990).

(16) Sonority Hierarchy (Clements 1990:292)
(strong) obstruent < nasal < liquid < glide < vowel (weak)

10. Vijayakrishnan (1999) discusses weakening in terms of alignment, and uses both left and right edges. The data discussed here require refering to positions preceding any type of PW boundary, but the distinction between edges is useful in analyzing additional variation in aspiration varieties, as was shown in Wiltshire (2002). As prefix and word-final positions act the same in some dialects, the constraint needs to refer to segments preceding any type of boundary.

11. If it were a single constraint, we would predict a link between the contexts of different kinds of weakening in the each dialect. Harris (1983) claims that processes such as aspiration and velarization can be independent, and Lipski (1994) supports this claim with details of numerous dialects in which aspiration and velarization are not linked.

While fortition in Argentinian Spanish changes a vocoid to a fricative in onsets, the Weak$|_{PW}$ constraint favors more sonorous outputs prefix and word-finally.

Weakness in terms of feature loss has been less widely discussed, though it can be seen as the converse of the special licensing properties of onset and word-initial positions, which have been both cross-linguistically and psycholinguistically motivated (Beckman 1998). Spanish /s/-aspiration and /n/-velarization have been described as debuccalization, the loss of features of supralaryngeal articulation (Trigo 1988, Lavoie 2000); Weak$|_{PW}$ constraints would thus favor [h] and [ŋ] prefix and word-finally, as they contain fewer featural specifications than [s] and [n].

In my view, Spanish syllabification, aspiration, velarization, and fortition have attracted attention because the allophonics of consonants may depend on word-final position independently from coda position; analyses that tried to rely on coda position alone required ordering syllabification, allophonic rules, and resyllabification or adding new types of constraints to OT (see Section 4). My proposals in this section provide for a surface-based analysis of the allophonics, and below I present aspiration, velarization, and fortition using constraints at the edges of PWs both to syllabify and to account for alternations themselves.

3. Analyses of Spanish varieties using Weak$|_{PW}$

3.1 Aspiration in Caribbean I Spanish

In dialects that aspirate, the change from input /s/ to output [h] means that an input coronal fricative surfaces as a laryngeal, incurring a violation of the following constraint:

(17) Max-IO(SL) Supralaryngeal nodes present in the input must be present in the output. (Colina 2002)

In order for aspiration to happen at all, this constraint must be outranked by constraints that condition aspiration. In all aspirating dialects, one conditioning context is coda position, here embodied as the constraint (18a). In dialects that produce [h] for /s/ at prefix and word boundaries even pre-vocalically, a constraint against /s/ before a word boundary (18b) is also highly ranked:

(18) a. *s$|_{\sigma}$ No [s] before syllable boundary (member of Weak$|_{\sigma}$ family)
b. *s$|_{PW}$ No [s] before word boundary (member of Weak$|_{PW}$ family)

While these are likely too specific to serve as good candidates for universal constraints, the intuition behind them is that a more fully specified segment is disfavored in the weak positions, before syllable and word-boundaries; I leave their exact formulation for future research.

The analysis proceeds as in Tableau 8, in one parallel evaluation. Note that the prosodic structure and the syllabification of these words are also determined by the parallel analysis of ranked constraints. The prosodic structures remain the same in dialects whose contexts for aspiration differ; only the constraint ranking relevant to the realization of the allophones differs. Ranking Weak$|_{PW}$ below Max-IO(SL), with Weak$|_{\sigma}$ above them, gives a variety that aspirates only in codas, whether internally, in prefixes, and word-finally, such as Buenos Aires Spanish (Kaisse 1999). Ranking Max-IO(SL) above both Weak constraints gives a dialect with no aspiration at all.

Tableau 8. Caribbean Spanish I Aspiration (Revised from Wiltshire, 2002)

Structures & Input	Candidate Outputs	Weak$\|_{PW}$	Weak$\|_{\sigma}$	Max-IO(SL)
[internal]$_{PW}$	[dis.ko]		*!	
/disko/	☞ [dih.ko]			*
/asul/	☞ [a.sul]			
	[a.hul]			*!
[morph – suf]$_{PW}$	[djes.mo]		*!	
/dies-mo/	☞ [djeh.mo]			*
/dies-es/	☞ [dje.seh]			*
	[dje.heh]			**!
[pre[morph]$_{PW}$]$_{PW}$	[des.[kremaða]]	*!	*!	
/des + kremada/	☞ [deh.[kremaða]]			*
/des + igual/	[de.s[igwal]	*!		
	☞ [de.h[igwal]			*
[word]$_{PW}$[word]$_{PW}$	[bitʃos].[raroh]	*!	*!	*
/bitʃos/ /raros/	☞ [bitʃoh].[ra.roh]			**
/bitʃos/ /estraɲos/	[bitʃo.s][eh.traɲoh]	*!		**
	☞ [bitʃo.h][eh.traɲoh.]			***

3.2 Velar nasals in Granadan Spanish

The same analysis as presented for /s/-aspiration can be applied to /n/-velarization as well, by treating "velarization" similarly as debuccalization, the loss of features of supralaryngeal articulation (Trigo 1988). A change from input /n/ to output [ŋ] incurs violations of Max-IO(SL), which must therefore be outranked by constraints that favor [ŋ] in dialects that velarize. In all such dialects, one conditioning context is coda position, as in (19a). In dialects with [ŋ] for /n/ at prefix and word boundaries even pre-vocalically, the analysis requires the high ranking of a constraint against nasals having place of articulation before a word boundary (19b):

(19) a. *n$|_{\sigma}$ No nasal place before syllable boundary (member of Weak$|_{\sigma}$ family)
b. *n$|_{PW}$ No nasal place before word boundary (member of Weak$|_{PW}$ family)

The analysis proceeds as in Tableau 9 below; again, the prosodic structure and syllabification of these words are also determined by the parallel analysis of ranked constraints. Syllabification remains the same across dialects, while the realization of consonantal allophones can differ. A dialect with velarization only in codas can be accounted for by reranking, as can one in which there is no velarization at all, while all dialects of Spanish share the same syllabification and word structure.

Tableau 9. Granadan Spanish velarization

Structures&Input	Candidate Outputs	Weak$\|_{PW}$	Weak$\|_{\sigma}$	Max-IO(SL)
[internal]$_{PW}$ /fin+es/ 'ends' /kanta+n/ 'they sing'	☞ [fi.neh]			
	[fi.ŋeh]			*!
	[kan.taŋ]		*!	
	☞ [kaŋ.taŋ]			*
[pre[morph]$_{PW}$]$_{PW}$ /en+amora/ 'enamors' /en+kuadrar/ 'to frame'	[e.n[a.mo.ra]]	*!		
	☞ [e.ŋ[a.mo.ra]]			*
	[en.[kwa.drar]]	*!		
	☞ [eŋ.[kwa.drar]]			*
[word]$_{PW}$[word]$_{PW}$ /sin//eso/ 'without that' /sin/ /fin/ 'without end'	[si.n][e.so]	*!		
	☞ [si.ŋ][e.so]			*
	[sin][.fiŋ]	*!		
	☞ [siŋ][.fiŋ]			**

3.3 Fortition in Argentinian Spanish

In Argentinian Spanish, we saw unusual behavior for high vocoids at prefix and word boundaries, compared to the general fortition found in the dialect. The constraint Weak$|_{PW}$ plays a new role here, blocking a process rather than triggering it. I first sketch the Baker and Wiltshire (2003) analysis of fortition here, and then show its interaction with Weak$|_{PW}$.

Baker and Wiltshire (2003), taking the vocoid /ɪ/ to be the underlying segment, motivate fortition to [ʒ] with the constraint Honset, modeled after Hnuc of Prince and Smolensky (1993). Like Hnuc, Honset is a gradient constraint that compares the sonority of different candidates, here favoring candidates of lesser sonority (hence, greater strength) in onsets.

(20) Honset: Be strong in onsets.

What determines 'how far a segment strengthens' depends on the language-specific ranking of feature faithfulness constraints relative to Honset, the underlying segment in the input, and constraints on output segments. In addition to Honset, Onset also plays a part here. As Harris and Kaisse recognize, "glides are onsets if nothing better is available" (1999:126). In order to satisfy the markedness constraints, we see violations of a lower ranked faithfulness constraint, which requires an input segment to maintain its various features in output:

(21) Identity IO[F]:Correspondent segments have identical values for feature F.

With our two markedness constraints — militating for onsets, and the stronger the better — ranked above (21), we see fortition. Word-internal /ɪ/ is syllabified in onset position to satisfy Onset and strengthened to [ʒ] to satisfy Honset (Tableau 10). Violations of Honset are marked only for the relevant segment here, the underlying /ɪ/. On the continuum from / I > j > ʝ > ʒ /, a candidate receives an * for each step of distance to the endpoint [ʒ].[12] With a low ranking of Ident-IO, the candidate which provides the strongest onset wins.

Tableau 10. *tramoya* 'trick'

/tramoɪ+a/	Onset	Honset	Ident-IO
[tra.moj.a]	*!		
[tra.mo.ja]		j**!	
☞ [tra.mo.ʒa]			*

Fortition is also seen word-internally in suffixes beginning with the /ɪ/. In Spanish verb paradigms, where /ɪ/ is the initial segment of third person preterit suffixes in -er/-ir verbs, we find these high vocoids are syllabified in an onset position when they are added to verb roots ending in a vowel, making them susceptible to fortition:

Tableau 11a. *creyo* 'he believed'

/kre+Io/	Ons	Honset	Id-IO
[krej.o]	*!		
[kre.jo]		j*!*	
☞ [kre.ʒo]			*

Tableau 11b. *creyeron* 'they believed'

/kre+Ieron/	Ons	Honset	Id-IO
[krej.e.ron]	*!		
[kre.je.ron]		j*!*	
☞ [kre.ʒe.ron]			*

Fortition does not occur, however, when the verb root ends in a consonant because Spanish prefers to syllabify the final consonant in the next syllable with the following glide. Following Harris (1983), Hualde (1992) and Rosenthall (1997), we analyze this as glides joining vowels in the nucleus whenever Onset is otherwise satisfied. This results in better satisfaction of the NoCoda constraint, and avoids the issue of Honset.

Tableau 12. *creció* 'he grew'

/kres+Io/	Onset	Honset	Ident-IO	NoCoda
[kres.jo]		j**!		*
[kres.ʒo]			*!	*
☞ [kre.sjo]		N/A		

Now we are ready to analyze vocoid fortition in prefixed environments and between words. Remember that while [ʒ] appears word-initially, whether after prefixes or after words, fortition does not occur when the relevant vocoid is at the end of the prefix or word. Prosodic word boundaries interact with both fortition and onset formation, in both prefixal and phrasal cases.

The internal PW boundary results in two differences in the output of the vocoid in prefixed forms vs morpheme-internally. The first difference is due to syllabification. On the model of *creció* [kre.sjo], we might expect *[de.sje.mar] for *desyemar*, with a lack of fortition where a prefix-final consonant can syllabify into onset and push the glide into the following nucleus. However, the PW boundary after the prefix /des-/ prevents a base-initial vocoid from being pushed aside by a different onset. Prefix-final

12. For further details, such as how outputs like [dʒ] are blocked, please see Baker and Wiltshire (2003).

/s/ remains in syllable-final position, the left edge of the stem remains aligned, and vocoid fortition occurs: [des.ʒe.mar]. As in Section 2.2, Align-L (PW,σ) outranks NoCoda to ensure that syllabification does not cross the PW boundary solely to prevent a coda violation:

Tableau 13. *desyemar* 'to de-yolk'

/des- + Iemar/	Align-L (PW,σ)	NoCoda	Honset	Ident-IO
[de.h[je.mar]]	*!			
[deh.[je.mar]]		*	j*!*	
☞ [deh.[ʒe.mar]]		*		*

Between words, the same constraint ranking ensures an equally felicitous output: e.g. *buenas yemas* 'good yolks' [bwe.nas].[ʒe.mas].

The second difference is the prefix- and word-final failure to strengthen even when the vocoid is or could be syllabified into onset position; this difference is attributed to the Weak$|_{PW}$ constraint. That is, on the model of /tramoɪ+a/ becoming [tra.mo.ʒa], we might expect word-final glides syllabified into onset position to strengthen. We do see onset formation across the PW boundary, as in *rey alto* [re.jal.to], which is expected from our ranking of Onset above Align-L. However, fortition is unattested here, making *[re.ʒal.to] ungrammatical, although it is preferred by Honset. The constraint Weak$|_{PW}$ counters fortition before PW boundaries, preventing the problematic *[re.ʒal.to] from winning. We leave Weak$|_{PW}$ ranked alongside Onset, as there is no conflict between them.

Tableau 14. *rey alto* 'tall king'

/reɪ + alto/	Weak$\|_{PW}$	Ons	Align-L(PW, σ)	Honset	Ident-IO
[rej.][al.to]		*!			
☞ [re.j][al.to]			*	j**	
[re.ʒ][al.to]	*!		*		*

Weak$|_{PW}$ also solves the analysis of a prefixed word such as *antiácido*, parsed with hiatus by Hualde (1992):

Tableau 15. *antiácido* 'antacid'

/antɪ+asido/	Weak$\|_{PW}$	Ons	Align-L(PW, σ)	Honset	Ident-IO
☞ [an̪.ti.[a.si.ðo]]		*			
[an̪.tj[a.si.ðo]]	*		*!*		
[an̪t.ʒ[a.si.ðo]]	*		*!		*

The winning candidate is more harmonic than candidates with glides or fricatives in terms of Weak$|_{PW}$, since the vowel is more sonorous, hence weaker, than either. With a tie between the higher-ranked constraints, the decision is left to lower-ranked Align. This ranking also accounts for hiatus across independent words, where, as observed by Harris and Kaisse "hiatus between words is the norm for most speakers" (1999:143).

Tableau 16. *yeti amigo* 'friendly yeti'

/ɪetɪ +amɪgo/	WEAK|$_{PW}$	ONS	ALIGN-L(PW, σ)	HONSET	IDENT-IO
☞ [ʒe.ti].[a.mi.ɣo]		*			
[ʒe.tj][a.mi.ɣo]	*		*!*		
[ʒet.ʒ][a.mi.ɣo]	*		*!		*

To summarize in a form comparable to Tableaux (8–9) in the previous sections, we have the parallel analysis of words and phrases with different structures:

Tableau 17. Argentinian Spanish Fortition

Structures&Input	Candidate Outputs	Wk|$_{PW}$	ONS	ALIGN-L (PW,σ)	HONS	ID-IO(F)
[internal]$_{PW}$ /plaɪ+a/ 'beach'	☞ [pla.ʒa]					*
	[pla.ja]				j**!	
/desɪert+o/ 'desert'	[deh.ʒer.to]					*!
	☞ [de.sjer.to]					
[pre[morph]$_{PW}$]$_{PW}$ /antɪ+asido/ 'antacid'	[an̪t.ʒ[a.si.ðo]]	*		*!		*
	☞ [an̪.ti.[a.si.ðo]]		*			
/des+Iemar/ 'to de-yolk'	☞ [deh.[ʒe.mar]					*
	[de.s[je.mar]			*!		
[word]$_{PW}$[word]$_{PW}$ /mas//ɪelo/ 'more ice'	☞ [mah].[ʒe.lo]					*
	[ma.s][je.lo]			*!		
/reɪ/ /alto/ 'tall king'	[re.ʒ][al.to]	*!				*
	☞ [re.j][al.to]			*	j**	
/ɪetɪ/ /amɪgo/ 'friendly yeti'	[ʒet.ʒ][a.mi.ɣo]	*		*!		*
	☞ [ʒe.ti].[a.mi.ɣo]		*			

4. Comparison with other accounts

A considerable number of other accounts have been proposed for various pieces of this data, e.g., Hualde 1992, Harris 1993, Kaisse 1999, Harris and Kaisse 1999, Kenstowicz 1996, Colina 1997, Face 2002, Colina 2002. Previous attempts within rule-based approaches and OT have proven to be more complex or less adequate in coverage.

Rule-based approaches divide syllabification into stages, building the nucleus, simple onset, complex onset, and coda; these apply in order word-internally (Hualde 1992, Harris 1993). After words are put into phrases, the simple onset rule reapplies, but the complex onset rule does not, in order to handle the difference between word-internal vs. cross-word syllabification. As Colina (1997) notes, this is an *ad hoc* restriction, unrelated to the motivation of the ONSET constraint. Furthermore, for aspirating varieties, rule-based approaches must order syllabification both before and after the rule of aspiration (Kaisse 1999), and, similarly, for fortition in Argentinian Spanish, Harris and Kaisse (1999) require extensive ordering. Though ordering simplifies the environment for a given alternation, such accounts suffer from unmotivated complexity, including abstract syllabifications and opacity, since segments appear in surface positions which would not trigger the rule (onset, not coda, for example). This critique holds true also for any OT account which allows for two levels of syllabification, for example Peperkamp (1997), whose analyses refer to an initial syllabification of the prefix alone, followed by one constraint ranking, in turn followed by resyllabification and a new ranking.

However most analyses within OT syllabify only once, and characterize aspiration, velarization, and fortition contexts as directly related to the surface forms. Previous accounts in OT of aspiration in Spanish (Kenstowicz 1996, Colina 1997, Face 1999, Colina 2002) also can claim some of the same advantages as my account here: they avoid resyllabification and refer only to output. However, they generally assume that aspiration is tied to coda position and add constraints that compare one output form to another. Kenstowicz (1996) extends correspondence constraints from Input-Output and Base-Reduplicant relationships to Uniform Exponence, an early Output-Output constraint.

(22) Uniform Exponence (UE): minimize the differences in the realization of a lexical item (morpheme, stem, affix, word).

This constraint requires lexical items that do not occur independently to match their own output shape in other forms. Kenstowicz uses UE to compare the realization of the prefix /des/ before a vowel-initial word with its realization before a consonant-initial one [deh]. Dialects in which aspiration applies prefix-finally (even before vowels) do so because of UE, and different dialects interpret the UE differently, which is problematic. Furthermore, since /des/ does not occur independently, it is difficult to evaluate the constraint; how does the prefix know to match its realization before a consonant-initial word, rather than vice versa?

Colina (2002) improves on Kenstowicz (1996) by considering the PW structure for prefixed words, and proposing a recursive word structure for Caribbean I varieties. However, she relies on a constraint similar to UE, in this case an Output-Output constraint on identity in the realizations of Prosodic Words; specifically, as she is analyzing aspiration, the constraint is IdentPrWd(SL). This constraint is interpreted as applying not only to prosodic words, but also to the prefixes adjoined to them in a recursive PW structure. In a prefixed form such as /des+igual/ 'unequal', the output is determined using both the input and an output [deh], with the high ranking of IdentPrWd(SL) choosing the output [de.hi.gwal]. Although Colina (2002) addresses the question of how the prefix knows to compare itself to the output [deh] in such cases, the answer involves a rather complex procedure. The grammar must really compare two types of forms at once, preconsonantal and prevocalic, to determine that the set with inputs /des+ kremada/, /des+igual/ and outputs [deh.kre.ma.ða], [de.hi.gwal] is superior to the set with the same inputs and outputs [des.kre.ma.ða],[de.si.gwal]. Both sets satisfy IdentPW(SL) but only the first contains no violations of her high ranked *s]coda constraint. This means that the output [deh] in [de.hi.gwal] is being chosen based on analogy with a different word in which is the /s/ appears in coda position. While this is possible using Output-Output constraints, it is certainly more complex than the account proposed here, in which outputs for the input /des+igual/ can be evaluated based soley on the input and constraint rankings, not on other output forms.

Another potentially serious problem with the interpretation of the IDENTPW(SL) constraint is that in order to handle dialect differences, Colina must rearrange the PW structure of prefixed words in different dialects. The implications of this move on syllabification are unclear; it is also unclear whether there is any other motivation for restructuring PWs in different varieties of Spanish. A similar analysis is presented in Face (2002), who analyzes prefixes as independent phonological domains (PDs). He modifies UE to the constraint UE-PD, and claims that UE-PD forces prefix-final /s/ to match the form of the prefix in preconsonantal position, where aspiration is forced by some high ranking constraint.

(23) UE-PD: minimize the differences in the realization of a phonological domain (Face 1999)

However, the PD analysis gives prefixes the same status as words, leaving their lack of stress to stipulation. Apart from problems with the term PD, the problem of dialect variation remains. As Face explains both syllabification and aspiration by "PDs", changing their structure for different aspiration facts in other varieties would also result in different syllabifications. Such accounts are therefore unable to simultaneously handle the similarities (syllabification) as well as the differences (location of aspiration) in different dialects.

One further possible OT analysis would be to follow the approach here, except to change perspective from positional markedness constraints (weakening in weak position), to a purely positional faithfulness account (strong segments survive only in strong positions). That is, rather than the WEAK$|_{PW}$ constraints, we rely on $_{PW}|$STRONG constraints. For the aspiration analysis, these would be $_{PW}|$s and $_{\sigma}|$s ranked above a general constraint against *[s], forcing [h] to surface in non-word-initial or non-syllable-initial positions. However, for dialects in which prefix and/or word-final /s/ is realized as [h] despite being in syllable-initial position, the ranking would have to demote $_{\sigma}|$s below *[s], with the unfortunate result that only word-initial [s]'s surface, and all others would incorrectly become [h] too (e.g., *[.me.heh.] for [.me.seh.]). Thus the analysis of aspiration requires a positional markedness constraint approach.

5. Conclusions

My analysis provides for syllabification, segmental alternations, and dialectal variations in Spanish with independently motivated constraints on prosodic structures. There are several advantages to this account. I have captured the locations of aspiration, velarization, and fortition in different dialects while maintaining a uniform syllabification and uniform prosodic word structure for all varieties of Spanish. We do not need rule ordering, abstract syllabifications, derivational levels, Output-Output constraints, or prosodic restructuring for dialect variation. My analysis of word structure as independent of syllabification allows for an account of these phenomena as relating to word edge positions in a monostratal version of OT. While other proposals each offer a subset of these advantages, none offers all the advantages to the account proposed here.

References

Baker, G.K. and Wiltshire, C.R. 2003. An OT treatment of palatal fortition in Argentinian Spanish. In *Romance linguistics: Theory and acquisition*, A.T. Pérez-Leroux and Y. Roberge (eds), 33–48. Amsterdam: John Benjamins.

Beckman, Jill. 1998. Positional Faithfulness. PhD Dissertation, University of Massachusetts, Amherst MA.

Clements, G.N. 1990. The role of the sonority cycle in core syllabification. In *Papers in Laboratory Phonology* 1: *Between the grammar and physics of speech,* J. Kingston and M. Beckman (eds), 283–333. New York NY: CUP.

Colina, S. 2002. Interdialectal variation in Spanish /s/ aspiration: The role of prosodic structure and output-to-output constraints. In *Structure, Meaning, and Acquisition in Spanish: Papers from the 4th Hispanic Linguistics Symposium*, J. Lee, K. Geeslin, and J.C. Clements (eds), 230–243. Somerville MA: Cascadilla.

Colina, S. 1997. Identity constraints and Spanish resyllabification. *Lingua* 103: 1–23.

Crowhurst, M. 1996. An optimal alternative to conflation. *Phonology* 13: 409–424.

Face, T.L. 2002. Re-examining Spanish 'Resyllabification'. In *Current Issues in Linguistic Theory: Selected Papers from the XXIXth Linguistic Symposium on Romance Languages,* D. Cresti, T. Satterfield and C. Tortora (eds), 81–94. Amsterdam: John Benjamins.

Guitart, J. 1979. On the true environment for weakening and deletion in consonant-weak Spanish dialects. Paper presented at the Conference on Non-English Language Variation in the Western Hemisphere, University of Louisville.

Harris, J.W. 1993. Integrity of prosodic constituents and the domain of syllabification rules in Spanish and Catalan. In *The View from Building 20*, K. Hale and S.J. Keyser (eds), 177–194. Cambridge MA: The MIT Press.

Harris, J.W. 1983. *Syllable Structure and Stress in Spanish*. Cambridge MA: The MIT Press.

Harris, J.W. and Kaisse, E.M. 1999. Palatal vowels, glides and obstruents in Argentinian Spanish. *Phonology* 16: 117–190.

Hualde, J.I. 1999. Patterns in the lexicon: Hiatus with unstressed high vowels in Spanish. In *Advances in Hispanic Linguistics,* J. Gutiérrez and F. Martínez-Gil (eds), 182–197. Somerville MA: Cascadilla.

Hualde, J.I. 1992. On Spanish syllabification. In *Current Studies in Spanish Linguistics*, H. Campos and F. Martínez-Gil (eds), 475–93. Washington DC: Georgetown University Press.

Kaisse, E. 1999. Resyllabification precedes all segmental rules. In *Formal Perspectives on Romance Linguistics*, M. Authier, B. Bullock and L. Reed (eds), 197–210. Amsterdam: John Benjamins.

Kenstowicz, M. 1996. Base-identity and uniform exponence: Alternatives to cyclicity. In *Current Trends in Phonology:Models and methods*, Vol 1., J. Durand and B.Laks (eds), 363–393. Salford: ESRI.

Lavoie, L.M. 2000. Phonological Patterns and Phonetic Manifestations of Consonant Weakening. PhD dissertation, Cornell University.

Lipski, J. 1994. *El español de América*. Madrid: Longman.

Núñez-Cedeño, R.A. and Morales-Front, A. 1999. *Fonología generativa contemporánea de la lengua española.* Washington DC: Georgetown University Press.

Peperkamp, S. 1997. *Prosodic Words* [HIL dissertations 34]. Den Haag: HAG.

Prince, A. and Smolensky, P. 1993. *Optimality Theory* [Technical Report 2]. New Brusnwick NJ: Rutgers.

Rosenthall, S. 1997. *Vowel/Glide Alternation in a Theory of Constraint Interaction*. New York NY: Garland.

Selkirk, E. 1995. The prosodic structure of function words. In *Papers in Optimality Theory*, J. Beckman, L. Walsh-Dickey, and S. Urbanczyk (eds), 439–469. Amherst MA: GLSA.

Selkirk, E. 1984. On the major class features and syllable theory. In *Language Sound Structures.* M. Aronoff and R. Oehrle (eds), 107–136. Cambridge MA: The MIT Press.

Trigo, L.R. 1988. On the Phonological Derivation and Behavior of Nasal Glides. PhD dissertation, MIT.

Vijayakrishnan, K.G. 1999. Weakening processes in the optimality framework. Ms, Rutgers Optimality Archive.

Wiltshire, C. 1999, Review of *Prosodic Words*, by S. Peperkamp. *Glot International* 4(4): 16–18.

Wiltshire, C. 2003. Beyond codas: Word and phrase final alignment. In *The Syllable in Optimality Theory*, R. Van der Vijver and C. Fery (eds), 254–268. Cambridge: CUP.

Wiltshire, C. 2002. Variation in Spanish and prosodic boundary constraints. In *Current Issues in Linguistic Theory: Selected Papers from the XXIXth Linguistic Symposium on Romance Languages,* D. Cresti, T. Satterfield and C. Tortora (eds), 362–376. Amsterdam: John Benjamins.

Optimality Theory and language change in Spanish*

D. Eric Holt
University of South Carolina

The present chapter discusses Optimality-Theoretic approaches to language change in Spanish, reviewing a number of works that invoke not only the interaction of faithfulness and markedness constraints, but also the role of perceptual, cognitive, systemic and external influences on linguistic structure and change at the level of segment and segmental inventory, syllable- and prosodic structure, and intersecting points of morphology, and mentions formal considerations that impact these. The chapter concludes with an appendix that attempts to list all works published to date that treat language change and variation in Spanish and Hispano-Romance from an OT perspective.

Keywords: Dispersion Theory, intrusive stop formation, language change (phonological, morphological), lexicon optimization, markedness, metathesis, Optimality Theory, sonority, sporadic sound change, syllable structure, underspecification

0. Introduction

Not long after the circulation of the earliest manuscripts in Optimality Theory (OT; Prince and Smolensky 1993, McCarthy and Prince 1993a,b), its application to language change was initiated (e.g., Jacobs 1995, Gess 1996, Holt 1997). While historical OT analyses frequently rely on traditional argumentation to sustain them, they are often innovative and allow for the establishment of a relation between changes that were not seen as interrelated previously. Likewise, OT approaches have been successful at incorporating or recovering previous insights into the new theoretical machinery (e.g., functional notions), where previous generative approaches typically viewed the rule component of a language, and changes to it, as the proper object of inquiry.

* The discussion presented here of OT and language change in general draws heavily from Holt (2003b), though the present work concentrates on Hispano-Romance. Thanks to two anonymous reviewers and to the editors for their comments; all inadequacies remain mine.

The question naturally arises for the historical linguist, How is language change to be characterized within a constraint-based approach that intends to be universal? An obvious answer, given the nature of OT, is via the divergent ranking of constraints; that is, that the history of a language might be viewed as being composed of a series of stages, each of which exhibits a specific constraint hierarchy. Slight reranking of the constraint hierarchies, that is, variation in the relative importance of the constraints from one language to another and from one time period to another, would elegantly capture variation in the syllable structure and phonological/phonetic forms of a given language family. Additionally, listener-oriented factors, like the effects of perception and reinterpretation by the hearer (as by the OT notion of lexicon optimization, related to the traditional concepts of reanalysis and restructuring) may play a role in the historical development of certain phenomena (e.g., Holt 1997). Likewise, several phonological processes and historical changes may be seen as interrelated, for example the impact caused by the loss of contrastive vowel length in Latin on the subsequent simplification of moraic (syllable-final and geminate) consonants from Latin to Hispano-Romance (Holt 1997, 2003b). The contributions to the recent volume on Optimality Theory and language change (Holt 2003a), while disparate in their specific implementation of OT, explore these themes, and make a strong contribution to the study of the fields of language change, Optimality Theory, and linguistic theory more broadly.

The present chapter will offer an overview of the questions that theoretical treatments (both standard generative and Optimality-Theoretic) sought to answer and discusses the results they obtained. A survey follows of a number of works in OT that emphasize the role of perception, cognition, systemic and external influences on linguistic structure and change specifically in Spanish and Hispano-Romance. Topics addressed will include the segment and segmental inventory, syllable- and prosodic structure, and morphological issues.

An appendix to the chapter attempts to list all works published to date that treat language change in Spanish and Hispano-Romance from an OT perspective.

1. Generative grammar and historical change in Hispano-Romance

One of the best-studied language families is Romance, and the earliest investigations of it (e.g., Diez 1874, Meyer-Lübke 1895 and particularly for Hispano-Romance, Menéndez Pidal 1904, Lapesa 1986, Lloyd 1987, Malkiel 1963–4 and Penny 1991) provided painstaking collections of data, along with many insightful observations that still serve as the foundations upon which current investigations frequently build. As Malkiel (1963–4:144) acknowledges, it is also important that matters of theory be addressed, though philologists and generative linguists have different ideas regarding 'theoretical refinement'. Under generative grammar (Chomsky 1957, 1965, Chomsky and Halle 1968) historical change is characterized differently. Hartman (1974:123), in discussing phonology, summarizes this shift in perspective:

> Kiparsky (1965) and King (1969) — with the impetus of Halle (1962) — have given us a theory of language change that differs from earlier theories in that it implies that language history is two-dimensional: that is, a historical grammar is not simply a list of sound-change laws in chronological order, but a diachronic series of synchronic grammars. Each synchronic grammar consists of a list of ordered rules, and historical changes include not only rule addition, but also rule loss, rule reordering, rule simplification, and restructuring of underlying forms. It is these additional types of change — principally rule reordering and simplification — that make phonological history different from synchronic phonology and thus interesting in its own right.

That is, "what really changes is not sounds, but grammars" (Postal 1968:270). This is because once the system of rules and the underlying forms of two languages are established, changes in the phonology between the two stages or varieties are logically limited to changes in the form, order or inventory of rules, or in the underlying representations. Language change, under this view, is not defined within a single grammar but is a description of a relationship between grammars (as noted by Reiss 2003).

Regarding the rule component, there were argued to be cases of rule *addition* (i.e., innovation), *loss*, *reordering* and *inversion*. Rule addition was the only type of change that could affect adult grammars (presumably occurring only at the end of the application of the system's rules, so that it would have only its effect, and allow communication with speakers who lacked the innovation); the others occurred between generations of language speakers.

Examples from the history of Spanish would include, for instance, the innovative palatalization of /l/ after /k/, the lexicalization of palatal *ll* from the initial clusters *pl, fl, cl* (*llover, llama, llave*), or the creation of *ch* from these same clusters postnasally (*ancho, hinchar, mancha*). Likewise, we may speak here of the loss of the rule of palatalization of the /l/ in the Latin clusters, and of their devoicing, as these phenomena have not persisted into Modern Spanish. (These data are treated in OT in Holt 1997, 1998, discussed below.) A case of rule reordering might be taken to obtain between dialectal treatments of /s/-aspiration and cross-morphemic syllabification. That is, in some dialects syllable-final /s/-aspiration appears to occur before syllabification across words (/mas o menos/ > [má-ho-mé-noh]; /nos+otros/ > [no-hó-troh], with aspiration, then resyllabification), and in others after resyllabification, (/mas o menos/ > [má-so-mé-noh]; /nos+otros/ > [no-só-troh], with resyllabification, then aspiration).

Rule inversion might be exemplified by certain cases of morpho-syntactic hypercorrection, as perhaps in the extension (overgeneralization) of second person singular *-s* in nonstandard Spanish to the preterit forms (e.g., *comistes* 'you ate', like present tense *comes*, versus standard *comiste*). (Similar data are treated in OT in Martínez 2000. See Bermúdez-Otero and Hogg 2003 for a treatment of rule innovation, loss and inversion in the history of English.)

Restructuring is the other locus of language change, presumed to be limited to the acquisition process of children, where discrete breaks in language learning between generations occur, as children may formulate a different set of rules than that of their parents, and reorganize the modifications of the parents' speech into a more systematic, simpler version of the grammar (Halle 1962, discussed in Labov 1972). This may have a profound effect on the lexicon, as the effects of innovative categorical rules may be transferred to the representations of underlying forms. This accords with Postal's (1968) Naturalness Condition, which demands that underlying representations be identical to phonetic representations unless required otherwise by evidence. (A similar point could be made regarding the relationship between sound change and analogy.)

McMahon (1994:44 et passim) points out several problems with classical generative approaches, for instance, the lack of evidence to support the assertion that languages are evolving to an ever more simple state; likewise, it is clearly the case that some rules introduce complexity/irregularity into the grammar, while other changes, like a sound shift (as in Romance lenition), seem not to be simplificatory. Further, early approaches tended to model synchronic grammar as a compendium of historical rules, with restructuring and rule loss seldom invoked. As Chomsky and Halle (1968:49) put it:

> …underlying representations are fairly resistant to historical change, which tends, by and large, to involve late phonetic rules. If this is true, then the same system of representation for underlying forms will be found over long stretches of space and time.

Under such a static model of grammar, the divergence of dialects and languages is limited principally to the order of late rules. For instance, the Romance languages would presumably share a common lexicon, which while true etymologically is untenable psycholinguistically. For instance, Harris (1969) posits underlying /lakte/, equal to its Latin root, for Modern Spanish *leche*, and formulates synchronic rules of vocalization, palatalization and vowel raising that recapitulate diachrony. Later approaches employing Lexical Phonology and Morphology (e.g., Kiparsky 1988, 1995, Kaisse 1993, Zec 1993) sought to move toward an explanation of change, including both actuation (why a change might begin) and transmission (how a change, once initiated, spreads). Proponents assume a less abstract analysis according to which underlying and surface forms are similar, and that the rules that operate in a grammar involve the integration of phonology and morphology at lexical and phrasal levels. Thus, Lexical Phonology offers a pathway whereby sound changes are incorporated into the synchronic grammar (McMahon 1994: 65) via a two-stage theory whereby phonetic variation is selectively integrated into the grammar and is passed on to successive generations via language acquisition (Kiparsky 1995: 642).

Within OT, some researchers have replicated this stratal model (e.g., Kiparsky 2000, Bermúdez-Otero and Hogg 2003, Gess 2003, Jacobs 2003, Minkova and Stockwell 2003), with separate, serially related OT constraint systems for stems, words and sentences. The aim is to yield a more restrictive and well-defined constraint inventory without need for recourse to output-output, sympathy or paradigm uniformity constraints, which these authors believe severely compromise OT. Likewise, many assume that a learner's phonetic input may lead to both reranking of constraints as well as to lexical restructuring via a principle of lexicon (and concomitantly, grammar) optimization. Interestingly, in many, if not most, OT studies on language change, candidates deemed 'nearly optimal' according to the evaluation of the constraint hierarchy subsequently become optimal ones when constraints are reranked. Naturally, one must justify the constraints employed in a given analysis and why they have been reranked to present a restrictive theory of sound change. Likewise, Bradley and Delforge (2006), surveyed below, call for a stratal model, couched in Dispersion Theory, that better allows for the incorporation of changes first at the phrasal level, then at the lexical level.

2. OT and language variation and change

If there are no rules, language change cannot be due to a change in the rule component, and if all constraints are universal, then it must be their relative ranking that determines dialectal variation and historical change. It is not always clear, however, that mere reranking is uniquely involved, since differences in underlying forms may play an important role as well, and restructuring of surface forms will impact the cues the learner has regarding the correct position of various faithfulness and markedness constraints.

Restructuring is effected according to the OT principle of lexicon optimization, which says that given the surface form of a morpheme and knowledge of the grammar, a learner will select the optimal underlying representation for that morpheme:

> [O]f all the possible underlying representations that could generate the attested phonetic form of a given morpheme, that particular underlying representation is chosen whose mapping to phonetic form incurs the fewest violations of highly ranked grammatical constraints. (Inkelas 1995, based on Prince and Smolensky 1993:192)

Under lexicon optimization, underlying forms may be fully specified, with only alternating structure unspecified, as the Evaluator will consider optimal those candidates with fewer faithfulness violations (e.g., Maximality — "do not delete any segment/feature"; and Identity — "do not change any segment/feature"). While this places a higher burden on the lexicon, it reduces the load placed on the grammar. That is, a speaker mentally stores what is heard produced and will only entertain a more abstract underlying form when there are related groups of words whose shared segments vary only in certain features. This implies that historical forms are not inherited genetically, but are eliminated from the lexicon (see Hutton 1996 for discussion of what he terms the Synchronic Base Hypothesis); in other words, language change is not a matter of derivation, but of substitution of one input for another. On the assumption that younger members of a linguistic community are important in spreading change (i.e., the transmission problem), newer generations of listeners will lack evidence that a phonetic feature is due to a phonological process, and will posit the surface form as a lexical item (or, faced with morphological alternations, the nonalternating structure common to the related forms). Taking again the example of Modern Spanish *leche* 'milk', it is not the case that [leče] would surface as the optimal output synchronically for the form /lakte/ (as in Harris 1969, discussed above), despite the relation to words like *lácteo* 'milky' and *lactar* 'to lactate'; the phonological shape of the historical source is too far removed from the modern form, and so the historical form may not serve as its underlying representation. Instead, /leče/ would be posited.

A related matter is that discussed above regarding the impact of lexicon optimization on the acquisition process. With regard to the initial ranking and final placement of faithfulness and well-formedness (markedness) constraints, lexicon optimization suggests that not only does the phonetic output lead the listener to posit surface-true lexical items (like /leče/), but it also will lead the learner to reposition constraints from their original ranking (e.g., the constraint that favors palatalization of /k/ before a front vowel). That is, for a constraint with an initially high ranking, the lack of phonetic evidence that it is violated will allow the listener to leave it in its original position. Likewise, when a listener does hear phonetic forms (like [kerer] *querer*) that violate a certain constraint, she will demote the constraint to allow for the grammaticality of the output form heard. Newer speakers would not be aware of a change in the ranking of constraints, but learn the final ranking of constraints based on the phonetic evidence.

Regarding changes to the constraint hierarchy, Tesar and Smolensky (2000) argue for a learning algorithm where only constraint demotion is possible, though it is an empirical question yet to be decided definitively, and certain historical changes may require recourse to constraint promotion (see, e.g., Holt 1997:chs.2–3, and Lleó 2003, who suggests that constraint promotion may only be available in the case of external or foreign influence on a language.)

3. Survey of major historical changes in Hispano-Romance treated in OT

In this section I survey a variety of segmental (vocalic and consonantal), prosodic (syllabic, syllable contact and metrical) and morphological (metathesis of clitics) data that have been treated using OT.

The development of *Cl* clusters from Latin to Hispano-Romance (Holt 1998) is of interest because of the divergent outcomes depending on their position in the word: initial *pl, fl, cl* show palatalization-cum-simplification (*llover, llama, llave*), while post-nasally they yield affricate *ch* (*ancho, hinchar, mancha*). As noted by Lloyd (1987), the Upper Aragonese forms show what is likely an intermediate stage to that of Modern Spanish: CLAVE > *cllau* [kʎ] 'key', PLOVERE > *pllover* [pʎ] 'to rain', FLAMMA > *fllama* [fʎ] 'flame'. Such forms would then either develop toward simplification (initially), or if retained, might undergo further modification. With the initial consonant of the medial clusters sharing phonological structure with the preceding homorganic nasal, there was an increased resistance to simplification, which then allowed the common processes of voicing and place assimilation to continue. This would have led /(n)kʎ/ to be produced as [(n)kʎ̥] and eventually lexicalized as /(n)č/, due to reinterpretation based on acoustic similarity, markedness considerations and lexicon optimization. That is, given that different vocal tract arrangements may yield similar acoustic speech signals, for the listener there may be articulatory ambiguity; however, the listener aims to pronounce words as nearly as possible in the way she has heard them, and reconstructs /tʃ/ (incorrectly). When alternate grammars may adequately account for the input, other factors determine the optimal grammar, which evolves to a more unmarked system; that is, this is 'emergence of the unmarked' (McCarthy and Prince 1993a,b), in that more complex segments have been reinterpreted as simpler ones.

Other classes of historical changes are best understood as the interaction of a faithfulness constraint with a family of markedness constraints.[1] A case that may serve to illustrate this point is the collapse of distinctive vocalic quantity in Latin, which had significant repercussions on the development of the vocalic and consonantal systems of Hispano-Romance (Holt 1997, 1999b, 2003b). Reanalysis by the listener of phonetic differences leads to loss of vowel length distinctions, which in turn initiated far-reaching changes that lead to the recovery of systemic balance in the distribution of long segments. The end result of these changes is that Old Spanish and Galician/Portuguese arrive at consonant inventories composed entirely of simple segments, having no mismatch with those segments that could be distinctively long (vowels and consonants in Latin, only sonorants in Early Hispano-Romance, none in Old Spanish and Galician/Portuguese). Systemic parity, initiated by listener reinterpretation, is recovered, and in a fashion that is maximally optimized and transparent to the listener and follows naturally from the implementation of Zec's (1995) theory of the relation of moraic theory and sonority classes:

(1) Major class features of segments:

	[consonantal]	[sonorant]
vowels	–	+
sonorants	+	+
obstruents	+	–

(2) Sonority classes from Latin to Old Spanish and Galician/Portuguese
Latin: μ = unrestricted
(all vowels and consonants may be moraic)
Hispano-Romance: μ = [+sonorant]
(vowels and sonorant consonants may be moraic)
Old Spanish, Galician/Portuguese: μ = [-consonantal]
(only vowels may be moraic)

Further, speakers reformulated the Latin Stress Rule as a constraint favoring heavy stressed syllables (Stress-to-Weight), and this constraint interacted with others militating against long elements (*Long-Vowel, *Long-[-ATR], NoDiphthong) to shape the evolution of the seven-vowel system of Late Spoken Latin ([i e ɛ a ɔ o u]), yielding [je < 'ɛ] (*bien* vs. *benéfico*) and [we < 'ɔ] (*bueno* vs. *bondad*) in Old Spanish,

1. Zubritskaya 1995 has argued that the loss of palatalization assimilation in consonant clusters in Modern Russian is due to the progressive demotion of the constraint requiring assimilatory spreading (Maximize Licensing in her account) below the family of constraints that militate against secondary articulation.

where an intensified stress accent arose due to heavier Germanic influence, and increased duration allowed lengthened lax vowels to be articulated heterogeneously (à la Donegan, e.g. 1978/1985). A host of evidence indeed appears to indicate that the stress accent of pre-Galician/Portuguese was weaker than that of pre-Old Spanish (Williams 1962:11–13, 53, 56–57, 78, 87–88): less syncope in Galician/Portuguese (e.g., *-ável* vs. *-able*, *dívida* vs. *deuda*, *dúvida* vs. *duda*); slower formation of yod/wau (as indicated by the voicing of the intervocalic consonants in (e.g., SAPIAT > *saiba* vs. Sp. *sepa* 's/he know (subj.)', and SAPUIT > *soube*, vs. Sp. *supe* 'I knew, found out'); hiatus (long retention of syllabic value of *e* in hiatus in forms like *fêmea* 'female', from versification); and diphthongization itself (c[ɛ]u vs. *cielo*, f[ɔ]go vs. *fuego*) indicates that stress in pre-Galician/Portuguese was weaker than in pre-Old Spanish.)[2]

The strong accent of intensity characteristic of Germanic (Meillet 1970:38) was apparently slower to take hold in the more distant and isolated territory where Galician/Portuguese was to develop. Under this scenario, Germanic influence primarily affected pre-Old Spanish territory, and led to the adoption of their preference for long lax vowels to become tense. That is, the constraint disfavoring long lax vowels that had been lower ranked in Late Spoken Latin became more dominant:

(3) Diphthongization in Old Spanish

/bɔno/ 'good'	STW	*Long-[-atr]	No Diphthong	*Long-Vowel
a. bɔno	*!			
b. bɔɔno		*!		*
☞ c. boɔno			*	

We see here that both serious candidates have a heavy penult, satisfying STW, while candidate (a) does not, and is so eliminated from consideration.[3] Candidate (b) is likewise eliminated from consideration because it shows a long lax vowel, disfavored under Germanic influence. When speakers became aware of this tendency toward fracture, lexicalization of this alternation resulted; that is, lexicon optimization leads to reanalysis of [oɔ] (< /ɔ/) as /oɔ/ (and similarly for /eɛ/ from [eɛ] < /ɛ/). Subsequent dissimilation and lexicon optimization leads to /wo/ (as in Italian; later /we/ in Old Spanish) and /je/.

The connection between the loss of vocalic quantity and the simplification of geminate and syllable-final consonants (first obstruents, later sonorants) is implemented

2. Lleó 2003:275 discusses additional evidence from Duffell 1999 and Bayo Julve 1998 for stress-timing (rather than more even syllable-timing) in Old Spanish (as well as in Old French).

3. The ranking of NoDiphthong and *Long-Vowel has remained constant, reflecting that all other vowels (i.e., the tense vowels and /a/) remained lengthened, but did not diphthongize. This is because for these vowels, phonetic conditions never yield a disfavored combination of length and [-atr]. Only lengthened lax vowels lead to phonological diphthongization because of their marked status in combining features that are difficult to sustain together for articulatorily-grounded reasons (Donegan 1978/1985:118).

via the progressive reranking of Max/Ident vis-à-vis the sonority hierarchy:[4,5]

(4) Reranking of faithfulness vis-à-vis sonority/moraicity hierarchy

Max	Latin
↓ Max	Late Spoken Latin, Hispano-Romance
↓ Max	Modern Spanish, Galician, Portuguese
↓	
$*O_\mu$ » $*N_\mu$ » $*L_\mu$ » $*G_\mu$ » $*V_\mu$	(Sonority hierarchy)

That is, while in Latin all segments may bear a mora (permitting both long vowels and geminate consonants), the progressive demotion of Max in later stages of Hispano-Romance leads to degemination both of obstruents (cuppa > *copa*; gutta > *gota*; bucca > *boca*) and then sonorants (annum > *año*, bella > *bella*, with palatal [ʎ]), as well as to the weakening and loss of syllable-final consonants (tructa > Moz. *truhta* > Sp. *trucha*; multu > *muito* > *mucho*):

(5) The surface moraic status of consonants in early Old Spanish.

/-k, -g/		$*O_\mu$ ('NMO')	Max/Ident	*N,*L,$*G_\mu$ ('NMS')
		(Syllable-final obstruents vocalize to bear mora)		
-k_μ, -g_μ		*!		
☞ -j_μ			* <+cons> * <-son>	*
/k_μ, g_μ/		(Intervocalic moraic obstruents lose their mora, simplifying)		
k_μ, g_μ		*!		
☞ k, g			* <μ>	
j_μ			* <+cons> *! <-son>	*
/n_μ, l_μ/		(Sonorant geminates still valid mora-bearers at this stage)		
☞ n_μ, l_μ				*
n, l			*! <μ>	

4. In Holt 2002, this approach is extended to the behavior of /-l/, whose higher sonority should have shielded it from erosion effects and ensured its mora in the early stages; instead, it vocalized (alteru > *outro*) along with /-k, -g/ (actor > *autor*). Previously, it was assumed that /-l/ was velarized, and stipulated that all velars vocalized. By synthesizing insights on the articulator group hypothesis from Padgett 1991/1995 (and subsequent work) and on the feature geometry of liquids from Walsh-Dickey 1997, /-l/ is seen as [-cont] at its primary coronal articulation and so is targeted by Lenition, in part the step-wise reduction of valid mora-bearing, thus syllable-final, segments.

5. In previous work I have employed the term NoMoraicConsonant (NMC) for typographical and expository convenience; really, NMC (and its subtypes, NoMoraicObstruent (NMO), NoMoraicSonorant (NMS), etc.) is a cover term for the interaction between faithfulness, the sonority hierarchy and moraicity.

At this stage (and abstracting away from vocalic and other changes), MULTU is realized at [mujto], CUPPA as [kopa] and CASTELLUM as [kastillo]. The ranking of Max/Ident with respect to the sonority hierarchy encodes the fact that erosion of an offending segment is better than total loss, and relates vocalization to reduction of geminates.

The relationship between faithfulness and the sonority hierarchy continues to shift in the same direction, toward unmarkedness, and eventually even the sonorant consonants lose their license to bear a mora. Further systemic factors having to do with perceptual distinctiveness lead to the simplification-cum-palatalization of /nn, ll/.

Thus, whereas Latin /-n-, -l-/ were lost in Galician/Portuguese (*pão*, *paço*), and the reduction of /nn, ll/ to /n, l/ caused no merger, they were retained in Old Spanish (*cana, pelo*). The next step-wise re-ranking of Max/Ident will cause the loss of the moraic status of /nn, ll/, and might be expected to yield /n, l/, as in Galician/Portuguese. However, they cannot lose their moraic status without occasioning merger unless some other change takes place to distinguish them. It appears, therefore, that merger avoidance was indeed a factor in the evolution of Spanish /nn, ll/. That is, systemic factors influence the learner/listener to restructure the grammar in a particular way to ensure that former communicative distinctions are maintained, while at the same time continuing to reestablish systemic parity in the distribution of moraic segments according to sonority. That is, because geminates are intervocalic consonants that bear a mora, the added weight yields length; a certain amount of energy is required to manifest this mora, and in production, length and energy are correlates of this unit of weight (i.e., the mora). Under the assumption that 'palatal' segments are actually doubly-articulated corono-dorsal structures (Keating 1988, Lipski 1989), it turns out that despite the loss of the mora, speakers do maintain some realization of 'doubleness', no longer as duration, but in articulation, with original COR and new DOR, i.e., 'palatal':

(6) Merger avoidance in Old Spanish of /nn, n/ by palatalization of /nn/

/nn n/	NMS	*Merge	Max/Ident/Dep
a. n n n (nn linked to COR)	*!		
b. n n		*!	* <μ>
☞ c. ɲ n (COR DOR)			* <μ> * +DOR

The appeal to *Merge builds on Dispersion Theory (DT; Flemming 1995/2002, Padgett 2003, and the discussion of Baker 2004, this volume below), and couches in OT terms the structuralist notions of maximization of perceptual distinctiveness in contrast and minimization of articulatory effort (Saussure 1916, Martinet 1964). In this tableau, what is being evaluated is a system of inputs, not an individual segment. That is, the contrast between segments is considered, and *Merge ('No output word has multiple correspondents in the input'; 'Maintain contrast', in effect) plays a role in the evolution of the long sonorants; since the high ranking of NMS forces loss of moraic status, doing so without further change would result in loss of the contrast *nn:n* (and also of *ll:l*).

If faithfulness is ranked below *MERGE, then a change to /ɲ, ʎ/ will preserve contrast. Candidate (a) represents the previously optimal state where geminate sonorants are licit, and contrast with the singletons. The double association to COR is intended to represent the fact that in production, the coronal articulation is lengthened. Candidate (b) shows that merger with *n* would happen if the previously moraic *nn* lost its mora, contrary to fact. Candidate (c) shows the result in Old Spanish: moraic status is still lost, but a change in articulation (the addition of DOR) allows the preservation of contrast between *nn:n*, now *ɲ:n*. The double implementation of COR is now replaced by the double articulation of COR-DOR. For Galician/Portuguese, given that /-n-, -l-/ were lost, elimination of the moraic status of /n_{μ}, l_{μ}/ does not violate *MERGE, and so nothing motivates a segmental change.

Other researchers have employed more articulated DT approaches to historical data in Spanish. For instance, Baker (2004, this volume) treats dispersion and duration in stop consonant contrasts from Latin to Spanish, and Bradley and Delforge (2006) treat systemic contrast and its role in the evolution of sibilant voicing.

Baker looks at the evolution of stops as they are affected by the series of changes collectively known as *lenition*, whereby voiceless geminate obstruents /pp, tt, kk/ simplified, while original /p, t, k/ had voiced to /b, d, g/ (e.g., CUPPA 'cup' > *copa*, GUTTAM 'drop' > *gota*, PECCATUM 'sin' > *pecado*, vs. LUPUM 'wolf' > *lobo*, ACUTUM 'sharp' > *agudo*, DICO 'I say' > *digo*), which caused no confusion because original /b, d, g/ had become the spirants [β, ð, ɣ] (which further frequently deleted intervocalically, e.g., CREDO 'I believe' > *creo*, REGINAM 'queen' > OSp. *reína*). This apparent chain shift, in which meaningful distinctions are realized at all stages, is analyzed via the interaction of constraints on maintenance and maximization of perceptual contrast (MAINTAINCONTRAST and MINIMUMDISTANCE, respectively), specifically relating to the features of duration, voice and continuancy (NOAPPROXIMANTS), along with a drive to weaken all consonantal articulations (LAZY) (as posited in atheoretical terms by Lloyd 1987 and Penny 1991, e.g.). Baker argues that the drag chain (in which simple voiced stops spirantized intervocalically first, which allowed for the voicing of the voiceless ones, followed finally by the degemination of the voiceless geminates) ensues from a constraint ranking that requires a three-way stop contrast at all times in Latin and Hispano-Romance, even though the realization of each stop series changes from one period to the next, as LAZY (for some unknown reason) assumes a higher ranking vis-à-vis the other constraints, leading in Modern Spanish to the merger between the voiced stops and approximants. (That is, these are now contextually determined.) Baker sees as an advantage to his approach that the role of duration-based cues in these processes in recognized.

Bradley and Delforge look at the loss of sibilant voicing contrasts in Old Spanish and its partial reemergence in several modern dialects (e.g., *has ido* contrasts with *ha sido* in voicing of the intervocalic [s] in the highlands of Ecuador, but both are pronounced with voiced [z] in certain dialects of central Spain). They examine the well known development of intervocalic voiced sibilants in medieval Spanish, which devoiced and merged with their voiceless counterparts. This is remarkable because it involved the loss of voicing between vowels, going against the trend of intervocalic consonant lenition in Western Romance (as discussed above), and because it involved neutralization in the syllable onset, a position favoring contrast preservation. Likewise, voicing in Ecuadorian Spanish is of interest because word-final position is usually associated with devoicing and neutralization of contrast, not with voicing and emergence of contrast. Bradley and Delforge show that Dispersion Theory provides an account of these patterns that allows explicit reference to articulatory and perceptual aspects of phonetic detail, yet limits the range of possible phonological contrasts.

(7) a. The sibilants of Old Spanish

i.	/t^s/	det^{s}iɾ	*deçir*	'to descend'	dental
	/d^z/	ded^{z}iɾ	*dezir*	'to say'	
ii.	/s̺/	os̺o	*osso*	'bear'	apicoalveolar
	/z̺/	oz̺o	*oso*	'I dare'	
iii.	/š/	fišo	*fixo*	'fixed'	prepalatal
	/ž/	fižo			

b. Devoicing of the sibilants of medieval Spanish (15th, 16th centuries; also shows result of deaffrication of the dentals)

i.	/z̺/ > /s̺/	des̺iɾ	*dezir*	'to say'
ii.	/z̺/ > /s̺/	os̺o	*oso*	'I dare'
iii.	/ž/ > /š/	fišo	*fijo*	'son'

Bradley and Delforge distinguish between sibilants (and obstruents more broadly) that bear a phonological specification of [voice] versus those that are neutral, or targetless with respect to voicing, in that they assume the laryngeal attitude of a neighboring sound.[6] That is, the articulatory gestures required to reach the perceptual target of phonological voicing or voicelessness presumably involve some degree of effort cost, and violate the markedness constraint *[αvoice]. In contrast, no effort is made to realize a neutral obstruent as voiced or voiceless, and the gradient phonetic realization of syllable-final sibilants (e.g., *de[s]de* ~ *de[z]de*) falls out naturally as the least marked laryngeal setting of the phonetic context. Other constraints that play an important role are *Merge, Space-sv ("minimal pairs differ in sibilant voicing at least as much as [s] and [z] between vowels") and σ[s ("a syllable-initial sibilant is [-voice]"). They further assume a distinction between lexical and postlexical phonological levels in OT that allows them to account for the phrasal behaviors exhibited in Ecuador and Spain that emerge precisely in those environments where [s] and [z] were contrastive in medieval Spanish. Finally, the paradox of losing contrast in syllable-initial position is resolved by the fact that voiced sibilants are marked both articulatorily and perceptually, a fact integrated into the DT apparatus.

6. This would seem to be similar in spirit to the (non-OT) approach taken in Roca and Johnson 1999, where the voicing or not of /s/ in English in words like *raisin* vs. *basic* is attributed in part to underspecification and in part to cyclicity.

Likewise, Holt 1999a, 2000 treats vowel harmony in Asturian, and appeals to Archiphonemic Underspecification (Inkelas 1995) under a constriction-based vowel geometry (Clements and Hume 1995); in effect, Asturiano creates archisegments that lack only the alternating features for those cases of alternating *a, e, o* (only); high harmony may then be viewed as feature-filling; this has the effect of optimizing both grammar and lexicon.

OT approaches to prosody have been employed in treatments of syncope (Hartkemeyer 1997, 2000a,b, Lleó 2003) and syllable contact phenomena (e.g., metathesis, Holt 2004a,b, and consonantal epenthesis, Martínez-Gil 2003).

Hartkemeyer offers an analysis of syncope that calls on an anchoring constraint (Left-Anchor-V) that favors retention of initial vowels and a constraint that disfavors all vowels in the output (*V). Thus, all vowels should delete unless a more dominant constraint prevents it (e.g., Left-Anchor-V, HeadMax).

Lleó (2003) analyzes the loss of unstressed vowels in Old Spanish and provides an account of why certain of them were deleted while others were preserved (e.g., sēcūru > *seguro* vs. oc(u)lu > *ojo* vs. secundu > *segund* or *segunt* 'second', later recovered). The conditions on vowel loss are made explicit, and include prosodic concerns (Foot-Trochee, Stress-to-weight, Parse-σ, HeadMax) regarding the position of the unstressed vowel in relation to the primary and secondary stress, as well as phonotactic constraints on complex codas (NoCoda, NoCodaComplex, Coda_{Son}>>$\text{Onset}_{\text{Son}}$) and morphological conditioning that bans deletion of lexical material (Max-Morpheme, Max-Segment, Max-/a/). Increased syncope in Old Spanish is interpreted as the result of Germanic influence, whose stress-timed characteristics impacted the prominence of stressed and unstressed syllables, and the later increase of apocope is interpreted as taking place under French influence. Thus, syllable structure constraints are shown to have had a rather variable position in the hierarchy of constraints in different periods of Spanish (going from a rather dominant to a low-ranked position, and back again to a very dominant one) (Lleó, 280):

(8) Stages in the position of NoCoda and Stress-to-Weight
- Stage 1 Late Hispanic Latin: NoCoda dominates STW
- Stage 2 Early Old Spanish: STW is promoted and outranks NoCoda
- Stage 3 Old Spanish (11th–13th centuries): NoCoda is further demoted
- Stage 4 Modern Spanish: NoCoda is promoted, STW is demoted

Finally, Lleó suggests that constraint demotion is the normal means of internal sound change, whereas constraint promotion might have to be appealed to in the case of external conditionings for change.

With regard to the analysis of Hartkemeyer, Lleó recognizes that it technically works, but rejects it for two main reasons: (i) that in treating all unstressed vowels alike, it fails to account for the differential loss of vowels due to metrical reasons (to comply with FtTroch and STW); and (ii), that given that vowels are basic to human language, and on the assumption that constraints are universal, a constraint banning vowels in such an blanket manner is suspect (Lleó, 276–277).

Metathesis has been treated as a case of optimization of syllable contact (Holt 2004a,b); that is, marked syllable contact brought about by syncope in Late Spoken Latin (cat(e)natu > *candado*) or by the concatenation of morphemes (*dezid#lo* ~ *dezildo*) is "repaired" such that the transition between syllables was improved. This is effected by the interaction of various constraints, including Syllable Contact Law, Minimal Distance in Sonority, Sonority Sequencing Principle, Align, and faithfulness constraints, primarily Linearity. The variation that existed is modeled according to a partially-ordered OT grammar (Anttila 2002), and further factors that determine the ultimate outcomes are morphological structure and the external influence exerted by the prescriptivist cultural institution the Real Academia Española.

The listener is argued to play a role as well. Namely, there would have been ambiguous evidence for the construction of the grammar and lexicon in that two processes of grammaticalization were underway: (i) the erosion of Latin demonstratives into the clitic pronouns and articles of Old Spanish, which showed ambivalent grammatical status and wavering prosodic independence; and (ii) the future and conditional "endings" of Old and Modern Spanish were developing from the present tense of the auxiliary verb HABERE 'to have' and the imperfect tense of either HABERE or IRE 'to go'. At the earlier stages, the process is still unsettled, and there are abundant citations of future and conditional forms with these atonic pronouns where the clitic appears between the infinitive and the emerging "endings": e.g., *amar lo é* ~ *lo amaré* (Lloyd 1987:311), *ferlo ia* (Penny 1991:205–6), and *excusarse ía* (Gracián, *Criticón*, from the Golden Age, cited in Lapesa 1986:392). Likewise, there is a strong tendency towards enclisis, with attestations such as *dixol* (~ *dixo le*), *diot* (~ *dio te*), *un colpel dio* (~ *un golpe le dio*) and *quem* (~ *que me*) (data principally from Martínez-Gil 2003). These factors suggest that there was confusion in speakers' minds regarding the morphological analysis of the clitic pronouns, which would arguably hinder the definitive ranking of ALIGN with regard to the other constraints and lead to its partial ranking, in the sense of Anttila (2002). Beginning in the 17th century, the grammar must have ALIGN » SYLLCON, since metathesis no longer obtains. The founding of the Real Academia Española de la Lengua (1713/1714), whose focus was (and is) to maintain the purity of the language,[7] surely played a decisive role. It is argued that this impulse toward purity would have disfavored the selection of metathesized forms, as each component morpheme would be compromised, and this appears to have led to the definitive ranking of ALIGN » SYLLCON. Within words, the metathesized forms were lexicalized, with no way to reconstruct their Latin form; on the other hand, morphological concatenation (as with the clitics and verbal forms) is productive, and would result in marked syllable contact upon each utterance. This conscious awareness would be susceptible to the prescriptivism of not overlapping or interleaving of segments of component morphemes.

Intrusive stop formation in Old Spanish also improves syllable contact, and Martínez-Gil (2003, who also treats Old French) compares rule-based approaches (e.g., Clements 1987) with his own constraint-based one. Data treated are of the sort Lt. HUM(E)RU > OSp. *ombro*, TREM(U)LAR > *tremblar*, INGEN(E)RAR > *engendrar*, *sal(i)r-á* > *saldrá*, etc., where a heterosyllabic cluster of rising sonority resulted from vowel loss, and obstruent epenthesis obtains, improving the phonotactics. Martínez-Gil argues that while Clements' analysis captures the facts, it lacks explanatory power, as it faces a number of limitations regarding why epenthesis is the repair employed, rather than

7. "Su propósito fue el de 'fijar las voces y vocablos de la lengua castellana en su mayor propiedad, elegancia y pureza'. Se representó tal finalidad con un emblema formado por un crisol al fuego con la leyenda *Limpia, fija y da esplendor*, obediente al propósito enunciado de combatir cuanto alterara la elegancia y pureza del idioma, y de fijarlo en el estado de plenitud alcanzado en el siglo XVI." (RAE)

other strategies, and stipulates the directionality of voicing and place assimilation and the appearance of an oral stop that define this phenomenon. Instead, he argues that the interaction of universal constraints on syllable contact, sonority slopes, identical clusters, licensing and faithfulness (both segmental and positional) determine the proper and attested outcomes, and yield a formally more elegant analysis.

Gutiérrez-Rexach (this volume) pursues a formal approach to sonority scales and syllable structure and their change over time from Latin and Spanish, and discusses metatheoretical issues such as the kinds of hierarchies that should be acceptable, continuous vs. discrete models, constraint aggregation/conjunction, and learning and computation. In his approach, he presents constraints on sonority distance, peak-margin distinctions and distance and other phenomena in logical terms, and offers various theorems, proofs and corollaries for each stage of development, showing that languages can instantiate a finer- or coarser grained sonority scale. He concludes that the formal properties of his analysis are more desirable and elegant than other approaches from a theory-internal standpoint.

4. Concluding remarks

In this chapter, I have discussed Optimality-Theoretic approaches to language change in Spanish and Hispano-Romance, and shown that it is often useful, indeed necessary, to appeal to factors broader than traditionally attributed to a strict classical sense of grammatical competence. That is, in addition to the interaction of faithfulness and markedness constraints, the role of perceptual, cognitive, systemic and external influences on linguistic structure and change is evident at all levels: that of segment and segmental inventory (*ll* vs. *ch*; the evolution of the vocalic system of Latin, with its consequences for the vocalization of syllable-final segments and the gradual simplification of the geminates, leading also to the creation of the palatals *ll* and *ñ*; the emergence of diphthongs *ie* and *ue*; the effects of duration reduction on lenition; the role of systemic contrast on sibilant voicing), syllable- and prosodic structure (syncope and metathesis, as well as the heavier Germanic influence on prosody that favored diphthongization), and intersecting points of morphology (morphemic conditioning of syncope in Vulgar Latin, clitic boundaries as an impediment to metathesis in Old Spanish after the establishment of the Real Academia). Likewise, it is also important to bear in mind issues regarding the formal instantiation of various concepts and constraints employed.

References

Anttila, A. 2002. Variation and phonological theory. In *The Handbook of Language Variation and Change*, J.K. Chambers, P. Trudgill and N. Schilling-Estes (eds.), 206–243. Cambridge MA: Blackwell.

Baker, G.K. 2004. Palatal Phenomena in Spanish Phonology. PhD dissertation, University of Florida, Gainesville. (Contains chapters on historical issues.)

Baker, G.K. 2006. Dispersion and duration in stop contrasts from Latin to Spanish. (This volume).
Bayo Julve, J.C. 1998. La teoría del verso desde el punto de vista lingüístico (El sistema de versificación del *Cantar de Mio Cid*), PhD dissertation, University of Barcelona.
Bermúdez-Otero, R. and Hogg, R.M. 2003. The actuation problem in optimality theory: Phonologization, rule inversion and rule loss. In *Optimality Theory and Language Change*, D. Eric Holt (ed.), 91–119. Dordrecht: Kluwer.
Bradley, T.G. and Delforge, A.M. 2006. Systemic contrast and the diachrony of Spanish sibilant voicing. In *Historical Romance Linguistics: Retrospectives and perspectives*, D. Arteaga and R. Gess (eds.), 19–53. Amsterdam: John Benjamins.
Chomsky, N. 1957. *Syntactic Structures*. The Hague: Mouton.
Chomsky, N. 1965. *Aspects of the Theory of Syntax*. Cambridge MA: The MIT Press.
Chomsky, N. and Halle, M. 1968. *The Sound Pattern of English*. New York NY: Harper and Row.
Clements, G.N. 1987. Phonological feature representation and the description of intrusive stops. In *Papers from the 23rd Annual Meeting of the Chicago Linguistics Society*, A. Bosch, B. Need and E. Schiller (eds.), 29–50. Chicago IL: Chicago Linguistics Society.
Clements, G. N. and Hume, E.V. 1995. The internal organization of speech sounds. In *The Handbook of Phonological Theory*, J. Goldsmith (ed.), 245–306. Oxford: Blackwell.
Diez, F. 1874. *Grammatik der romanischen Sprachen*. Paris: A. Franck.
Donegan, P. 1978. The Natural Phonology of Vowels. PhD dissertation, The Ohio State University. (Published 1985, New York NY: Garland).
Duffell, M.J. 1999. The metric cleansing of Hispanic verse. *Bulletin of Hispanic Studies* 76:151–168.
Flemming, E. 1995. Auditory Representations in Phonology. PhD dissertation, UCLA. (Published 2002, New York NY: Routledge.)
Gess, R. 1996. Optimality Theory in the Historical Phonology of French. PhD dissertation, University of Washington.
Gess, R. 2003. Bibliography on optimality theory and language change. In *Optimality Theory and Language Change*, D.E. Holt (ed.), 413–417. Dordrecht: Kluwer.
Gutiérrez-Rexach, J. 2006. Sonority scales and syllable structure: Toward a formal account of phonological change. (This volume).
Halle, M. 1962. Phonology in generative grammar. *Word* 18:54–72. (Reprinted in Fodor, J.A. and Katz, J.J. (eds.). 1964. *The Structure of Language: Readings in the philosophy of language*, 334–352. Englewood Cliffs NJ: Prentice Hall).
Harris, J.W. 1969. *Spanish Phonology*. Cambridge MA: The MIT Press.
Harrison, K.D. and A. Kaun. 2000. Pattern-responsive lexicon optimization. *Papers from the Annual Meeting of the North-Eastern Linguistic Society 30* (1999), M. Hirotani, A. Coetzee, N. Hall, and Y.-K. Kim (eds.), 327–340. Amherst, Massachusetts: GLSA.
Hartkemeyer, D. 1997. Romancing the vowels: An optimality-theoretic account of vowel loss from Vulgar Latin to Early Western Romance. *Studies in the Linguistic Sciences* 27: 99–117.
Hartkemeyer, D. 2000a. An approach to atonic vowel loss patterns in two Early W. Romance Grammars: A contrastive examination of Old French and Old Spanish. In *New Approaches to Old Problems: Issues in Romance Historical Linguistics. Selected Papers from the LSRL XXIX Parasession*, S.N. Dworkin and D. Wanner (eds.), 65–84. Amsterdam: John Benjamins.
Hartkemeyer, D. 2000b. *V: An Optimality-Theoretic Examination of Vowel Loss Phenomena, with Special Reference to Latin, Early Western Romance, and Basque. PhD dissertation, University of Illinois at Urbana-Champaign.
Hartman, S.L. 1974. An outline of Spanish historical phonology. *Papers in Linguistics* 7: 123–191.
Holt, D.E. 1997. The Role of the Listener in the Historical Phonology of Spanish and Portuguese: An Optimality-Theoretic account. PhD dissertation, Georgetown University. (Available on Rutgers Optimality Archive at <http://roa.rutgers.edu>).

Holt, D.E. 1998. The role of comprehension, reinterpretation and the uniformity condition in historical change: The case of the development of *Cl* clusters from Latin to Hispano-Romance. In *Proceedings of the Western Conference on Linguistics (WECOL)* 1996, V. Samiian (ed.), 133–148, Fresno CA: Department of Linguistics, California State University.

Holt, D.E. 1999a. Underspecification, constriction-based vowel geometry and scalar raising in Asturiano. *The 73rd Annual Meeting of the Linguistic Society of America,* Los Angeles, January 7–10, 1999.

Holt, D.E. 1999b. The moraic status of consonants from Latin to Hispano-Romance: The case of obstruents. In *Advances in Hispanic Linguistics: Papers from the Second Hispanic Linguistics Symposium*, J. Gutiérrez-Rexach and F. Martínez-Gil (eds.), 166–181. Somerville MA: Cascadilla.

Holt, D.E. 2000. Comparing approaches to the underlying specification of Spanish vowels. *The 29th meeting of the Linguistic Association of the Southwest (LASSO 29)*, Benemérita Universidad Autónoma de Puebla (BUAP), Mexico, October 13–15, 2000.

Holt, D. E. 2002. The articulator group and liquid geometry: Implications for Spanish phonology present and past. In *Romance Phonology and Variation (Papers from LSRL 30)*, Caroline Wiltshire and Joaquim Camps (eds.), 85–99. Philadelphia: John Benjamins.

Holt, D.E. 2003a. Remarks on optimality theory and language change. In *Optimality Theory and Language Change*, D. E. Holt (ed.), 1–30. Dordrecht: Kluwer.

Holt, D.E. 2003b. The emergence of palatal sonorants and alternating diphthongs in Old Spanish. In *Optimality Theory and Language Change*, D.E. Holt (ed.), 285–305. Dordrecht: Kluwer.

Holt, D.E. 2004a. Optimization of syllable contact in Old Spanish via the sporadic sound change metathesis. *Probus: International Journal of Latin and Romance Linguistics* 16.43–61. (Special issue on historical phonology of Romance, J.-P. Montreuil (ed.)).

Holt, D.E. 2004b. Sobre los cambios fónicos esporádicos que optimizan el contacto silábico en el español antiguo: El caso de la metátesis. Proceedings of the *XIII Congreso de la Asociación de Lingüística y Filología de América Latina (ALFAL)*, Universidad de Costa Rica, February 18–23, 2002. (Published on CD-ROM in February 2004).

Hutton, J. 1996. Optimality Theory and historical language change. Paper presented at the 4th Phonology Workshop, Manchester, England, May 1996.

Inkelas, S. 1995. Consequences of lexicon optimization. *Proceedings of the North-Eastern Linguistic Society 25 (1994)*, J. Beckman (ed.), 289–302. Amherst MA: GLSA.

Jacobs, H. 1995. Optimality Theory and sound change. In *Proceedings of the North-Eastern Linguistic Society 25 (1994)*, J. Beckman (ed.), 219–232. Amherst MA: GLSA.

Jacobs, H. 2003. The emergence of quantity-sensitivity in Latin: Secondary stress, iambic shortening and theoretical implications for 'mixed' stress systems. In *Optimality Theory and Language Change*, D.E. Holt (ed.), 229–247. Dordrecht: Kluwer.

Kaisse, E.M. 1993. Rule reordering and rule generalization in lexical phonology: A reconsideration. In *Studies in Lexical Phonology*, S. Hargus and E.M. Kaisse (eds.), 343–363. San Diego CA: Academic Press.

Keating, P. 1988. Palatals as complex segments: X-ray evidence. *UCLA Working Papers in Phonetics* 69: 77–91.

King, R. 1969. *Historical Linguistics and Generative Grammar*. Englewood Cliffs NJ: Prentice Hall.

Kiparsky, P. 1965. Phonological Change. PhD dissertation, MIT.

Kiparsky, P. 1988. Phonological change. In *Linguistics: The Cambridge Survey*, F. Newmeyer (ed.), 363–415. Cambridge: CUP.

Kiparsky, P. 1995. The phonological basis of sound change. In *The Handbook of Phonological Theory*, J. Goldsmith (ed.), 640–670. Cambridge MA: Blackwell.

Kiparsky, P. 2000. Opacity and cyclicity. *Linguistic Review* 17:1–15.

Labov, W. 1972. *Sociolinguistic Patterns*. Philadelphia PA: University of Pennsylvania Press.

Lapesa, R. 1986. *Historia de la lengua española* (9th ed.). Madrid: Gredos.

Lipski, J. 1989. Spanish *yeísmo* and the palatal resonants: Toward a unified account. *Probus* 1:211–223.

Lleó, C. 2003. Some interactions between word, foot and syllable structure in the history of the Spanish language. In *Optimality Theory and Language Change*, D.E. Holt (ed.), 249–283. Dordrecht: Kluwer.

Lloyd, P. 1987. *From Latin to Spanish,* Vol. I: *Historical phonology and morphology of the Spanish language*. Philadelphia PA: The American Philosophical Society.

Malkiel, Y. 1963–4. The interlocking of narrow sound change, broad phonological pattern, level of transmission, areal configuration, sound symbolism: Diachronic studies in the Hispano-Romance consonant clusters *cl-*, *fl-*, *pl-*. *Archivum Linguisticum* 15/16:144–173, 141–133.

Martinet, A. 1964. *Elements of General Linguistics*. Chicago IL: University of Chicago Press.

Martínez, G.A. 2000. Analogy and Optimality Theory in a morphological change of Southwest Spanish. In *New Approaches to Old Problems: Issues in Romance Historical Linguistics. Selected Papers from the LSRL XXIX Parasession*, S.N. Dworkin and D. Wanner (eds.), 85–96. Amsterdam: John Benjamins.

Martínez-Gil, F. 2003. Consonantal intrusion in heterosyllabic consonant-liquid clusters in Old Spanish and Old French: An Optimality Theoretical account. In *A Romance Perspective on Language Knowledge and Use. Selected Papers from the 31st Linguistic Symposium on Romance Languages (LSRL), Chicago, 19–22 April 2001*, R. Núñez-Cedeño, L. López and R. Cameron (eds.), 39–58. Amsterdam: John Benjamins.

McCarthy, J. and Prince, A. 1993a. Generalized alignment. *Yearbook of Morphology* 79–153.

McCarthy, J. and Prince, A. 1993b. Prosodic Morphology I: Constraint interaction and satisfaction. Ms. University of Massachusetts, Amherst, and Rutgers University. (Available on Rutgers Optimality Archive at <http://roa.rutgers.edu>).

McMahon, A.M.S. 1994. *Understanding Language Change*. Cambridge: CUP.

Meillet, A. 1970. *General Characteristics of the Germanic Languages* (Trans. by William P. Dismukes). Coral Gables CA: University of Miami Press.

Menéndez Pidal, R. 1904. *Manual de gramática histórica española*. Madrid: Espasa-Calpe.

Meyer-Lübke, W. 1895. *Grammaire des langues romanes*. Paris: H. Welter.

Minkova, D. and Stockwell, R. 2003. English vowel shifts and 'optimal' diphthongs: Is there a logical link? In *Optimality Theory and Language Change*, D.E Holt (ed.), 169–190. Dordrecht: Kluwer.

Padgett, J. 1991. Stricture in Feature Geometry, PhD dissertation, University of Massachusetts. (Revised version published 1995, Stanford CA: CSLI).

Padgett, J. 2003. The emergence of contrastive palatalization in Russian. In *Optimality Theory and Language Change*, D.E. Holt (ed.), 307–335. Dordrecht: Kluwer.

Penny, R. 1991. *A History of the Spanish Language*. Cambridge: CUP.

Postal, P. 1968. *Aspects of Phonological Theory*. New York NY: Harper and Row.

Prince, A. and Smolensky, P. 1993. Optimality Theory: Constraint interaction in generative grammar. Ms. Rutgers University and University of Colorado, Boulder. Published in 2004 by Blackwell.

Real Academia Española. 2002. La Real Academia Española, Breve historia, Origen y fines. <http://www.rae.es>.

Reiss, C. 2003. Language change without constraint reranking. In *Optimality Theory and Language Change*, D.E. Holt (ed.), 143–168. Dordrecht: Kluwer.

Roca, I. and Johnson, W. 1999. *A Course in Phonology*. Oxford: Blackwell.

Saussure, F. de. 1916. *Cours de linguistique générale*. C. Bally, A. Sechehaye and A. Riedlinger (eds.). Paris: Payot.

Tesar, B. and Smolensky, P. 2000. *Learnability in Optimality Theory*. Cambridge MA: The MIT Press.

Walsh-Dickey, L. 1997. The Phonology of Liquids. PhD dissertation, University of Massachusetts, Amherst.

Williams, E.B. 1962. *From Latin to Portuguese: Historical phonology and morphology of the Portuguese language*. Philadelphia PA: University of Pennsylvania Press. (First edition published 1938).

Zec, D. 1993. Rule domains and phonological change. In *Studies in Lexical Phonology*, S. Hargus and E. Kaisse (eds.), 365–405. San Diego CA: Academic Press.

Zec, D. 1995. Sonority constraints on syllable structure. *Phonology* 12:85–129.

Zubritskaya, K. 1995. Markedness and sound change in OT. In *Proceedings of the North-Eastern Linguistic Society* 25 (1994), J. Beckman (ed.), 249–264. Amherst MA: GLSA.

Appendix: Bibliography on Optimality Theory and language variation and change in Spanish

0. Introduction. What follows is an attempt to list all works published to date that treat aspects of language variation and change in Spanish and Hispano-Romance from an Optimality-Theoretic perspective (Section 1). These are most frequently phonological in nature, but there is also research on morphophonology (e.g., Morris 2005, on analogical leveling based on phonological naturalness or unmarkedness couched in the Optimal Paradigms model of McCarthy 2005) and morphosyntax (e.g., Martínez 2000, on analogy based on imperfect learning; and Koontz-Garboden 2004, on indirect transfer of verbal aspect due to language contact). Given the continued expansion of this line of research, omissions may be inevitable, regrettably. In addition to the author's own research, contributions have been gathered from individual subscribers to the Optimality Theory (optimal@ucsd.edu) and Historical Linguistics (histling@listserv.sc.edu) electronic discussion lists, whom I gratefully acknowledge, and from the Rutgers Optimality Archive (http://roa.rutgers.edu).

In Section 2, the reader will find works that list, review and discuss the areas of language variation and change in OT in general.

1. Bibliography of Spanish- and Hispano-Romance related works

Historical change

Baker, G.K. 2004. Palatal Phenomena in Spanish Phonology. PhD dissertation, University of Florida, Gainesville. (Contains chapters on historical issues).

Baker, G.K. 2006. Dispersion and duration in stop contrasts from Latin to Spanish. (This volume).

Bradley, T.G. and Delforge, A.M. 2006. Systemic contrast and the diachrony of Spanish sibilant voicing. In *Historical Romance Linguistics: Retrospectives and perspectives*, R. Gess and D. Arteaga (eds.), 17–51. Amsterdam: John Benjamins.

Gutiérrez-Rexach, J. 2006. Sonority scales and syllable structure: Toward a formal account of phonological change. (This volume).

Hartkemeyer, D. 1997. Romancing the vowels: An Optimality-Theoretic account of vowel loss from Vulgar Latin to Early Western Romance. *Studies in the Linguistic Sciences* 27:99–117.

Hartkemeyer, D. 2000a. An OT approach to atonic vowel loss patterns in two Early W. Romance grammars: A contrastive examination of Old French and Old Spanish. In *New Approaches to Old Problems: Issues in Romance Historical Linguistics. Selected Papers from the LSRL XXIX Parasession*, S.N. Dworkin and D. Wanner (eds.), 65–84. Amsterdam: John Benjamins.

Hartkemeyer, D. 2000b. *V: An Optimality-Theoretic Examination of Vowel Loss Phenomena, with Special Reference to Latin, Early Western Romance, and Basque. PhD dissertation, University of Illinois at Urbana-Champaign.

Holt, D.E. 1996. From Latin to Hispano-Romance: A constraint-based approach to vowel nasalization, sonorant simplification, and the Late Spoken Latin open mid vowels. In *Papers from CLS 32*, L.M. Dobrin, K. Singer and L. McNair (eds.), 111–123. Chicago IL: Chicago Linguistic Society.

Holt, D. E. 1997. The Role of the Listener in the Historical Phonology of Spanish and Portuguese: An Optimality-Theoretic account. PhD dissertation, Georgetown University. (Available on Rutgers Optimality Archive).

Holt, D. E. 1998. The role of comprehension, reinterpretation and the uniformity condition in historical change: The case of the development of *Cl* clusters from Latin to Hispano-Romance. In *Proceedings of the Western Conference on Linguistics (WECOL)* 1996, V. Samiian (ed.), 133–148. Fresno CA: Department of Linguistics, California State University.

Holt, D. E. 1999. The moraic status of consonants from Latin to Hispano-Romance: The case of obstruents. In *Advances in Hispanic Linguistics: Papers from the Second Hispanic Linguistics Symposium*, J. Gutiérrez-Rexach and F. Martínez-Gil (eds.), 166–181. Somerville MA: Cascadilla.

Holt, D. E. 2003a. Remarks on Optimality Theory and language change. In *Optimality Theory and Language Change*, D.E. Holt (ed.), 1–30. Dordrecht: Kluwer.

Holt, D. E. 2003b. The emergence of palatal sonorants and alternating diphthongs in Old Spanish. In *Optimality Theory and Language Change*, D. E. Holt. (ed.), 285–305. Dordrecht: Kluwer.

Holt, D. E. 2004a. Optimization of syllable contact in Old Spanish via the sporadic sound change metathesis. *Probus: International Journal of Latin and Romance Linguistics* 16:43–61. (Special issue on historical phonology of Romance, J,-P. Montreuil (ed.)).

Holt, D. E. 2004b. Sobre los cambios fónicos esporádicos que optimizan el contacto silábico en el español antiguo: El caso de la metátesis. Proceedings of the *XIII Congreso de la Asociación de Lingüística y Filología de América Latina (ALFAL)*, Universidad de Costa Rica, February 18–23, 2002. (Published on CD-ROM in February 2004).

Holt, D. E. 2006. Optimality Theory and language change in Spanish. (This volume).

Koontz-Garboden, A. 2004. Language contact and Spanish aspectual expression: A formal analysis. *Lingua* 114:1291–1330.

Lleó, C. 2003. Some interactions between word, foot and syllable structure in the history of the Spanish language. In *Optimality Theory and Language Change*, D.E. Holt (ed.), 249–283. Dordrecht: Kluwer.

Martínez, G. A. 2000. Analogy and Optimality Theory in a morphological change of Southwest Spanish. In *New Approaches to Old Problems: Issues in Romance Historical Linguistics. Selected Papers from the LSRL XXIX Parasession*, S.N. Dworkin and D. Wanner (eds.), 85–96. Amsterdam: John Benjamins.

Martínez-Gil, F. 2003. Consonant intrusion in heterosyllabic consonant-liquid clusters in Old Spanish and Old French: An Optimality Theoretical account. In *A Romance Perspective on Language Knowledge and Use*, R. Núñez-Cedeño, L. López and R. Cameron (eds.), 39–58. Amsterdam: John Benjamins.

Morris, R. E. 2005. Attraction to the unmarked in Old Spanish leveling. *Selected Proceedings of the 7th Hispanic Linguistics Symposium* (University of New Mexico, October 16–18, 2003) [Proceedings Project]. D. Eddington (ed.), 180–191. Somerville MA: Cascadilla. (Available at <http://www.lingref.com/>).

Variation

Bradley, T.G. 2005. Sibilant voicing in Highland Ecuadorian Spanish. *Lingua(gem)* 2(2):9–42. (Available on Rutgers Optimality Archive).

Cutillas Espinosa, J.A. 2004. Meaningful variability: A sociolinguistically-grounded approach to variation in Optimality Theory. *Advances in Optimality Theory*, a monograph issue of the *International Journal of English Studies* (*IJES*) 4(2):165–184, P. Boersma and J.A. Cutillas (eds.). (Available on Rutgers Optimality Archive.)

Díaz-Campos, M. and Colina, S. 2006 The interaction between faithfulness constraints and sociolinguistic variation: The acquisition of phonological variation in first language speakers. (This volume.)

González, C. 2005. The phonetics and phonology of spirantization in North-Central Peninsular Spanish. In Joseba Lakarra (ed.), *Anuario del Seminario de Filología Vasca Julio de Urquijo–International Journal of Basque Linguistics and Philology* XXXIX-1. 315–342.

González, C. 2006. Constraint re-ranking in three grammars: Spirantization and coda devoicing in Peninsular Spanish. In *New Analyses in Romance Linguistics. Selected Papers from the 35th Symposium on Romance Languages (LSRL), Austin, March 2005*, J.P. Montreuil (ed.). Amsterdam: John Benjamins.

Holt, D.E. 2000. Comparative Optimality-Theoretic dialectology: Singular/plural nasal alternations in Galician, Mirandese (Leonese) and Spanish. In *Hispanic Linguistics at the Turn of the Millennium: Papers from the Third Hispanic Linguistics Symposium*, H. Campos, E. Herburger, A. Morales-Front and T.J. Walsh (eds.), 125–143. Somerville MA: Cascadilla.

Morris, R.E. 1998. Stylistic Variation in Spanish Phonology. PhD dissertation, The Ohio State University. (Available on Rutgers Optimality Archive).

Morris, R.E. 2000. Constraint interaction in Spanish /s/-aspiration: Three Peninsular varieties. In *Hispanic Linguistics at the Turn of the Millennium: Papers from the 3rd Hispanic Linguistics Symposium*, H. Campos, E. Herburger, A. Morales-Front and T.J. Walsh (eds.), 14–30. Somerville MA: Cascadilla.

Piñeros, C.-E. 2002. Markedness and laziness in Spanish obstruents. *Lingua* 112: 379–413. (Cross-dialectal study. Available on Rutgers Optimality Archive).

2. General studies and reviews of variation and change

Anttila, A. 2002. Variation and phonological theory. In *The Handbook of Language Variation and Change*, J.K. Chambers, P. Trudgill and N. Schilling-Estes (eds.), 206–243. Cambridge MA: Blackwell.

Bermúdez-Otero, R. 2006a. Phonological change in Optimality Theory. In *Encyclopedia of Language and Linguistics* (2nd ed.). K. Brown (ed.), Vol. 9, 497–505. Oxford: Elsevier.

Bermúdez-Otero, R. 2006b. Diachronic phonology. In *The Cambridge Handbook of Phonology*, P. de Lacy (ed.). Cambridge: CUP.

Gess, R. 2003. Bibliography on Optimality Theory and language change. In *Optimality Theory and Language Change*, D.E. Holt (ed.), 413–417. Dordrecht: Kluwer.

Holt, D.E. 2003a. *Optimality Theory and Language Change* [Studies in Natural Language and Linguistic Theory 56]. Dordrecht: Kluwer.

Holt, D.E. 2003b. Remarks on Optimality Theory and language change. In *Optimality Theory and Language Change*, D.E. Holt (ed.), 1–30. Dordrecht: Kluwer.

Zubritskaya, K. 1997. Mechanism of sound change in Optimality Theory. *Language Variation and Change* 9:121–148.

References

McCarthy, J.J. 2005. Optimal paradigms. In *Paradigms in Phonological Theory*, L. Downing, T.A. Hall and R. Raffelsiefen (eds.), 170–210. Oxford: OUP.

Duration, voice, and dispersion in stop contrasts from Latin to Spanish

Gary K. Baker
University of Georgia

This paper takes a new look at the evolution of stops from Latin to Spanish. In a series of sound changes that have often been described as a chain shift, geminates reduced to singletons, voiceless stops voiced, and voiced stops approximantized. These changes have generally been attributed to lenition, which I assume here. I analyze these changes in Optimality Theory as variant constraint ranking over time, couching the analysis in the terms of Flemming's (1995) Dispersion Theory, a functionalist approach that takes whole systems of contrast into account rather than focusing on piecemeal change. I thus view the changes in question not only as the predictable effects of lenition in word-medial, intervocalic position (where they took place) but as part of a suite of changes that weakened stops in the same way while maintaining extant contrasts in the process. I focus on the phonetic cue of closure duration in addition to voicing distinctions, based on the findings of numerous researchers that duration functions crosslinguistically as a major means of marking voiceless/voiced stop contrasts. I moreover show that modifications to Dispersion Theory recognizing a more direct role for faithfulness (as in Padgett 2003) allow us to motivate constraint reranking over time as an effect of language acquisition and reanalysis of underlying forms (see Holt 2003a). Reference here to traditionally unspecified phonetic detail (e.g. stop closure duration) is argued to provide both a richer model and a fuller understanding of the nature and mechanisms of contrast underlying the changes in question. Moreover, since lenition — an often vaguely defined concept — is here shown to operate in highly similar ways across these changes, the current approach provides for a more coherent, unified analysis than those heretofore presented.

Keywords: approximantization, chain shift, closure duration, constraint reranking, contrast maintenance, degemination, dispersion theory, geminates, geminate sonorants, geminate stops, voiced geminate stops, lenition, lexicon optimization, merger, palatalization, sonority, systemic markedness, VOT

0. Introduction

This paper analyzes historical changes undergone by the Spanish stop series in intervocalic position. From Latin to modern Spanish, both geminate and singleton stops undergo weakening in the same environment (word-medial, intervocalic), yet meaningful distinctions among affected segments are preserved. This series of changes amounts to a chain shift, a phonological event that has proven challenging for Optimality Theory (OT; Prince and Smolensky 1993). I motivate these reflexes within the OT framework through recourse to Dispersion Theory (DT; Flemming 1995, 2002), a phonetics-based approach that takes into account systemic pressures to maintain and optimize auditory contrasts among words. This account integrates innovations to DT (Padgett 2003b) to explain the chain shift and provide solid phonetic grounds for the observed changes, both in the synchronic and diachronic sense. We will see that distinctiveness is consistently maintained along the cross-linguistically common phonetic dimensions of closure duration and voice, even as widespread lenition is concurrently observed. The historical analysis rests on the assumption that the same formal machinery that has generally concentrated on synchronic reflexes is applicable to diachronic change. I therefore view historical change as a series of overlapping synchronic systems. Reflected in variant constraint rankings in OT, changes arise in a Labovian manner to be propagated (or not) intergenerationally through the acquisition process. I discuss this more fully below (see also Holt 2003a, this volume for an overview of the synchrony/diachrony interface).

I argue that this approach provides for a more coherent, unified analysis than has been presented heretofore and contributes a degree of formal rigor and phonetic detail not commonly found in historical linguistics. I moreover show that an approach couched in the same terms provides a model for variant reflexes and attested language typologies elsewhere in Romance (Portuguese, standard Italian).

The paper is organized as follows. In Section 1, I present the historical data under analysis. Section 2 provides background on key phonetic characteristics of the segments in question, and Section 3 details the theoretical assumptions underlying the paper. Section 4 presents the analysis itself, while Section 5 discusses other accounts of the historical reflexes. Section 6 provides further discussion of historical Spanish reflexes and conclusions.

1. Data

The phonemic inventory of Latin included voiced/voiceless pairs of occlusives at the three cardinal points of articulation: alveolar/dental, labial, and velar (see Maddieson 1984:32). Voiceless stops and, to a much lesser extent, the voiced ones, contrasted with geminate articulations, as did the coronal /s/. Two nasals (/m n/) and two liquids (/r l/) likewise had phonemically distinct geminate forms. Voiceless fricatives /f/ and /h/ were also available, though neither geminated. This inventory is seen in Figure 1 below. Note that I use a double grapheme (/CC/) to represent geminates as opposed to the IPA long consonant (/Cː/). I do this primarily for convenience and representional clarity.

(1) The consonant inventory of Latin

	(place)	labial		alveolar/dental		velar	
(manner)		sing.	gem	sing.	gem.	sing.	gem.
plosive		p b	pp (bb)	t d	tt (dd)	k g	kk (gg)
fricative		f		s	ss	h*	
nasal		m	mm	n	nn		
liquid							
lateral				l	ll		
tap/trill				r	rr		*glottal

The system underwent considerable structural changes into Old Spanish. While all of the simple (non-geminate) segments persist into Spanish (though some with altered articulations and with the exception of the aspirate /h/, lost very early on), Latin geminate obstruents underwent degemination in the history of Spanish — as well as throughout Western Romance, reflecting what is generally considered a lenition process (Harris-Northall 1990, Penny 1991; see also Kirchner 1999, 2001):[1]

(2) Degemination of geminate obstruents into Old Spanish

pp > p	L. CUPPA > Sp. *copa* 'cup'
tt > t	L. GUTTA > Sp. *gota* 'drop'
kk > k	L. BUCCA > Sp. *boca* 'mouth'
dd > d	L. (*IN)ADDERE > Sp. *añadir* 'to add'
ss > s	L. GROSSU > Sp. *grueso* 'thick'

Following Hayes (1989), I assume that geminates are moraic and generally limited — due to their structure — to intervocalic position, where their mora can form part of a preceding syllable.[2] This was the case in Latin: the three-way contrast between voiceless geminates, their singleton (non-geminate) counterparts, and voiced singletons obtained only in word-medial, intervocalic position. As a consequence, the simplification of the voiceless geminate obstruents would have caused a significant loss of phonemic contrast had other changes not taken place. The degemination process,

1. I define lenition here as the lessening of an articulatory gesture (in the sense of Browman and Goldstein 1986, 1992) either spatially (in terms of magnitude) or temporally (in terms of duration). Loss of occlusion in a shift from /b/ > /β/ is spatial lenition, as the magnitude of stricture of the stop gesture has been lessened; temporal weakening is manifest in the shorter duration of the stop closure from /t/ > /d/ (see Section 2 below). Voicing — to the extent that it is truly present in intervocalic lenition (see below) — is not viewed as an additional gesture *per se*. Rather, it is the lack of a transition due to gestural overlap between the voicing gestures of the flanking vowels. This apparent assimilation then shows an easing of transitions and thence lenition, as the vocal cords are not stopped and restarted (see Westbury and Keating 1986).

2. Initial (and non-moraic) geminates have been reported in languages such as Leti (Hume *et al.* 1997) and Malayalam (Mohanan 1989). See Davis (1999) for an alternate analysis, however; he motivates an analysis of moraic initial geminates in Trukese in line with Italian geminate structure.

however, was in effect licensed by the voicing of singleton intervocalic stops (see Lloyd 1987:144), such that no loss of phonemic contrast, and hence no potential homonymic clash, resulted from their degemination. This is shown in Figure 3.

(3) Voicing of intervocalic (singleton) obstruents in Old Spanish
(V)p(V) > b   L. LUPU > OSp *lobo* 'wolf'
(V)t(V) > d   L. VITA > OSp *vida* 'life'
(V)k(V) > g   L. FOCU > OSp *fuego* 'fire'
(V)s(V) > z   L. CASA > OSp *ca*[z]*a* 'house'

Furthermore, the voicing seen in (3) was itself made possible by the approximantization of intervocalic voiced obstruents (Harris-Northall 1990:7). This is exemplified in Figure 4.[3]

(4) Approximantization of intervocalic voiced Latin stops
L. SUDARE   > su[ð]ar 'to sweat'
L. CABALLU   > ca[β]allo 'horse'
L. AUGUSTU   > a[ɣ]osto 'August'

This process is ongoing in modern Spanish, in which voiced stops /b d g/ are realized [β ð ɣ] in intervocalic position.[4]

Loss of phonemic distinctiveness was thus avoided all round. In effect, then, we have a chain shift, as recognized in the literature (Alarcos Llorach 1965, Lloyd 1987, Walsh 1991, Wireback 1997). I take these changes to constitute a drag chain, in which

3. Many cases of intervocalic /d g/ from Latin were ultimately lost in Spanish; ongoing lenition drove these segments to total loss (e.g. L. REGEM > Sp. *rey* [rej] 'king', L. HODIE > Sp. *hoy* [oj] 'today'; see Penny 1991:68–71). Those that resisted deletion later merged with the voiced results of former /t k/ when they, too, lenited to voiced approximants in what is clearly a pattern of weakening. Harris-Northall (1990) attributes this to a second shift or wave of weakening subsequent to the initial series of changes seen in the chain shift. The net effect of this second round of weakening is the loss of an overt contrast in favor of a two-way distinction. The treatment proposed here accounts for both shifts. Note that this 'traditional' account (cf. Lloyd 1987, Penny 1991) has not gone unchallenged. For a recent analysis that questions voiced stop~approximant contrasts in Old Spanish, see Martínez-Gil (1998). I abstract away from such approaches here in favor of an analysis of a general pattern of weakening and contrast. It should be pointed out, however, that such analyses do not seriously undermine the treatment proposed here; minus an intermediate stage, this treatment nevertheless accounts for — in precisely the same terms — the two-way voiceless stop~voiced approximant contrast still observed today. This is seen below. Note that Piñeros (2002) provides a synchronic analysis of voiced stop weakening in Spanish in terms of markedness and contrast maintenance.

4. The traditional idea of the spirantization — that is, fricativization — of these segments in modern Spanish has been challenged in recent times and is not adopted here. Lavoie (2000) shows through phonetic analysis that Spanish voiced stops do not weaken to fricatives but rather to approximants, while phonological evidence of this comes from Baković (1994). Importantly, recent work in fricatives suggests that this class of sounds is not well understood but should likely not be considered as weaker than stops (see Ladefoged and Maddieson 1996). Here, then, the traditional 'fricatives' [β ð ɣ] are taken to be approximants, lacking the precise, highly controlled obstruction that earmarks true fricatives. I retain the traditional symbols here, however, for expository ease.

changes in one set of sounds leave a gap which other sounds may exploit.[5] Such restructuring is not random but rather motivated by production- or perception-based drives. Vowel shifts, for example, have been shown to respond to perceptual drives, thus maintaining efficient margins of contrast (see Lindblom 1986). Here, a drive to weaken articulations system-wide was in effect, while a systemic drive to maintain contrasts informed restructuring. Thus, intervocalic voiced stops approximantize, allowing the voicing of intervocalic voiceless stops, which itself leaves open the possibility of degemination of the voiceless geminate stops:

(5) Intervocalic stop drag chain from Latin to Old Spanish

1. /b d g/ > [β ð ɣ]
↑
2. /p t k/ > [b d g]
↑
3. /pp tt kk/ > [p t k]

In the case of the geminate voiced occlusives /bb dd gg/, the above solution was untenable; their singleton correspondents, already being voiced, could not weaken through voicing to leave them phonemic 'room' to degeminate. Degemination here resulted rather in merger with singleton congeners. Note that the occurrence of these voiced geminates was so rare that the loss of contrast was trivial, and researchers have commonly paid scant attention to them (Lloyd 1987:243; see also Harris-Northall 1990:6).[6] I account for the loss of these segments below.

2. Phonetic underpinnings

2.1 Duration as a key distinctive feature

All of the changes described above are linked along the phonetic dimension of closure duration. Recourse to this feature thus provides a straightforward means of approaching the data. Indeed, the importance — perhaps the primacy — of duration as a basis for certain phonological distinctions is either supported directly or implied in a great deal of work.

Categorical distinctions between singletons and geminates have been found in numerous studies — including work on Italian — to be almost exclusively a function

5. The alternative, a push chain, suggests a level of speaker awareness that is, I find, counterintuitive to general concepts of sound change. That is, it would suggest that speakers, realizing that a particular sound change was threatening to neutralize a contrast, apply some compensatory change to prevent it.

6. Kirchner (2001) demonstrates the markedness of voiced stop geminates as highly effortful segments. He cites Ohala (1983), who explains in terms of aerodynamics why voiced obstruent geminates require more effort than their voiceless counterparts: maintaining the trans-glottal air pressure differentials required for voicing over a sustained period of stop closure is an articulatorily costly maneuver. See also Podesva (2000) and Hayes and Steriade (2004) for the markedness of voiced geminate stops.

of closure duration (Rochet and Rochet 1995, Giovanardi and Di Benedetto 1998, Esposito and Di Benedetto 1999, Mattei and Di Benedetto 2000, for Italian; Cohn *et al.* 1999, for various languages of Indonesia; Arvaniti 1999, for Cypriot Greek; Shrotriya *et al.*1995, for Hindi). Similarly, voiceless/voiced geminate distinctions are at least partly acoustically coded in terms of duration: findings by Esposito and Di Benedetto (1999:2058) show that voiced geminates are always shorter than their voiceless counterparts. Indeed, voiceless geminates are as a class longer than voiced ones.[7]

Voiced and voiceless singleton stops are also distinguished by closure duration, with voiceless stops showing longer closure than voiced (Diehl *et al.* 1990, Kent *et al.* 1996). Similarly, Lavoie (2001:159) finds the main acoustic correlate of stop lenition in Spanish to be lessening of duration rather than vocal fold vibration. In her data, putative voicing lenition of intervocalic stops in Spanish is most consistently represented in the acoustic signal by durational distinctions, with true voicing only obtaining in a subset of cases. Indeed, she concludes that voicing is often only a percept: "A decrease in the duration of a gesture will yield the percept of voicing of a voiceless stop or the percept of degemination" (Lavoie 2000:217). Note, too, that in both her Spanish and English data, voiceless stops are as a class longer than all voiced stops (2000:136), in line with Catford (1977), who claims that voiced stops are universally shorter than voiceless ones. Lavoie moreover cites numerous studies providing evidence of duration as a sufficient cue to voicing distinctions (Lavoie 2000:136–9). Lewis (2002), citing studies by Machuca-Ayuso (1997) and Zampini and Green (1999), similarly argues for the primacy of closure duration in voiceless/voiced stop distinctions in Spanish; he characterizes real voicing as an ancillary cue "at best" in intervocalic position. These findings accord with results of experiments in both English and Spanish. Lisker (1957) finds that English-speakers perceive *ruby* as *rupee* when the bilabial's closure duration is increased. Martínez-Celdrán (1993) also finds evidence of duration-based categorical perception in Spanish: closure duration above a set threshold is perceived as voiceless, below the threshold as voiced. In this light, duration-based distinctions seem to be a principal means of marking voiceless/voiced geminate contrasts in real time and clearly play a role in voiceless/voiced singleton stop distinctions.

As for approximantized (singleton) stops, Lavoie finds that approximants are the products of a decrease in both the duration and magnitude of the stop gesture (Lavoie 2001:166–7). This is in line with other evidence that approximantized voiced stops in Spanish show lesser duration than their occlusive counterparts (Romero 1996).

7. Esposito and Di Benedetto's graph shows some exceptions to this rule: before /i/, the geminate /k:/ is only fractionally longer than geminate /d:/ and fractionally shorter than /b:/, while before /u/, geminate /k:/ is only fractionally longer than /d:/. In the context of central /a/, these data show clear voice-based duration distinctions. It seems safe at this point to assume that, in general, voiceless geminates are longer than voiced geminates, a relationship that certainly holds for individual places of articulation. Ham (1998) does find, however, that duration-based distinctions are less robust between voiced/voiceless geminates than between singletons. I assume here that this only contributes to the markedness of voiced geminate stops and their eventual loss in Late Spoken Latin.

2.2 Voicing

The above should not be taken to suggest that voice does not provide an important cue in voiceless/voiced stop distinctions in medial position. Kent *et al.* (1996) cite, in addition to closure duration, both the voice bar (voicing during or just after closure) and F0 cues, while Diehl *et al.* (1990) cite these cues as well as lengthening/shortening of the preceding vowel.

As noted above for voiced geminate stops, voicing during oral closure requires that supraglottal pressure remain less than subglottal to ensure continued vocal fold vibration. This can be accomplished by expansion of the phonating cavity before the point of occlusion, typically via relaxation of the cheeks, active tongue root advancement, or other such maneuvers (see Ladefoged and Maddieson 1996:50 and references cited therein). Passive devoicing still readily occurs cross-linguistically and requires that voicing be reinitiated following consonantal release. The delay in voice onset time (VOT) is a major cue to voiceless/voiced distinctions: very short lags (or no lag with prevoicing) mark voiced stops, longer lags voiceless (unaspirated) stops, and the longest intervals voiceless aspirated stops (Lisker and Abramson 1964). In the case of Spanish, Lisker and Abramson (1964) find negative VOT values — indicating prevoicing — for initial voiced stops but do not consider intervocalic position due to the approximantization noted above. This is because approximants, as non-occlusive segments, should not interrupt voicing. I return to this below. Note, too, that phonemic distinctions along a VOT continuum typically parallel a three-way voiced/voiceless unaspirated/voiceless aspirated contrast. In Spanish, a non-aspirating language, the VOT distinction becomes a simple twofold voiced/voiceless one. Given this, I take VOT distinctions to be an aspect of the basic voicing distinction targeted here.

2.3 Other cues

The other acoustic cues mentioned above — fundamental frequency (F0) contrasts and preceding vowel length — are not integrated into this analysis. The influence of a preceding vowel's duration on the perception of a following consonant's length has met some controversy in the literature. Fowler (1992) raises important questions concerning the validity of the premises on which much of the work on this putative effect is based. Diehl *et al.* (1990) moreover cite results by a study by Javkin (1976) that finds that voicing during consonant production actually creates a percept of lengthening in the preceding vowel, such that lengthened vowels before voiced consonants could be viewed as an effect rather than a cause. Finally, Esposito and Di Benedetto (1999) posit that evidence of an effect based on preceding vowel duration in geminate/singleton distinctions is better viewed as a function of overall speech timing.

I similarly do not look at F0. Though F0-based cues doubtless play a role in voiced/voiceless stop contrasts, I take these to be enhancement strategies (see Diehl *et al.* 1990) and abstract away from them. I do this in part to avoid an excessive degree of complexity in the analysis, but also because duration- and voice-based cues to geminate/singleton and voiceless/voiced contrasts seem relatively uncontroversial and constitute both necessary and sufficient conditions for the contrasts in question.

3. Theoretical Preliminaries

3.1 Dispersion Theory

DT (Flemming 1995, 2002) picks up on Lindblom's (1986) work in Adaptive Dispersion in vowel systems. Lindblom shows that vowel inventories tend to develop in such a way as to maximize contrastiveness by dispersing the vowels in the auditory space. Thus, the cross-linguistically common five-vowel system of /i e a o u/ not only differentiates vowels in terms of tongue height (acoustically, F1 values) and frontness/ backness (F2 values) but also via lip-rounding in the back vowels, which serves to further lower formants and thus enhance the important F2 distinction.

Flemming applies these ideas to the evolution of language inventories, positing conflicting drives that shape inventories of contrasting segments. He formalizes these concepts as three basic goals underlying the selection of phonological contrasts in languages: 1) to maximize the number of contrasts; 2) to maximize the distinctiveness of contrasts; and 3) to minimize articulatory effort. The first goal enriches the communicative potential of the language, the second ensures an optimal degree of perceptibility, while the third lessens the articulatory cost of such distinctions. These goals obviously conflict: a maximal number of phonemes reduces the degree to which they can be acoustically contrastive, while articulatory effort is impacted by the required degree of refinement needed to maintain contrasts. DT thus formalizes the insight evident in most historical accounts of the chain shift in question (e.g. Lloyd 1987, Penny 1991): the systematic nature of the changes serves to preserve meaningful contrasts in the language.

As OT models phonological processes (and indeed grammars) as the interaction of conflicting, universal constraints, DT's conflicting drives are readily integrated into the framework. Flemming (1995) models the drive to maximize the perceptual distance between contrasting forms as the constraint family MinimumDistance (MinDist), which require that a particular perceptual distance be maintained along some acoustic dimension (F=feature). The MinDist constraints naturally fall into a fixed ordering, as any satisfaction of a greater perceptual distance implies satisfaction of the (necessarily higher ranked) lesser distance.

(6) Implicational hierarchy of MinDist constraints
MinDist (F=1) >> MinDist (F=2) >> MinDist (F=3, etc.

The drive to minimize articulatory effort is encoded by markedness constraints. Here I use Kirchner's (2001) Lazy to formalize general lenition, widely observed in the historical data:

(7) Lazy Minimize articulatory effort

Other, less general constraints are invoked as they become relevant to the analysis (see below).

To formulate the drive to maintain contrasts, I diverge here from Flemming (1995) in adopting Padgett's (2003a, b) *Merge constraint:

(8) *Merge No output word has multiple correspondents in the input

*Merge is formulated as a faith constraint, while Flemming's (1995) original program was wholly output-based. Padgett (2003a,b) argues that faithfulness is necessary in the theory to explain the tendency to preserve identity (crucial here for diachronic transmission of grammars). However, since conventional faith constraints only maintain contrasts indirectly by requiring input-output identity on a piecemeal basis, a constraint is also required that makes a direct appeal to contrast maintenance. *Merge does this by militating against neutralization.

To illustrate, consider the voiced geminate stops in Latin. Their maintenance in the early inventory (Fig. 1 above) despite their articulatory cost suggests that faithfulness — both to systemic contrasts (*Merge here) and individual segment features (Ident, enforcing input-output faith to a particular feature) — outranks markedness (say, *Gem^{dd} 'no voiced geminate stops', grounded in the articulatory cost of maintaining voicing during a prolonged stop closure). This is modeled in Tableau 1.

(9) Tableau 1: Voiced geminate stops in Latin

/tt dd t d/	*Merge	Ident(dur)	*Gem^{dd}
a.☞ tt ~ dd ~ t ~ d			*
b. tt ~ t ~ d (< dd)	*!	*	

Candidate 9a is more harmonic than 9b, which fatally violates the top-ranked constraint penalizing neutralization. Note that 9b also inevitably violates the Ident faith constraint, which here targets duration as an acoustic cue (see below). As Padgett (2003a,b) points out, violation of *Merge always entails violation of some conventional faith constraint, though the inverse is not true; some feature could change that does not incur merger, as we will see below. It is important to understand that if we assume that /dd/ simply shortens its duration and merges with /d/, then [d] in 9b now represents both underlying /d/ and /dd/, with the latter thus accounting for 9b's Ident(dur) violation. Of course, ranking *Gem^{dd} above the faith constraints would model loss of the voiced geminate stops, as is illustrated more completely below.

As is, Tableau 1 presents a rather conventional OT conflict between faith and markedness. In Section 4, MinDist constraints are integrated into the tableaux to formalize the notion of systemic markedness that informs the evolution of the stop series. Before engaging in the analysis, however, I turn to the assumptions underlying the approach to historical change, outlined in the following section.

3.2 Integrating historical change into OT

Early work in the OT framework that analyzed historical processes (e.g. Gess 1996, Holt 1997) emphasizes the concept of variant constraint rankings over time to model diachronic change. While this approach is not new or unique to OT — Labov (1965) emphasizes the importance of synchronic processes in much historical change — treating different stages of a language over time as overlapping synchronic 'snapshots' does lend itself to OT's much touted universal relevance; language- or, in this case, grammar-specific rankings of universal constraints are as effective in formalizing intra-linguistic variation (both dialectal and diachronic) as that obtaining across different languages. Simple reranking from one phase to another is, however, merely descriptive, and a number of researchers have questioned the justification for such rerankings (see Holt 2003a for a detailed discussion of these issues). In a sense, OT practitioners have sometimes put the cart before the horse in their assumption that if constraints rerank, the language will follow.

More recent work in the field (e.g. Anttila & Cho 1998, Cho 1998, Holt 2003a, this volume) motivates constraint reranking (as grammar change) over time in terms of language variation, subsequent phonologization of change, and eventual transmission via the language acquisition process. In essence, language learners structure their grammars in terms of the output they encounter (see Tesar & Smolensky 2000). Thus, if by some process A > B in their parents' grammar they do not encounter a form A, they have no reason to posit (an utterly abstract) A as an underlying form, choosing rather B in a process called *lexicon optimization* (Prince and Smolensky 1993). Reranking occurs as grammars are restructured to account for the changes. More specifically, Gnanadesikan (1995) posits that children begin the acquisition process with maximally unmarked grammars, in which markedness constraints outrank all faithfulness; as they encounter marked forms in the output around them, faith and markedness constraints shift accordingly in the grammar. Constraint reranking then takes place intergenerationally as part of the acquisition process.

But then why does A > B arise? We must imagine a Labovian-style cauldron of language change, some of it arising randomly from the very fact of change itself (the vagaries inherent in any human activity), some more focused, responding to articulatory demands (minimizing effort) or auditory ones (giving rise to more felicitous language transmission via more distinctive cues between contrasting segments). Such changes are propagated or not as a function of factors that are often unknowable to phonology. The job of the phonologist is to determine to what extent measurable factors — production- or perception-oriented — can be reasonably hypothesized to shape the changes.

Consider again the loss of voiced geminate stops in Latin. Here we may plausibly view the loss as production-driven. As speakers variably merged this segment with singleton /d/ due to its articulatory cost, learners of this grammar would encounter this sound less and less in the output until they at last had no reason to formulate /dd/ as an underlying form. With no related faith constraint to rank above markedness (*Gem^{dd}), this form would simply never surface in their grammars.

Anttila and Cho (1998) posit that such change goes through a three-part process whereby a stable grammar A moves through a transitional grammar B — characterized by variability — on the way to a new stable grammar C. Grammar B reflects rather fluid constraint interaction, as speakers variably introduce a change. When this spreads and is acquired by language learners, a stable Grammar C arises. We will see this process in the analysis of the stops in the following section.

4. A dispersion analysis of stop contrasts

4.1 Spanish

As discussed in Section 3.1, MIN(IMUM)DIST(ANCE) constraints set limits on margins of contrast along some auditory dimension. I integrate the relevant cues (duration and voice) into the analysis via a single scale.

(10) Medial stop auditory contrasts

	tt	dd	t	d	ð	Ø
duration	5	4	3	2	1	0
voice	–	+	–	+	+	

Note that the scale is wholly phonologized (categorical) and thus only broadly reflects quantitative phonetic differences. While this idealizes the situation somewhat, it also reflects the general limits imposed by the human auditory system as evinced cross-linguistically. In terms of the duration-based hierarchy, there is little evidence of additional gradations (Ladefoged and Maddieson 1996:93).[8] And while some languages (e.g. Hindi) employ much finer VOT distinctions to contrast stops through aspiration, Spanish, a non-aspirating language, recognizes only a binary voiced-voiceless contrast, reflected in the binary values given in (10). Integration of the separate cues into a single value also reflects the fact that in most systems these two cues operate together in phonological contrasts. Finally, this approach also prevents having to posit two separate MINDIST series, which would add significant complexity to the analysis.

Degree of contrast between members is calculated as a duration and voice 'differential' based on the scale in (10). Thus /tt/ contrasts with /d/ by a factor of 4, i.e. 3 degrees of duration difference plus 1 voicing difference. /t/ differs from /ð/ by a factor of 3, and so on.

We may thus posit a series of MINDIST constraints targeting the dimension of contrast in question (which I call simply DV):

8. Ladefoged & Maddieson only discuss the two-way geminate/singleton distinction. In their discussion of traditional fortis/lenis distinctions, however, they seem to recognize that, at least in some cases, length likely functions as a contrastive feature between singleton stops (Ladefoged and Maddieson 1996:95–98). Sources cited therein also suggest that duration is a more reliable distinguishing feature than actual voicing.

(11) MinDist$_{(DV=1)}$ >> MinDist$_{(DV=2)}$, etc.
Have a minimum DV distance 1,2, etc.

Markedness constraints also come into play. Lazy, as noted above, serves as a sort of macro-constraint encoding the general drive to minimize articulatory effort. Lazy is taken here to drive the lenition of stops via lessening of gestural duration and magnitude. Lazy thus subsumes *Gem^{dd} cited above, a more specific markedness constraint grounded in the articulatory effortfulness of voicing geminate stops.

These constraints allow us to posit a tableau that generates the original plosive inventory of Latin (I focus on the coronal series rather than the velars or labials for expository convenience):

(12) Tableau 2: 'Classical' Latin

/tt dd t d/	*Merge	ID(DV)	MinDist2	MinDist3	*Gem^{dd}
a. ☞ tt ~ dd ~ t ~ d				*****	*
b. tt ~ dd ~ t ~ ð		*!		***	*
c. tt ~ t ~ d (< dd)	*!	*		**	
d. tt ~ t ~ ð (< d, dd)	*!	**		*	
e. (tt >) t ~ d (< dd)	*!*	**		*	

As in Tableau 1, high-ranked faith characterizes this highly conservative system, enforcing both the quantity (via *Merge) and quality (via Ident) of contrasts. Duration- and voice-based differentials are consistent (2 on our scale). Cohorts providing more favorable auditory contrasts via merger (12c,d,e) fatally violate faith constraints. 12b violates Ident(DV) but not *Merge, as it alters /d/ durationally without sacrificing a contrast.

Following Anttila and Cho's (1998) three-stage transition model, we can now posit the second, unstable grammar. Imagine that *Gem^{dd} was competing with *Merge and Ident, rising or falling below it in the ranking, according to speaker or even register. This is akin to Boersma and Hayes' (2001) concepts of stochastic interaction, whereby constraints in such a situation are strictly, though variably, ranked. The net result is variation: voiced geminate stops are realized varyingly among speakers as geminate and singleton. This is shown in (13) below.

(13) Transitional rankings for loss of voiced geminate stops
*Gem^{dd} >> *Merge, Ident(DV) [tt t d] ≻ [tt dd t d]
*Merge, Ident(DV) >> *Gem^{dd} [tt dd t d] ≻ [tt t d]

Eventual stabilization of *Gem^{dd} over *Merge gives rise to a more or less stable grammar modeled in Tableau 3 below, which speakers would have inherited at some point prior to the changes that later gave rise to Old Spanish. Note that in Tableau 3 the eventual winner ([tt t d]) has become the underlying representation, essential to our understanding of how synchronic change informs historical processes. New speakers acquiring the language modeled above would never hear the voiced geminate stops and consequently never posit them as underlying forms. Nor would they entertain a possible four-way contrast.

(14) Tableau 3: Stable grammar prior to Old Spanish

/tt t d/	MinDist2	*Gem^{dd}	*Merge	ID(DV)	MinDist3	Lazy
a. ☞ tt ~ t ~ d					**	*
b. t ~ d ~ ð	*!			***	**	
c. tt ~ t ~ ð				*!	*	*
d. (tt >) t ~ d			*!	*	*	*
e. (tt >) t ~ ð			*!	**		*

Minimum distance differentials are stable (MinDist2 was never in doubt), with no merger and faith to the dominant cues of duration and voice, reflected in the ranking of *Merge and Ident alongside MinDist. The inclusion of low-ranked Lazy here foreshadows imminent changes, however: general lenition, of which * Gem^{dd} is a precursor, asserts itself as the language evolves toward Old Spanish. This is seen in Tableau 4 below. (I forgo schematizing tying candidates from here on out, as it is implicit in transitional grammars. Here, for example, Lazy would have toggled with MinDist(DV=2) to favor, alternately, candidate 15a or 15b.)

(15) Tableau 4: transitional grammar in Old Spanish

/tt t d/	*Merge	Lazy	MinDist2	ID(DV)	MinDist3
a. tt ~ t ~ d		*5!			**
b. ☞ t ~ d ~ ð		*2	*	***	**
c. tt ~ t ~ ð		*4!		*	*
d. (tt >) t ~ d	*!	*4		*	*
e. (tt >) t ~ ð	*!	*3		**	
f. (tt,t >) d ~ ð	*!		*	****	*

Lenition manifests itself in terms of duration and voice, favoring shorter and/or voiced segments in intervocalic position. Note that Lazy violations are tallied hereafter on a relative basis, with competing candidates ranked among themselves. Thus, the 'laziest' candidate, 15f, reduces /tt t d/ to [d ð], the two least effortful segments.[9] Bear in mind again that forms (words) are not lost in cases of merger but are rather still represented by merged sounds. That is, 15f merges formerly contrastive segments (/tt t/) as [d ð], but no words are lost: [d ð] are simply more common across the lexicon. 15b is ranked the second least effortful: [t d ð] shows overall less articulatory effort than 15c's [tt t ð], 15a's [tt t d], or even the [t d] of 15d or [t ð] of 15e, which are in effect [t t d] and [t t ð], respectively.

Despite the effects of lenition, the three-way contrast is conserved here (*Merge >> Lazy), though at some cost in auditory distinctiveness (Lazy >> Ident(DV)). That is, the winning candidate now violates MinDist2, since [d~ð] only differ by 1 on our

9. A reviewer questions whether /d/ should be seen as less effortful than /t/. I follow Westbury & Keating (1986) in seeing the stopping and restarting of voicing between voiced segments (i.e. intervocalic /t/) as more costly than simple maintainence of voice in intervocalic /d/. /d/ is also of lesser duration. Note that in this light, the DV scale of (11) also serves as a weakening scale, omitting the highly effortful voiced geminate stops.

scale. Tableau 4 also demonstrates the autonomy of *Merge as a sort of 'systemic faith' constraint: it is no longer in lock step with Ident(DV); contrasts are maintained even though faith to duration and voice features is violated several times.

Once new speakers had acquired the language from the outputs in Tableau 4, restructuring would take place and stabilize the system. This is reflected in Tableau 5 with adjusted underlying forms and faithfulness.

(16) Tableau 5: Stabilized Old Spanish

/t d ð/	*Merge	ID(DV)	Lazy	MinDist2	MinDist3
a. ☞ t ~ d ~ ð			*2	*	**
b. t (< d) ~ ð	*!	*	*3		
c. (t >) d ~ ð	*!	*		*	*

*Merge and faithfulness are top-ranked, with Lazy and MinDist2 ranked below, since both constraints favor different winning candidates.

The scant margin of acoustic distinctiveness between /d ð/ is redressed in modern Spanish. /d ð/ merge, resulting in a wider overall margin of acoustic contrast. This is modeled in Tableau 6, where MinDist constraints rise to compete with *Merge and Ident(DV):

(17) Tableau 6: transitional grammar in Modern Spanish

/t d ð/	(MinDist2)	MinDist3	*Merge	ID(DV)	Lazy
a. t ~ d ~ ð	*	**			*3
b. t ~ d (< ð)		*	*	*	*4!
c. ☞ t ~ (d >) ð			*	*	*2
d. (t >) d ~ ð	*	*	*	*	

Minimum distancing eventually outweighs both faith (*Merge, Ident) and articulatory efficiency (Lazy) in the interest of providing more felicitous margins of contrast. The winning candidate increases this margin to 3. This system thereafter was stabilized as seen in Tableau 7.

(18) Tableau 7: Stabilized grammar in Modern Spanish

/t ð/	MinDist3	*Merge	ID(DV)	Lazy
a. ☞ t ~ ð				*2
b. t ~ d	*!		*	*3
c. t (< ð)		*!	*	*4
d. d ~ ð	*!		*	*1
e. (t >) ð		*!	*	

This is of course the current system in Spanish. Maintenance of a dual contrast in intervocalic position is reflected in top-ranking of *Merge and Ident. Lazy is dominated to prevent further weakening (but see below). Note that no strict ranking of the (tied) top-ranked constraints would change anything; 18a harmonically bounds all the others.

I would stress here that our only really viable means of understanding [t~ð] contrasts in modern Spanish is through recourse to concepts of dispersion. Given the ongoing prevalence of lenition in this context in many Spanish dialects (see analysis of Cuban below), we have no other intuitive way to explain why the voiceless segments — in the same context, with the same points of articulation — should resist the weakening that affects their voiced congeners. We could appeal to faithfulness, of course, but that does not seem satisfying from a functionalist viewpoint. Moreover, faithfulness cannot explain why the changes took place originally. Only contrast maintenance provides a viable means of checking voiceless stop lenition in intervocalic position.

To complete the present analysis, the following table (19) details the crucial constraint rankings that motivate the historical changes traced above. It reflects the general model of Anttila and Cho (1998): the first column establishes the originating stable system; the second shows the crucial 'toggling' of competing constraints, with the boldface indicating the eventual dominant drive; the third column shows the re-established stable system. Note that the bolded constraints describe the general trends that have shaped the intervocalic stop system: articulatory markedness, targeting reduced effort, drives loss of geminates, voicing, and approximantization, while the drive to provide greater auditory distinctiveness 'remediates' a too-crowded (in the acoustic space) formset into modern Spanish.

(19) Overview of constraint interaction

Grammar A →	Grammar B →	Grammar C
Classical Latin: loss of voiced geminate stops		
MinDist2, *Merge, ID(DV) >> *Gem^{dd}	*Merge, ID(DV) >> << ***Gem**	*Merge, ID(DV), MinDist2 >> Lazy
Latin to Old Spanish: systemic weakening to [t d ð]		
*Gem, *Merge, ID(DV), MinDist2 >> Lazy	ID(DV), MinDist2 >> << **Lazy**	*Merge, ID(DV), MinDist2 >> Lazy
Old Spanish to Modern Spanish: merger and better contrast		
*Merge, ID(DV) >> Lazy, MinDist2	*Merge, ID(DV) >> << **MinDist3**	MinDist3, *Merge, ID(DV) >> Lazy

4.2 Residual issues and elsewhere in Romance

In this section I sketch analyses in similar terms of variation both within and outside Spanish. I begin with variant stop realization in different contexts in standard Spanish. I have concentrated solely on intervocalic position here due to the fact that Latin geminates and the historical chain shift occurred only in that environment. Intervocalic position has long been recognized as perhaps the prime weakening environment, and we have seen the prime role that lenition plays in the historical processes under examination. Since we are working within the DT framework that targets entire language systems, however, we must also consider contrasts in other environments. Here I limit myself to voiced and voiceless stop contrasts in word- and utterance-initial positions in Spanish.

In word-initial position we see the same stop/approximant contrasts as in intervocalic position: [t ð] for coronals, [p β] for labials, [k ɣ] for velars. Hence, *la* [t]*oma* '(s)he takes it'~ *la* [ð]*oma* '(s)he tames it'. However, in utterance-initial position (after a pause or silence), the voiced stops are realized as fully occlusive (as they are after nasals). This outcome seems somewhat problematic for a theory that underscores the maintenance of meaningful contrasts and contrastive margins, since utterance-initial position may be viewed as a particularly salient position and hence one in which one might expect a premium to be placed on contrastiveness. The same can be claimed for word-initial position, however, where full [t~ð] contrast is indeed observed, and so I submit quite simply that the drive to strengthen segments in prosodically salient positions (see Fougeron and Keating 1997) outranks the MinDist3 constraint enforcing margins of contrast. Following Baker and Wiltshire (2003), let us invoke a constraint HOnset "have harmonic onsets" (after HNuc of Prince and Smolensky 1993) that enforces maximally strong onsets. We then explode HOnset into an implicational hierarchy in accordance with Fougeron and Keating's (1997) findings that degrees of fortition parallel a hierarchy based on relative prosodic prominence (utterance-initial > word-initial > syllable-initial):

(20) Implicational hierarchy of harmonic onset constraints
$\text{HOnset}|_{\#} >> \text{HOnset}|_{w} >> \text{HOnset}|_{\sigma}$
Have strong onsets utterance-, word-, then syllable-initially

By ranking MinDist3 between $\text{HOnset}|_{\#}$ and $\text{HOnset}|_{w}$, we account for the occurrence of [d] in utterance-initial position.

(21) $\text{HOnset}|_{\#} >> \text{MinDist3} >> \text{HOnset}|_{w} >> \text{HOnset}|_{\sigma}$
[t d] ≻ [t ð]

A similar constraint could enforce occlusivization after nasals, a common assimilatory process crosslinguistically (see e.g. Kirchner 2001).

The current analysis responds to dialectal variation, as well. Certain dialects of Spanish reveal variant rankings from those in (18), with Lazy dominating MinDist3 and Ident(DV) but not *Merge, such that /t/ is realized as voiced intervocalically. This has been observed in Havana Spanish by Lipski (1994). Note, however, that though MinDist3 (and MinDist2) are theoretically violated by the intervocalic [d ~ ð] contrast, Caribbean dialects often weaken [β ð ɣ] to the point of deletion, in which case [d] 'contrasts' with [Ø], a possibility contemplated in our duration/voice scale (10) above. In any event, lenition is clearly an ongoing drive in Spanish dialects, particulary in fast-speech registers.

A contrastive zero realization of /b d g/ occurred in the history of Portuguese, as well. As in virtually all of Western Romance, degemination and voicing of voiceless stops took place from Late Spoken Latin into early Galician/Portuguese in what also constitutes a chainshift. Geminates simplified to singletons, their singleton congeners voiced, while voiced stops either fricativized (/b/ > [v] L.FABAM > *fava* 'bean') or suffered deletion (d > Ø, L.SEDEM > *see*, *sé* 'seat'; g > Ø, L.SIGILLUM > *selo* 'stamp'; data from Parkinson 1988). Here I abstract away from the spirantization of /b/ and vocalization of /g/ before front vowels (L.REGEM > *rei* 'king') to focus on the overall weakening pattern implicit in the deletion of /d g/. We may view this as parallel to the Spanish reflexes but with an additional degree of weakening that effectively bypasses the auditorily crowded /d~ð/ phase of Old Spanish. That is, weakening of voiced stops in Portuguese proceeds all the way to zero. Such deletion of segments is modeled in OT by variant ranking of Max ('no deletion', Prince and Smolensky 1993). Max would be top-ranked in Spanish (not shown in tableaux above), thus barring outright deletion even as lower-ranked Ident(DV) permits featural changes. By contrast, this faith constraint in Portuguese is ranked alongside Ident and below Lazy, allowing for deletion. This is shown in (22) below.

(22) Tableau 8: Late Spoken Latin into early Galician/Portuguese

/tt t d/	*Merge	MinDist2	Lazy	Max	ID(DV)	MinDist3
a. tt ~ t ~ d			*6!			**
b. t ~ d ~ ð		*!	*3		***	**
c. tt ~ t ~ ð			*5!		*	*
d. tt ~ d ~ ð		*!	*4		**	*
e. ☞ t ~ d ~ Ø			*2	*	***	*
f. t ~ ð ~ Ø		*!		*	***	
g. (tt >) t ~ ð	*!		*4		**	

Top-ranked *Merge and MinDist2 force a three-way contrast with minimum distances of 2 on our scale, eliminating 22b, d, f, and g. In the case of 22f, I view the approximant as being too close to zero (the deleted segment) to satisfy this minimum distance. This is crucial, as 22f would otherwise be optimal under Lazy, which ultimately does determine the winner. 22e emerges as optimal in an example of emergence of the unmarked: with higher-ranked constraints satisfied, it is the least marked candidate (under lower-ranked Lazy) that is most harmonic. Note that I also assume here that, at this transitional stage of the language, deletion is not tantamount to merger in that speakers innovating the change were still aware of an underlying form. Thus, a zero-marked form such as Port. *seØe* (< SEDEM) still maintains a contrast with forms distinguished from it solely by the presence of [t] or [d]. It is not until restructuring and lexicon optimization take place — with speakers positing no underlying form for this [Ø] and thus losing an active contrast with /t d/ — that systematic contrast is truly lost. At this stage, then, candidates 22e–f do not violate *Merge. Note finally that evidence of ongoing weakening of /b d g/ in dialects of Portuguese Portuguese (Parkinson 1988:139) suggests some toggling of Lazy >><< Ident(DV) in current Portuguese grammars.

Finally, standard Italian as it is currently known is straightforwardly modeled in this analysis. This conservative grammar retains voiceless and voiced geminate stops and voiceless and voiced singleton stops with little evidence of lenition. We model this grammar by ranking our faith and smaller margin MinDist constraints over lenition and wider margins:

(24) Standard Italian stop contrasts
*Merge, Ident, MinDist(DV=2) >> Lazy, MinDist(DV=3)
[tt dd t d] ≻ [t d ð], [t ð], etc.

Note that southern and central Italian dialects have maintained the geminate /tt/ even while weakening /t/ to [d] and /d/ to [ð] intervocalically (Walsh 1991:152). This apparently 'mixed' system is more challenging, featuring a degree of conservatism alongside significant weakening. I leave the analysis of these dialects for future work.

5. Other accounts

The chain shift dealt with here has not gone unnoticed by linguists and historians of Spanish. Researchers have long acknowledged the dominant role of lenition, though only occasionally advancing full-blown analyses of the array of sound changes involved.

Martinet (1964) considers language contact and suggests that the Celtic substratum, with its widespread intervocalic consonant lenition, influenced Latin. Given the systemic, internally driven focus of the present work, I do not take such external influences into account even as I accept that substratal elements may well have played some role. However, any valid synchronic analysis must be able to account for such change within its own bounds, particularly when such historical language-contact phenomena are so notoriously difficult to prove. Furthermore, given pervasive intervocalic lenition in modern dialects (e.g. *he hablado* 'I have spoken' [e.a.βlaw]; *fabula* 'fable' [faw.la]), it does not seem necessary to posit a prime role for external motivations.

Alarcos Llorach (1965) suggests a systemic account: an increase in geminates arising from assimilations in consonant clusters such as RS (> ss) or PT (> tt) led to an imbalance, which was redressed by simplification of the geminates. This sets off the chain reaction that voices voiceless stops and approximantizes voiced ones. This push chain analysis, like Martinet's, undermines the phonetic naturalness of intervocalic weakening; intervocalic stops tend naturally to weaken, regardless of their relative frequency in the inventory. Indeed, the total assimilation of implosive consonants in these clusters may itself be viewed as a kind of weakening, such that the new geminates created are a result rather than a cause of lenition.

Harris-Northall (1990) opts for a scalar approach. He views the historical changes in terms of a strength hierarchy, taken from Foley (1977). This hierarchy closely parallels my DV scale in function, providing a continuum along which all the changes can be reconciled, even when these changes do not match up step for step: kk > k > g > ɣ, tt > t > d > ð, etc. Harris-Northall recognizes the difficulty of providing one elegant formulation of apparently divergent processes in a rule-based approach: the attempt to capture generalizations through collapsed rules "destroys all the transparency and explicability of a basically clear phonetic change" (Harris-Northall 1990:29). This underscores the advantage of the approach espoused here: one common process — lenition in terms of closure duration and voicing — links all the changes in question. Moreover, the OT architecture featuring constraint interaction captures generalizations: lenition as a single constraint drives the temporal weakening of all the stops.

Holt (1999, 2003b) addresses the loss of Latin geminates and provides analysis in the OT framework, drawing a parallel between the loss of distinctive length in the Latin vowel system and the degemination processes seen above. He posits that a drive for systemic parity forced degemination in order to create better balance with the vowel system. Extending the ideas of Zec (1995), he concludes that the absence of long vowels in a language should imply absence of long consonants. These arguments crucially link sonority and moraicity: the more sonorous a segment, the more licensed it is to bear a mora (the unit of syllabic weight). This would follow naturally from the universal moraicity of vowels. Consonants, less sonorous, are themselves banned from underlying moraicity unless geminate, in which case they are held to bear a mora (see Hayes 1989). Holt posits that a ban on moraic consonants systematically rose in the grammar, following the sonority hierarchy to degeminate first obstruents, then nasals, laterals, and rhotics.

This approach is both elegant and tempting, particularly given the long resistance of geminate sonorants to degemination (see next section). Very generally, however, it fails to link degemination with voicing and approximantization of singletons, since it posits special phonological motivation behind loss of moraic segments. This in essence relegates lenition to an incidental process, at least in the case of geminates. More specifically, I see a basic problem with the assumption that there is an integral link between long vowels and long (i.e. geminate) consonants. Cross-linguistically, long vowels are far more common than geminates, which are themselves relatively rare. This would seem to support Holt's assumption: long vowels are less marked and thus obtain more often. However, we do not see that long consonants only arise in systems with long vowels, which we might also expect were both inventories subject to common constraints on phonological length contrasts. As the author notes, Italian and Sardinian both have long consonants but no long vowels. A second problem with Holt's premises has to do with the supposed relationship between geminates and sonority. There is no compelling cross-linguistic evidence that languages favor more sonorant segments for gemination. As noted above, voiced obstruents are far less common than their voiceless counterparts, despite being theoretically more sonorous (see Kirchner 2001, Hayes and Steriade 2004). Moreover, Podesva (2000) finds typological evidence implying an inimical relationship between high sonority and gemination. His forty-language survey shows geminate nasals to be more common than liquids, themselves more common than glides, which suggests that one might explode a general ban on geminates into an implicational hierarchy of $*\text{G}\textsc{em}_{glide} >> *\text{G}\textsc{em}_{liquid} >> *\text{G}\textsc{em}_{nasal}$, quite the contrary of the sonority-based hierarchy Holt (1997, 1999) proposes. In this light, Holt's phonology-driven approach, if accurate, seems to controvert much typological and phonetic evidence.

Wireback (1997) argues that speakers maintain contrasts in line with established strength patterns, reversing weakening processes when necessary in order to (re)establish jeopardized contrasts. His approach acknowledges the drive to maintain meaningful contrasts under threat of merger by lenition and as such generally accords with the present treatment. However, he does not bring much phonetic detail to processes that are widely attested and hence quite unmarked cross-linguistically (intervocalic weakening and its nature). My account provides greater phonetic detail and formalizes the sound changes in a quantifiable model that allows for ready application to other dialects.

6. Discussion and conclusions

6.1 The palatal geminates and the trill

The geminate sonorants of Latin (/nn ll rr/) could not follow the stops in their evolution. Indeed, duration-based distinctions with singleton counterparts /n l/ persisted for centuries after the loss of the geminate occlusives (Alarcos Llorach 1971), with the rhotic contrast arguably never being lost.[10] Clear articulatory and acoustic bases underlie the behavior of /nn ll/, as they are far more constrained in terms of voicing and stricture options than the stops. These sonorants "depend on pulses from the vocal folds" for their production (Ladefoged 1996:110); voiceless nasals and laterals are thus highly marked segments. Approximantization of nasals and laterals is similarly a marked option due to perceptual factors: antiformants that arise in the production of both segments damp formant transitions (Fant 1960, Johnson 1997:153–7, Kirchner 2001:173, 256 n96; also Ladefoged and Maddieson 1996:118). Consequently, we must assume that the lenition affecting the geminate occlusives was here stymied by the markedness of both approximantized and voiceless nasals and laterals. Spanish similarly eschewed deletion of the singleton segments with nasalization of the preceding vowel, the solution opted for by Portuguese (L. BO**N**UM > Port. *bom* [bõ] 'good'; L. A**NN**UM > Port. *ano* 'year'). In essence, the nasal and lateral cohorts had 'nowhere to weaken to' while still maintaining contrastiveness, hence their resistance to the reduction affecting other singleton~geminate contrasts. I view the eventual palatalization of geminate /nn ll/ as an alternate strategy. Rather than weakening, I consider palatalization to be reanalysis (with retained geminate status; see Baker 2004, to appear) driven by a trend toward gestural condensation in the language that had already created new palatals (/nj, lj/ > [ɲ ʎ]; L.FILIA > *fi*[ʎ]*a* > *hija* 'daughter'). Duration-based cues were realigned in spatial terms, evident in the greater degree of linguopalatal contact of /ɲ ʎ/. Gesturally, we see lesser duration but greater magnitude (see Lloyd 1987:243, Recasens 1991:266; also Holt 2003b). Duration-based distinctions are lost in favor of contrasts based on salient F2 excursions.

10. I assume that a phonological geminate~singleton distinction still exists between the Spanish trill and flap, despite considerable phonetic differences undermining such a position (see Recasens and Pallarès 1999). I view differences based on lingual tension and contact to be the predictable and obligatory articulatory consequences of a duration-based geminate/singleton relationship. Variant lingual tension and precision are simply required to achieve the multiple taps that characterize the geminate's greater duration.

The resistance of /rr/ to approximantization is explicable in terms of articulation: the singleton tap, already a weak segment, could not further shorten and approximantize without risking deletion. Moreover, the highly effortful trill (see Solé 2002) has been shown to be quite resistant to coarticulatory influences, thus precluding palatalization in line with /ɲ ʎ/ (Recasens and Pallarès 1999, 2001; see also Hock 1991:120,134 and Tuttle 1997:28). Contrast maintenance has thus dictated heretofore that this distinction be retained. Note, though, that ongoing instability in modern dialects suggests that this geminate, too, is undergoing widespread reanalysis (fricativization, assibilation, velarization; see Hammond 2000).

6.2 Voicing: An epiphenomenon of duration contrasts?

Given the arguments put forth here and in the literature, it is tempting to consider a less primary role for voice in phonological contrasts than has generally been contemplated. In the present context, we might easily imagine an early pre-Latin system (call it Proto-Latin) in which duration-based distinctions dominated, with voicing arising as an enhancement strategy. Voiceless stops are typologically unmarked in the world's language systems; the presence of voiced stops in a language implies voiceless stops, but not vice versa (Maddieson 1984). If we imagine an early system without voiced consonants but in which length-based vowel distinctions were indeed present, we might also entertain the notion that length-based consonant contrasts evolved in the language independently of voice. Voicing might then have emerged (perhaps only as a percept to begin with) as a secondary characteristic to underpin duration-based contrasts. Consider Tamil, in which voicing is predictable based on the length of the stop: geminates are voiceless, singletons are voiced. Diehl *et al.* (1990) conclude that voicing in these languages is allophonic, i.e. non-contrastive. They moreover cite evidence that voicing actually creates a percept of lesser duration in stop closures, viewing voicing as an enhancement strategy to underscore duration-based distinctions (Diehl *et al.* 1990:256–7). Such a perspective implies a primary role for duration as a feature.

Now, for traditional phonological purposes, inherent durational distinctions between voiced and voiceless stops have been of little interest; length and voice are inextricably bound up together. From the perspective of phonetics, however, we would like to better understand the precise nature of linguistic evolution. While the SPE program of distinctive feature theory assigns [± voice] a prime role in phonological contrast, it cannot capture the phonetic reality that is fundamental to DT: contrasts are viewed in terms of perceptual distinctiveness involving constellations of phonetic features that may not, alone, seem to be distinctive. As such, DT's functionalist approach captures a phonetic truth wholly missed by more traditional approaches, that voice and length (and other cues, as well) both contribute to key contrasts in the Spanish system. Finally, then, voice *cum* length enhancement only provides additional evidence for the basic concepts of dispersion: systems of contrasts tend to evolve in such a way as to optimally exploit available phonetic cues while concurrently reducing articulatory complexity and effort.

6.3 Conclusion

In this paper I have motivated a broad pattern of change in the history of Spanish that has had important consequences for the phonological inventory of the language. While historians of the language have long acknowledged both the widespread effects of lenition in the evolution of the language from Latin and the apparent systemic preservation of contrasts evident in the chain shift, I have applied their insights to the basic formalism of Optimality Theory through recourse to the concepts of Dispersion Theory. With DT's direct appeal to contrast preservation and enhancement, the chain shift can be straightforwardly modeled. I have moreover brought a greater degree of phonetic detail to the analysis, the advantages of which are twofold. First, by appealing to the dual acoustic features of duration and voice, I integrate into the analysis phonetic detail that has long gone unaddressed as a non-distinctive feature. At the very least this provides better understanding of the nature of phonological change; by including a richer array of phonetic cues in the analysis, we are better able to appreciate certain aspects of allophony (see e.g. Padgett's (2003b) analysis of Russian palatalization). Thus, approximantization may well reflect intervocalic lenition but it also, on this view, provides a better contrast in terms of both voicing and closure duration than occlusive [d]. More importantly, perhaps, by recognizing and factoring in closure duration, I provide a more unified analysis of an apparent suite of changes: degemination, voicing, and approximantization, all of which seem to respond to the same drives, both to weaken intervocalic stops in terms of gestural duration and magnitude and to shore up auditory distinctiveness for more effective contrasts.

Though only sketched above, this analysis also provides some basis for the idea that in modern Spanish the underlying form of voiced stops should be viewed as the approximants, with exceptional fortition of these segments in utterance-initial position and following nasals. This is because of the proposed greater systemic markedness — in perceptual terms — of the /t ~ d/ contrast: the approximant is argued to constitute a better contrast with /t/ than does /d/.

More generally, the account provides a straightforward means of accounting for certain chain shifts without recourse to innovations to the 'classic' architecture of Optimality Theory. The surface opacity inherent in such chain shifts baffles the direct input-output mapping featured in the original theory (see McCarthy 2002:163–6). By recognizing the drive to maintain meaningful contrasts in language as a rankable constraint, we can motivate the chain shift without such mechanisms as local conjunction (Kirchner 1996) or sympathy (McCarthy 1999), which undermine key aspects of the original theory.

References

Alarcos Llorach, E. 1965/1971. *Fonología Española*. Madrid: Gredos.

Anttila, A. and Cho, Y-m. Y. 1998. Variation and change in optimality theory. *Lingua* 104: 31–56.

Arvaniti, A. 1999. Effects of speaking rate on the timing of single and geminate sonorants. *Proceedings of the International Congress of Phonetic Sciences* 14: 599–602.

Baker, G.K. 2004. Palatal Phenomena in Spanish Phonology. PhD dissertation, University of Florida, Gainesville.

Baker, G.K. To appear. An acoustic basis for palatal geminate behavior in Spanish. In New Perspectives on Romance Linguistics, Vol. 2: Phonetics, Phonology, and Dialectology. Selected Papers from the 35th Linguistic Symposium on Romance Language, Austin, Texas, February 2005. Jean-Pierre Montreuil (ed), 1–14. Amsterdam: John Benjamins.

Baker, G.K. and Wiltshire, C. 2003. An OT treatment of palatal fortition in Argentinian Spanish. In *Romance Linguistics: Theory and Acquisition*, A.T. Pérez-Leroux and Y. Roberge (eds), 33–48. Amsterdam: John Benjamins.

Baković, E. 1994. Strong onsets and Spanish fortition. *MIT Working Papers in Linguistics* 23: 21–39.

Boersma, P. and Hayes, B. 2001. Empirical tests of the gradual learning algorithm. *Linguistic Inquiry* 32: 45–86.

Browman, C.P. and Goldstein, L. 1986. Towards an articulatory phonology. *Phonology Yearbook* 3: 219–252.

Browman, C.P. and Goldstein, L. 1992. Articulatory phonology: An overview. *Phonetica* 49: 155–80.

Catford, J.C. 1977. *Fundamental Problems in Phonetics*. Bloomington IN: Indiana University.

Cho, Y.-m.Y. 1998. Language change as reranking of constraints. In *Historical Linguistics* 1995, Vol.2, R. M. Hogg and L. van Bergen (eds), 45–62. Amsterdam: John Benjamins.

Cohn, A., Ham, W. and Podesva, R.J. 1999. The phonetic realisation of singleton-geminate contrasts in three languages of Indonesia. *Proceedings of the International Congress of Phonetic Sciences* 14: 587–590.

Davis, S. 1999. On the representation of initial geminates. *Phonology* 16: 93–104.

Diehl, R.L., Kluender, K.R. and Walsh, M.A. 1990. Some auditory bases of speech perception and production. In *Advances in Speech, Hearing and Language Processing*, W.A. Ainsworth (ed.), 243–68. London: JAI.

Esposito, A. and Di Benedetto, M.G. 1999. Acoustic and perceptual study of gemination in Italian stops. *Journal of the Acoustical Society of America* 106: 2051–2062.

Fant, G. 1960. *Acoustic Theory of Speech Production*. 's-Gravenhage: Mouton.

Flemming, E.S. 1995. *Auditory Representations in Phonology*. PhD dissertation, UCLA.

Flemming, E.S. 2002. *Auditory Representations in Phonology*. London: Routledge.

Foley, J. 1977. *Foundations of Theoretical Phonology*. Cambridge: CUP.

Fougeron, C. and Keating, P. 1997. Articulatory strengthening at edges of prosodic domains. *Journal of the Acoustical Society of America* 101:3728–40.

Fowler, C.A. 1992. Vowel duration and closure duration in voiced and unvoiced stops: There are no contrast effects here. *Journal of Phonetics* 20: 143–165.

Gess, R. 1996. Optimality Theory in the Diachronic Phonology of French. PhD dissertation, University of Washington.

Giovanardi, M. and Di Benedetto, M.G. 1998. Acoustic analysis of singleton and geminate fricatives in Italian. *European Student Journal of Language and Speech* (www.essex.ac.uk/web-sls/).

Gnanadesikan, A. 1995. Markedness and faithfulness constraints in child phonology. Ms. University of Massachusetts, Amherst. (ROA).

Ham, W. 1998. Phonetic and Phonological Aspects of Geminate Timing. PhD dissertation, Cornell University.

Hammond, R.M. 2000. The phonetic realizations of /rr/ in Spanish: A psychoacoustic analysis. In *Hispanic Linguistics at the Turn of the Millennium: Papers from the Third Hispanic Linguistics Symposium*, H. Campos, E. Herburger, A. Morales-Front and T. J. Walsh (eds), 80–100. Somerville MA: Cascadilla.

Harris-Northall, R. 1990. *Weakening Processes in the History of Spanish Consonants*. London: Routledge.

Hayes, B. 1989. Compensatory lengthening in moraic phonology. *Linguistic Inquiry* 20: 253–306.

Hayes, B. and Steriade, D. 2004. The phonetic bases of phonological markedness. In *Phonetically-Based Phonology*, B. Hayes, R. Kirchner and D. Steriade (eds), 1–54. Cambridge: CUP.
Hock, H.H. 1991. *Principles of Historical Linguistics* (2nd ed.). Berlin: Mouton de Gruyter.
Holt, D.E. 1997. The Role of the Listener in the Historical Phonology of Spanish and Portuguese: An Optimality-Theoretic Account. PhD dissertation, Georgetown University.
Holt, D.E. 1999. The moraic status of consonants from Latin to Hispano-Romance: The case of obstruents. In *Advances in Hispanic Linguistics: Papers from the Second Hispanic Linguistic Symposium*, J. Gutiérrez-Rexach and F. Martínez-Gil (eds), 166–81. Somerville MA: Cascadilla.
Holt, D.E. 2003a. Remarks on optimality theory and language change. In *Optimality Theory and Language Change*, D. Eric Holt (ed.), 1–30. Boston MA: Kluwer.
Holt, D.E. 2003b. The emergence of palatal sonorants and alternating diphthongs in Old Spanish. In *Optimality Theory and Language Change*, D. Eric Holt (ed.), 285–305. Boston MA: Kluwer.
Hume, E., Muller, J. and van Engelenhoven, A. 1997. Nonmoraic geminates in Leti. *Phonology* 14: 371–402.
Javkin, H.R. 1976. The perceptual basis of vowel duration differences associated with the voiced/voiceless distinction. *Report of the Phonology Laboratory, University of California, Berkeley* 1:78–92.
Johnson, K. 1997. *Acoustic and Auditory Phonetics*. Cambridge MA: Blackwell.
Kent, R.D., Dembowski, J. and Lass, N. 1996. The acoustic characteristics of American English. In *Principles of Experimental Phonetics*, N. Lass (ed.), 185–225. St. Louis MI: Mosby.
Kirchner, R. 1996. Synchronic chain shifts in optimality theory. *Linguistic Inquiry* 27: 341–50.
Kirchner, R. 1999. Geminate inalterability and lenition. Ms. UCLA.
Kirchner, R. 2001. *An Effort-Based Approach to Consonant Lenition*. London: Routledge.
Labov, W. 1965. On the mechanism of linguistic change. *Georgetown University Monographs on Languages and Linguistics* 18: 91–114.
Ladefoged, P. 1996. *Elements of Acoustic Phonetics* (2nd ed.). Chicago IL: University of Chicago.
Ladefoged, P. and Ian Maddieson. 1996. *The Sounds of the World's Languages*. Oxford: Blackwell.
Lavoie, L.M. 2000. *Phonological Patterns and Phonetic Manifestations of Consonant Weakening*. PhD dissertation, Cornell University.
Lavoie, L.M. 2001. *Consonant Strength: Phonological Patterns and Phonetic Manifestations*. New York NY: Garland.
Lewis, A.M. 2002. Contrast maintenance and intervocalic stop Lenition: When is it alright to lenite? In *Current Issues in Romance Linguistics: Proceedings of LSRL 29, Ann Arbor, Michigan, 1999*, T. Satterfield, C. Tortora and D. Cresti (eds), 160–71. Amsterdam: John Benjamins.
Lindblom, B. 1986. Phonetic universals in vowel systems. In *Experimental Phonology*, J. Ohala and J.J. Jaeger (eds), 13–44. Orlando FL: Academic.
Lipski, J. 1994. *El español de América*. Madrid: Longman.
Lisker, L. 1957. Closure duration and the intervocalic voiced-voiceless distinction in English. *Language* 33: 42–49.
Lisker, L. and Abramson, A.S. 1964. A cross-language study of voicing in initial stops: Acoustical measurements. *Word* 20: 384–422
Lloyd, P.M. 1987. *From Latin to Spanish*. Philadelphia PA: American Philosophical Society.
Machuca-Ayuso, M.J. 1997. *Las obstruyentes continuas del español: Relación entre las categorías fonéticas y fonológicas en habla espontánea*. PhD dissertation, Universitat Autónoma de Barcelona.
Maddieson, I. 1984. *Patterns of Sound*. Cambridge: CUP.
Martinet, A. 1964. *Economie des changements phonétiques*. Bern: Franck.
Martínez Celdran, E. 1993. La percepción categorial de /b-p/ en español basada en las diferencias de duración. *Estudios de Fonética experimental* 5: 223–239.
Martínez-Gil, F. 1998. On the spelling distinction *b* vs. *u/v* and the status of spirantization in Old Spanish. In *Theoretical Analyses on Romance Languages*, J. Lema and E. Treviño (eds), 283–316. Amsterdam: John Benjamins.

Mattei, M. and Benedetto, M.G. 2000. Acoustic analysis of Singleton and Geminate nasals in Italian. *European Student Journal of Language and Speech* (www.essex.ac.uk/web-sls/).

McCarthy, J. 1999. Sympathy and phonological opacity. *Phonology* 16: 331–99.

McCarthy, J. 2002. *A Thematic Guide to Optimality Theory*. Cambridge: CUP.

Mohanan, K.P. 1986. *The Theory of Lexical Phonology*. Dordrecht: Reidel.

Ohala, J.J. 1983. The origin of sound patterns in vocal tract constraints. In *The Production of Speech*, P. F. MacNeilage (ed), 89–116. New York NY: Springer.

Padgett, J. 2003a. The emergence of contrastive palatalization in Russian. In *Optimality Theory and Language Change*, D.E. Holt (ed.), 307–35. Boston MA: Kluwer.

Padgett, J. 2003b. Contrast and post-velar fronting in Russian. *Natural Language and Linguistic Theory* 21: 39–87.

Parkinson, S. 1988. Portuguese. In *The Romance Languages*, M. Harris and N. Vincent (eds), 131–69. Oxford: OUP.

Penny, R.J. 1991. *A History of the Spanish Language*. Cambridge: CUP.

Piñeros, C.-E. 2002. Markedness and laziness in Spanish obstruents. *Lingua* 112: 379–413.

Podesva, R.J. 2000. Constraints on geminates in Buginese and Selayarese. In *WCCFL 19 Proceedings*, R. Billerey and B.D. Lillehaugen (eds), 343–356. Somerville MA: Cascadilla.

Prince, A. and Smolensky, P. 1993. *Optimality Theory: Constraint Interaction in Generative Grammar*. Piscataway NJ: Rutgers Center for Cognitive Science.

Recasens, D. 1991. *Fonètica descriptiva del català*. Barcelona: Institut d'Estudis Catalans.

Recasens, D. and Pallarès, M.D. 1999. A Study of /ɾ/ and /r/ in the light of the 'DAC' coarticulation model. *Journal of Phonetics* 27: 143–69.

Recasens, D. and Pallarès, M.D. 2001. Coarticulation, assimilation, and blending in Catalan consonant clusters. *Journal of Phonetics* 29: 273–301.

Rochet, L.B. and Rochet, A.P. 1995. The perception of the single-geminate consonant contrast by native speakers of Italian and Anglophones. In *Proceedings of ICPhS95*, K. Elenius and P. Branderud (eds), 616–619. Stockholm: Arne Strömbergs Grafiska.

Romero, J. 1996. Articulatory blending of lingual gestures. *Journal of Phonetics* 24: 99–111.

Shrotriya, N., Siva Sarma, A. S., Verma, R., and Agrawal, S. S. 1995. Acoustic and perceptual characteristics of Hindi geminate stop consonants. In *Proceedings of ICPhS95*, K. Elenius and P. Branderud (eds), 132–135. Stockholm: Arne Strömbergs Grafiska.

Solé, M.-J. 2002. Aerodynamic characteristics of trills and phonological patterning. *Journal of Phonetics* 30: 655–88.

Tesar, B. and Smolensky, P. 2000. *Learnability in Optimality Theory*. Cambridge MA: The MIT Press.

Tuttle, E. 1997. Palatalization. In *The Dialects of Italy*, M. Maiden and M. Parry (eds), 26–31. London: Routledge.

Walsh, T. 1991. The demise of lenition as a productive phonological process in Hispano-Romance. In *Linguistic Studies in Medieval Spanish*, R. Harris-Northall and T.D. Cravens (eds), 149–163. Madison WI: Hispanic Seminary of Medieval Studies.

Westbury, J.R. and Keating, P.A. 1986. On the naturalness of stop consonant voicing. *Journal of Linguistics* 22: 145–66.

Wireback, K.J. 1997. *The Role of Phonological Structure in Sound Change from Latin to Spanish and Portuguese*. New York NY: Peter Lang.

Zampini, M. and Green, K. 1999. The voicing contrast in English and Spanish: The relationship between production and perception. In *Language Processing in the Bilingual*, T. Langendoen and J. Nicol (eds). Oxford: Blackwell.

Zec, D. 1995. Sonority constraints on syllable structure. *Phonology* 12: 85–129.

The interaction between faithfulness constraints and sociolinguistic variation

The acquisition of phonological variation in first language speakers*

Manuel Díaz-Campos and Sonia Colina
Indiana University / The University of Arizona

The present paper examines the constraints governing the acquisition of sociolinguistic variables. More specifically, it investigates the acquisition of the school variety of Venezuelan Spanish characterized, according to previous research, by increased levels of retention of [ð̞] in lower-socioeconomic-class children. The paper offers a quantitative analysis that provides empirical evidence for faithfulness effects in high activation domains, as well as a formal account of the data framed within Optimality Theory (OT). Positional faithfulness constraints are shown to interact with extra-linguistic variables such as socioeconomic class, age, indicating the acquisition of stylistic variation. The results of the empirical investigation reveal a pattern of deletion of intervocalic [ð̞] in younger lower-socioeconomic background children that is consistent with the informal variety spoken in the immediate community. This favorable tendency toward deletion is overruled when intervocalic [ð̞] is located in high activation domains, such as stressed syllable and word-initial position. In contrast, the older, lower-socioeconomic background children have fewer instances of deletion. The results suggest that the grammar of older, lower-socioeconomic class children contains two rankings, one favoring deletion and another one (acquired later) favoring retention. These rankings get activated as a consequence of external constraints such as *socioeconomic class*, *age*, and *style*. Probabilistic weights attached to each one of the rankings account for the general likelihood of selection of each ranking.

Keywords: sociolinguistics, Optimality Theory, stylistic variation, socioeconomic variation, first language acquisition, phonology

* The authors would like to express their gratitude to two anonymous reviewers and to the editors for their comments; any remaining errors are the authors' sole responsibility.

0. Introduction

Recent research in the area of child phonology reveals the crucial role of faithfulness in predicting changes across time for attaining adult-like pronunciation. Stemberger and Bernhardt (1999) point out that over time, through the promotion of faithfulness constraints, children's pronunciation experiences transformations to become more similar to the adult's phonological system. The pronunciation changes referred by Stemberger and Bernhardt (1999) necessarily imply not only developmental variation, but also sociolinguistic-driven variation. In other words, the child is acquiring the phonological structure of the language and at the same time is becoming part of the speech community. Studies examining the acquisition of sociolinguistic variables in Spanish have showed that children from an early age are influenced by variation patterns found in the sociolect spoken by members of the immediate community (Díaz-Campos 2001, 2004a, 2004b, 2005, and in press; for other languages, see Docherty et al. 2006, Foulkes et al. 2005, Kerswill and Williams 2000, and Roberts and Labov 1995). That is, sociolinguistic variable phenomena are also present in children's speech. At the very beginning, the influence of the immediate community is found. Then, the children, under the influence of other social contexts, expand their repertoire by adapting their speech to those different contexts.

The perspective presented by Stemberger and Bernhardt (1999), which builds on a long tradition going back at least to Jacokson (1941), focuses on general principles governing phonological development in child language. According to their viewpoint, children's production of words does not necessarily reflect the adult system in an obvious manner. These differences found in children's speech can be explained by adopting a cross-linguistic point of view that takes into account general phenomena that seem to be common across the languages of the world regardless of the great variation that can be attributed to individual factors. Stemberger and Bernhart (1999: 418) point out that children tend to be unfaithful to the adult pronunciation in the following ways: 1) some classes of speech sounds might not be present (e.g. fricatives), 2) there might be a reduction of phones in words in comparison to the adult input, 3) codas might be absent, 4) there might be reduction of consonant clusters, 5) possible phone sequences may be reduced, and 5) there may be fewer contrasting units than in adult speech. The differences found in children's speech mentioned above are not exclusively characteristic of child phonology. Some of these processes are also found in adult speech and reflect universal patterns cross-linguistically. Stemberger and Bernhart (1999) propose an optimality theoretical account (henceforth, OT) based on a proposal according to which constraints are motivated by communicative function, information processing, and cognitive forces (Boersma 1998, Hayes 1999, Bermúdez-Otero & Börjars 2006).

Given the observations presented above, one has to wonder about the nature of the interaction between faithfulness constraints and sociolinguistic variation. The present paper examines the relationship between faithfulness and internal constraints governing the acquisition of sociolinguistic variables. More specifically, we focus on the acquisition of the more formal variety spoken at school where, according to previous research, levels of [ð̞]-retention increase in the lower-socioeconomic class children after being exposed to this new variety. The first part of the paper presents a quantitative analysis that provides empirical evidence for faithfulness effects in high activation domains (i.e. onset, stressed syllables, word-initial position). This empirical analysis in child language regarding intervocalic [ð̞] has not been done in any variety of Spanish, so very little is known about acquisition of sociolinguistic variables in Spanish speaking children. The work of Díaz-Campos 2001, 2004a, 2004b, 2005, and in press has examined these issues with the purpose of understanding the linguistic and extra-linguistic factors involved in acquiring the sociolinguistic norms from the adult model. Regarding the adult model and, more specifically, the adult Venezuelan norm, the only published article is the one by D'Introno and Sosa (1986) in which they present descriptive statistics including some linguistic and sociolinguistic factors. Even though deletion of intervocalic [ð̞] is a well known phenomenon in the descriptive literature about Spanish dialectology, it is only very recently that it has become the object of study in child speech. Furthermore, theoretical or probabilistic analyses are scarce both in adult and child speech. Hence the need to provide a theoretical account of this phenomenon particularly in child speech, which is the focus of the present paper. In the second part of the paper, we provide a formal account of such effects within OT.

1. Background

1.1 Sociolinguistic research in adult data

This section provides a brief description of the phenomenon analyzed and some background of previous sociolinguistic studies that examine adult data. The linguistic variable under analysis is retention and deletion of coronal intervocalic approximants.[1] Examples of deletion and retention of intervocalic approximants are given in (1a) and (1b).

(1)	a.	Deletion		
		Machado	[matʃáo]	'Machado (Spanish last name)'
		helado	[eláo]	'ice-cream'
		puede	[pwé]	'he-she can'
	b.	Retention		
		Machado	[matʃáð̞o]	'Machado (Spanish last name)'
		helado	[eláð̞o]	'ice-cream'
		puede	[pwéð̞e]	'he-she can'

1. Recent phonetic literature has established the approximant nature of this sound, traditionally believed to be a fricative. We also adopt the view, in agreement with recent proposals (Bakovic 1994, Barlow 2003), that [ð̞] is underlyingly an approximant that can be realized as an occlusive in word-initial position or when preceded by a nasal or [l]. These assumptions, however, have no bearing on the outcome of the current analysis, given that in an OT framework the constraints and constraint ranking select the optimal output independently of the form of the underlying representation (cf. Richness of the Base, McCarthy 2002). In agreement with an anonymous reviewer, we also acknowledge the possibility of variation regarding the degree of aperture of the approximant, which may in some instances and in some dialects be phonetically realized as a [+continuant] obstruent, i.e. a fricative.

Many varieties of Spanish including Caribbean and Peninsular dialects present variation in the production of [ð̞] in intervocalic position (Cedergren 1979, D'Introno and Sosa 1986, Samper-Padilla 1996). These sociolinguistic studies established that intervocalic approximant deletion and retention is determined by factors such as phonetic context, grammatical category, and external constraints such as socioeconomic class, gender, and style. Regarding phonetic context, all the studies (Cedergren 1979, D'Introno and Sosa 1986, Samper-Padilla 1996) consistently found that participial endings in *ado* (e.g. *cantado* 'sang', *hablado* 'spoken', etc) favor deletion of intervocalic approximant. There seems to be a grammatical conditioning that is reflected in the results due to the criteria used to define the phonetic context, which define it by separating different words endings such as –*ado*, -*ido*, etc.[2] Not surprisingly, all studies also found that the grammatical category adjective favored deletion as well, reflecting the tendency to delete intervocalic [ð̞] in past participles. Concerning external factors Cedergren (1979), and D'Introno and Sosa (1986) found that lower-socioeconomic class speakers favored deletion. Cedergren and D'Introno and Sosa found stylistic variation according to which informal styles, defined as less attention paid to speech, favored deletion. All investigations also revealed a conservative tendency in female speakers showing more retention in their speech than male speakers. In Labovian sociolinguistics, intervocalic [ð̞] can be described as a marker since it shows not only socioeconomic stratification, but also stylistic variation. However, we do not have any evidence that deletion of intervocalic [ð̞] is evaluated negatively and associated with specific groups within the speech community.

The fact that intervocalic approximant deletion is a common sociolinguistic variable in Venezuelan adult speech was one of the reasons why we decided to study this phenomenon in children's speech. The comparison with previous adult findings will serve to determine whether the same pattern of variation is present in children's speech. Intervocalic [ð̞] is also a linguistic variable suitable for sociolinguistic analysis since it is very frequent and allows the possibility to collect enough data to carry a quantitative analysis. We also have to point out that it is only very recently that the study of variation in child speech has began to attract the attention of researchers (for English see Docherty et al. 2006, Foulkes et al. 2005, Kerswill and Williams 2000, and Roberts and Labov 1995, Roberts 1994 and for Spanish Díaz-Campos 2001, 2004a, 2004b, 2005, and in press). The analysis of variation in child speech is essential to determine the sociolinguistic meaning of certain variants in children's speech, and it challenges previous positions according to which variation would have been expected to emerge during adolescence, when youngsters begin to establish contacts outside of their immediate community (for more details see Labov 1964).

2. The evidence presented in previous work (Cedergren 1979, D'Introno and Sosa 1986, Samper Padilla 1996) seems to indicate that there is a grammatical conditioning according to which past participles forms favor deletion. More recently Bybee (2002) has argued that this grammatical effect might be related to the fact that past participles are frequent tokens, so that weakening of intervocalic [ð̞] is more likely to happen because of speech automatization effects.

1.2 Faithfulness and high activation domains

As mentioned above, current research suggests that language acquisition consists of gradual reranking of faithfulness above markedness constraints (Bernhardt & Stemberger 1998, Stemberger & Bernhardt 1999; Barlow and Gierut, 1999; McCarthy 2002 and references therein; Levelt and van de Vijver 2004).[3] The present paper focuses on the role of faithfulness constraints in variable phonological phenomena in children's speech as it can be found in formal styles. Specifically, we examine the effect of high activation internal constraints in predicting patterns of retention and deletion of intervocalic approximants in interaction with sociolinguistic constraints such as socioeconomic class, age, and style. According to Stemberger and Bernhardt (1999), there is evidence in adult phonology (Alderete et al. 1999, Beckman 1997), as well as in child phonology (Stemberger and Bernhardt 1999), that reveals that faithfulness is highly ranked in high activation domains (i.e. onset, stressed syllables, word-initial). Saliency seems to generate the preservation of segmental information. Taking this observation into account, one might expect that the deletion of intervocalic approximants would be less likely to happen in these contexts where faithfulness dominates markedness constraints.

The sociolinguistic literature examining phonological variation phenomena in adult speakers of American English (Wolfram 1969, Fasold 1972, and Labov 1989) reveals that (-t,d) deletion in the pronunciation of words such as *lost*, *said*, *just*, *must*, etc is less likely to occur in stressed syllables.[4] Roberts (1994) reports results according to which there is a statistically significant difference indicating that deletion of (-t,d) is disfavored in stressed syllables in her data regarding (-t,d) deletion in children from Philadelphia. She also reveals that deletion is favored by the presence of a consonant cluster in an unstressed syllable. As one can appreciate, these empirical results are very much in agreement with the formal theoretical observations that describe stressed syllables as high activation domains where faithfulness is more strictly enforced; enforcement (higher ranking) of faithfulness in high activation domains can be argued to be phonetically motivated (i.e. grounded, in the sense of Archangeli and Pulleyblank 1994), given the presence of strong perceptual cues in these domains.

1.3 Sociolinguistic nature of the phenomenon

The quantitative analysis presented here is based on a study examining deletion and retention of intervocalic approximants in Spanish-speaking children (Díaz-Campos

3. Hale and Reiss (1998), however, argue for an initial state in which Faithfulness outranks Markedness.

4. The previous literature on (-t,d) deletion does not address the notion of phonetic grounding and how it might interact with "high activation domains". Nonetheless, one might speculate that if it were a matter of phonetic pressures all environments where (-t,d) is in a consonant cluster would behave in the same way favoring deletion, but this is not the case since multiple factors condition (-t,d) deletion (for more details see Wolfram 1969, Fasold 1972, Guy 1980).

2001). Díaz-Campos (2001) examines the acquisition of sociolinguistic variation in a sample of 30 monolingual Spanish-speaking children. His investigation focuses on determining how sociolinguistic variation can be defined by observing the interaction between *socioeconomic class* and *age*. This interaction between socioeconomic class and age is a way to observe whether there is an adjustment in the use of the variants of /ð/ in the different socioeconomic class groups across time as children become exposed to the more formal variety of language spoken at school. No previous work has done this type of sociolinguistic analysis in Spanish speaking children. Figure 1 shows the findings of the interaction between socioeconomic class and age.

Figure 1 reveals that levels of retention increase in 3.5 to 4.5 year-old lower-socioeconomic class children, while levels of retention are high in the upper-socioeconomic class children in general terms. The results in Figure 1 reveal a change in the children of the lower-socioeconomic class according to which there is an adjustment in the levels of retention as children are exposed to the more formal variety spoken at school. In other words, lower-socioeconomic class children show a pattern that is similar to upper-socioeconomic class speakers at 4.6 to 5.9 years of age revealing exposure to a more formal variety of the language. Figure 2 shows the data of upper-socioeconomic class children divided by age in comparison with lower-socioeconomic background children.

As can be seen in Figure 2, there is 20% difference in levels of retention between younger and older lower-socioeconomic background children, while patterns of

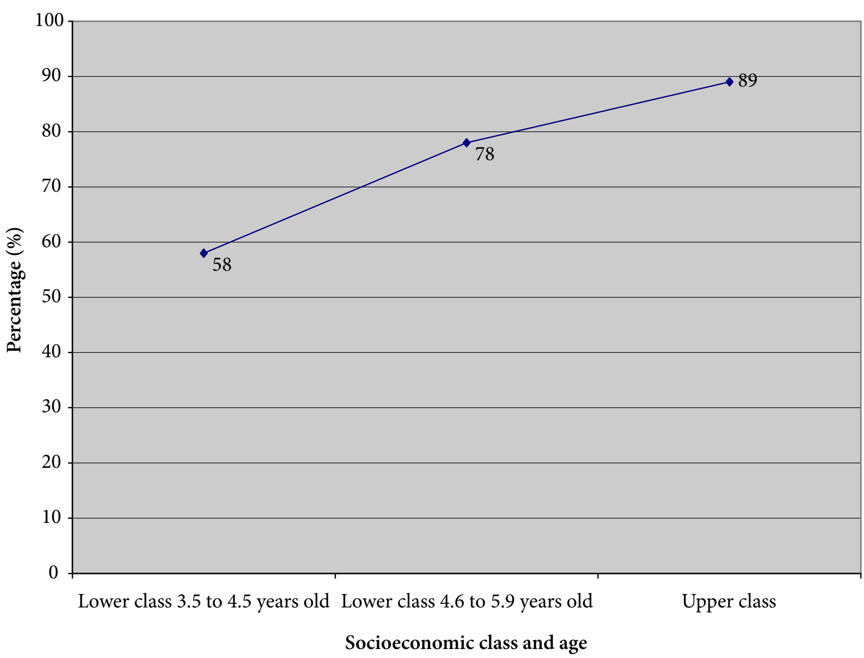


Figure 1. Interaction between socioeconomic class and age

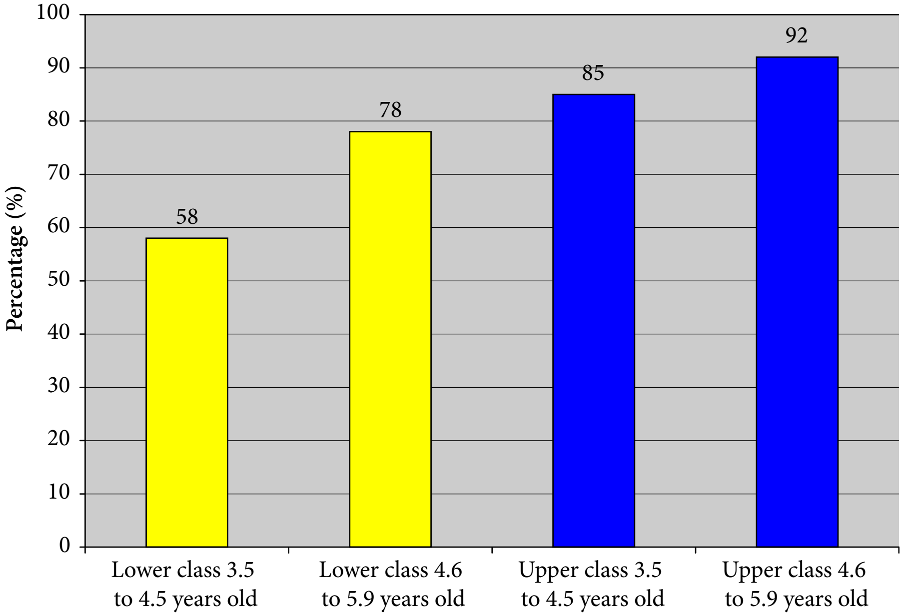


Figure 2. Retention of the dental approximant according to age and socioeconomic class

retention are more stable in upper-socioeconomic background children, indicating that exposure to the prestige norm might be a crucial factor to explain these findings.[5]

Díaz-Campos (2005) examines the acquisition of individual variation by analyzing the interaction between *style* and *age*. The assumption of the investigation is that individual variation (i.e. stylistic variation according to attention paid to speech) would appear in the 4.6 to 5.9 year-old children since this is the group that shows a change by increasing the levels of retention after one year of schooling. Figure 3 presents the results for the interaction between *style* and *age*.

Figure 3 reveals that 4.6 to 5.9 year-old children retain more intervocalic approximants than the 3.5 to 4.5 year-old children in careful style sections of the interview. These findings indicate that children are beginning to show stylistic variation in their use of intervocalic approximant. Levels of retention adjust according to the formality of the situation. These results are consistent with the ones presented above according to which the interaction between *socioeconomic class* and *age* indicates that lower-socioeconomic class children incorporate a new formal variety in their speech.

Previous investigations indicate that adult speakers of several dialects of Spanish exhibit variation in the use of variable intervocalic approximant. External factors such as socioeconomic class and style predict the variable use of the variants of intervocalic

5. Even though we do not have data regarding child directed speech to this particular group of children, Foulkes et al. (2005) have found that caretakers tend to favor the use of prestige forms in child directed speech. We might speculate that this exposure to the prestige variants might be a stronger tendency in upper-socioeconomic background caretakers.

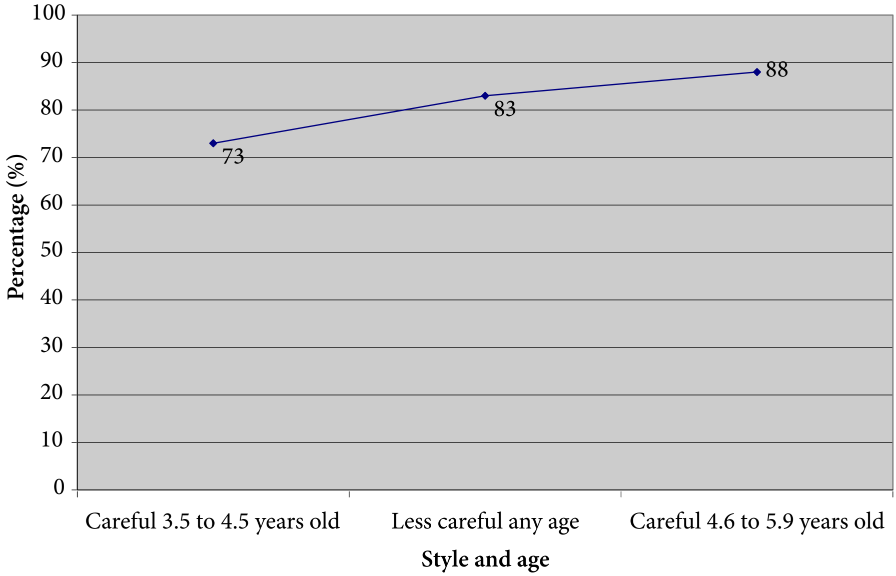


Figure 3. Retention of intervocalic approximants according to style and age

approximants, showing the sociolinguistic nature of the phenomenon. Studies observing children's data also reveal that their intervocalic approximants are under the same sociolinguistic constraints that govern patterns of variation in adult speakers. The fact that intervocalic approximant deletion is a common phenomenon in Venezuelan Spanish makes it suitable for the investigation of the interaction of faithfulness with phonological variation in high activation domains.

2. Methodology of the quantitative study

For the present study, 30 children were selected from the corpus *Competencia narrativa de niños en edad escolar* 'Narrative Competence of School-age Children' (Shiro 1996). All the subjects recorded are monolingual Spanish speakers from Caracas, Venezuela. The speakers are divided into five groups according to age: 3.5 to 3.9, 4 to 4.4, 4.5 to 4.9, 5 to 5.4, and 5.5 to 5.9 year-olds.

The corpus can also be divided by social class and sex. There are 16 lower-class speakers and 14 upper-class-speakers. Socioeconomic status was determined by taking into account salary and level of education of the parents, type and location of the school, and type and area of housing of the children's family. With regard to sex, there are 16 male speakers and 14 female speakers.

The children were interviewed for a period of forty-five minutes to an hour. The interview in each case included four different activities. The first one included a conversation with the children with questions such as: (1) How old are you? (2) How did you celebrate your birthday? (3) Do you have brothers and sisters? (4) Do you play with your brothers and sisters? (5) Do you get along with them? (6) What does your father do for a living? (7) What does your mother do for a living? (8) Does your father or your mother read stories to you at night? (9) Can you tell that story? (10) Who do you play with at school? (11) What is your favorite TV program? (12) What is that TV program about? There were several other questions with the same characteristics.

The second part of the interview included a trigger situation in which the interviewer was trying to obtain a story in which the children were emotionally involved. Labov (1972) suggests that topics triggering the speaker's emotional reaction are more likely to produce casual speech. The classical Labovian interview includes topics such as the danger of death in order to initiate the emotional involvement of the speaker during the conversation. Labov points out that talking about accidents, sickness, and natural disasters may be appropriate to generate the conditions for emotional speech. The topics suggested by Labov (1972) were adapted to the interviews of the children in this research. The interviewer shared a personal experience with the child as follows: "One day I was in the kitchen serving myself a glass of Coke and I did not hold the glass firmly. The glass fell down and broke, hurting my feet. Have you ever had something like that happen to you?" Another trigger situation included the following: "One day I was very sick and had to go to the doctor. Have you ever visited the doctor? What was that experience like?" The trigger situations worked very well for almost all the children. They were able to narrate a situation and to express their emotional reactions.

The third part of the interview was a play activity with toys representing the characters from the movie *Aladdin*. The characters from *The Flintstones* were also used during the interview. The children were able to narrate their own version of the movie or to create new situations playing with the characters. Lower- and upper-class speakers were very familiar with the characters from both *Aladdin* and *The Flintstones*.

Finally, the last part of the interview included a storytelling activity using the tale *La gallinita* 'The little hen'. The children had to retell the story with the pictures of the characters and events in the book. All the situations contained during the interview created a positive environment for obtaining a large amount of discourse suitable for performing a quantitative analysis.

2.1 Statistical analysis

Goldvarb 2001, a linguistic software program specifically designed for the study of sociolinguistic variation, was used for performing a statistical analysis of the data. The logistic regression analysis performed with GoldVarb 2001 provides the probabilistic weight for each one of the factors included within each factor group, indicating the significant statistical contribution of each factor with respect to the dependent variable. The maximum weight is 1.00 and the minimum 0.00. A weight greater than .500 favors the application value and a lesser probability disfavors it (see Sankoff 1998 and Paolillo 2002 for more statistical details regarding the software).

Two factors groups were created in order to test whether the so-called high activation domains seem to follow the predicted pattern proposed in the theoretical literature. That is, that faithfulness constraints are highly ranked in high activation domains inhibiting processes of weakening or deletion in those positions. The first factor group is *stress*. Three factors are included in this group: 1. Pre-tonic, (e.g. *Panadería* 'bakery') 2. post-tonic (e.g. *Cantado* 'sang'), 3. and tonic (e.g. *panadero* 'baker'). The second factor group included is *position within the word*. This factor group is composed of two factors: 1. word-initial (e.g. *Aladino dice* 'Aladdin said'), and word-medial (e.g. asustado 'scared').

The dependent variable selected for the quantitative analysis was the retention and deletion of intervocalic [ð̞].[6] This way of defining the dependent variable meets the requirements of binarity necessary to run the logistic regression analysis. The application value selected was retention since we want to determine whether retention is more likely to occur in high activation domains. In other words, the quantitative analysis provides us with the group factors favoring retention in hierarchical order as well as the factor's probabilistic weight in relation to the dependent variable.

3. Results

The analysis is based on 1,092 tokens extracted from the corpus *Competencia narrativa de niños en edad escolar* (1996) 'Narrative Competence of School-age Children.' In general terms, the data show 83% of [ð̞] retention and 17% of deletion. These tendencies are very similar to the ones described for adult speakers by D'Introno and Sosa (1986) (12% of deletion). Table 1 and Figures 4 and 5 present the results of the probabilistic analysis. The factors found to be statistically significant are presented in order of selection. This order of selection is very important because it indicates the degree of impact of the factor group selected on the dependent variable from more important to less important. Recall that the range of the weight varies from 0 to 1. A weight above 0.5 favors the occurrence of the application value; while a weight below 0.5 disfavors it.

The first factor group selected in order of importance was *stress*. The results reveal that retention of the intervocalic approximant is more likely to occur in the context of a tonic syllable, whereas pre-tonic and post-tonic syllables disfavor cases of retention. This result is consistent with our hypothesis that high activation domains would be favorable to the preservation of segmental material in the output (in OT terms, faithfulness constraints tend to be highly ranked in those salient positions).

6. Based on previous research (D'Introno and Sosa 1986), we know that retention or deletion are the variants with sociolinguistic meaning in the community. For the purpose of coding, any intermediate realizations were categorized as instances of retention. Spectographic analysis of sample of tokens coded was consistent with the auditive coding. In order words, "gradient" variants are considered retention and "total deletion" was coded as deletion.

Table 1. Results of the high activation domain analysis (input probability = .863 (910/1092); sample size per factor in parentheses; significance P < 0.001)[7]

Factor group	Factors	No	%	Weight
Stress	Tonic	303/337	89	.599
	Post-tonic	275/351	78	.442
	Pre-tonic	151/178	84	.427
Position within the word	Word-initial	436/504	86	.600
	Word-internal	474/588	80	.414

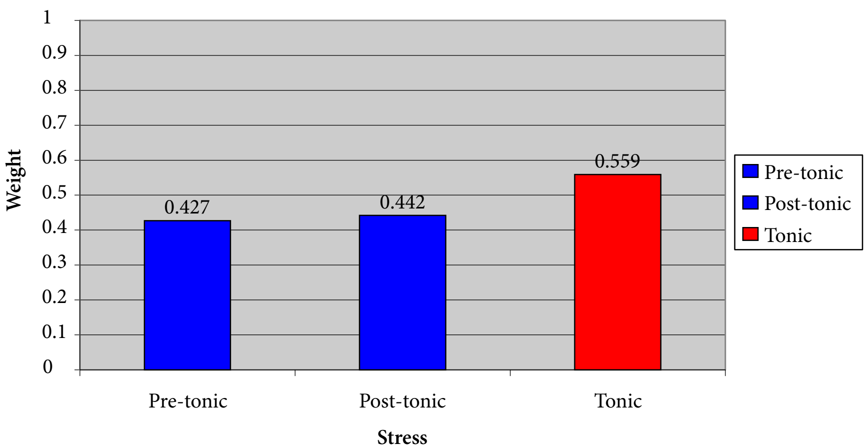


Figure 4. Retention of intervocalic approximants according to stress

Table 1 and Figure 5 indicate that *position within the word* is next in terms of importance in the analysis. Retention of the intervocalic approximant in word-initial position has a favorable weight of .600, while in word-internal position it has a disfavorable weight of .414. This result also coincides with the expected tendencies according to which high activation domains would favor faithfulness to the input.

The findings of the quantitative analysis presented above corroborate Stemberger and Bernhardt (1999:435) observations:

> Position in the word or syllable that are high in activation tend to show higher faithfulness (in both adult and child phonology) than locations that are low in activation. Through decades of work in psycholinguistics (see e.g., Levelt, 1989), we have independent information about word and syllable positions that are high or low in activation:
> High: onset, stressed, word-initial
> Low: coda, unstressed, word-final, second position

7. The logistic regression analysis reveals that pretonic and postonic environments behave in the same way, indicating that deletion is more likely to be found in these positions as predicted by the notion of high activation domains. In the case of stress, high activation would be associated with the tonic syllable.

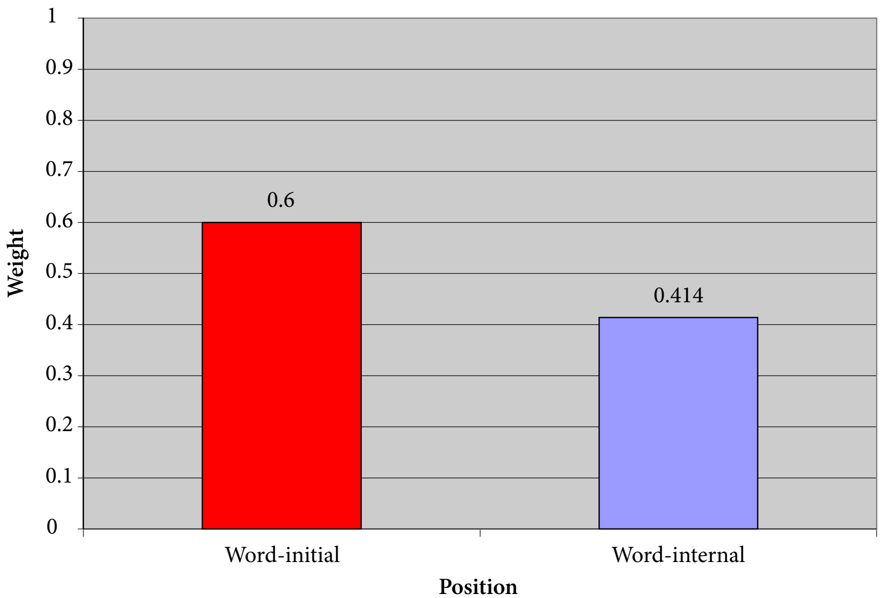


Figure 5. Retention of intervocalic approximants according to position within the word

Clearly, the variable phenomenon examined in the present paper (i.e. retention and deletion of intervocalic approximants) shows the interaction of sociolinguistic constraints and phonological constraints in the speech samples of children analyzed. It seems the case that phonological constraints can overwrite sociolinguistic ones. The findings of the previous research indicate that factors such as social class, style and age predict the use of the variants of intervocalic approximant. Furthermore, the analysis presented here reveals that the deletion of intervocalic approximants is constrained by faithfulness in high activation domains. The next section presents a formal analysis of these facts within Optimality Theory (OT) (McCarthy and Prince 1993a, 1993b, 1994; Prince & Smolensky 1993; Kager 1999; McCarthy 2002).

4. Optimality-theoretic analysis

This section of the paper further examines the interaction between phonological variation and faithfulness constraints. The goal is to propose a formal account of the phenomenon under investigation, namely retention or deletion of intervocalic approximants. The use of OT to account for variation was recognized early on. For instance, Paolillo (2002: 208) refers to the work of Kiparsky (1993), who proposed that speakers can have multiple rankings simultaneously and one of them would be selected randomly at evaluation time. In our proposal, the so-called "random" selection can be accounted for by including external constraints that predict which ranking will be selected, as variationist studies have demonstrated in the description of sociophonetic variation.

Our analysis focuses on the acquisition of the formal variety that children are exposed to at institutional settings.[8] We propose a formal account of the acquisition data presented above for lower-socioeconomic class children. In general terms, we adhere to the optimality-theoretic account of variation as differences in constraint rankings. More specifically, in accordance with the partial ordering theory (Reynolds 1994, Anttilla and Cho 1997, Nagy and Reynolds 1997, McCarthy 2002 and references therein), we view a particular grammar as a partial ordering of constraints in which constraints which conflict may be in free ranking with respect to one another, leading to variation in the output. Free ranking does not imply that ranking selection is totally unpredictable, only that it is not governed by grammatical principles; instead, a wide range of extragrammatical factors may affect the choice of ranking (e.g. sociolinguistic variables) (Kager 1999: 404). More specifically, each input-to-output mapping is obtained by applying a totally ordered hierarchy of constraints that is randomly sampled from the total orderings that are consistent with the grammar. If the sampling is uniform (each ordering has equal likelihood of being chosen each time), then each total ordering will be in force fifty per cent of the time (McCarthy 2002:227). However, if the sampling is not uniform, some rankings may be in force more often than others (they will have a higher likelihood of being chosen each time). This is precisely the case for some of the data under analysis. We propose that the relevant facts can be captured through probabilistic weights, associated with each one of the rankings that indicate the probability/likelihood that a particular ranking will be chosen on the basis of external constraints, such as socioeconomic class and age. The probabilistic weights, which express the likelihood of retention of intervocalic approximants and, therefore, the selection of a certain constraint ranking leading to that outcome, are determined statistically. The unranked-constraint (free-ranking) approach spoused here preserves strict domination by having one main grammar split into subhierarchies (each with strict domination) at the point of variation (for the 'unranked' constraints) (Kager 1999: 404); probabilistic weights reflect the likelihood of selecting one branch/ranking versus the other.

The unranked-constraint plus probabilistic-weight approach presented in this paper is compatible with (and therefore translatable into) the Gradual Learning Algorithm (GLA), a constraint-ranking algorithm for learning optimality-theoretic grammars. Two crucial concepts for the GLA are continuous ranking scales and stochastic evaluation (Boersma 1998, Boersma and Hayes 2001).[9] In the GLA, at evaluation time, the position of each constraint is temporarily perturbed by a random positive or negative value (stochastic evaluation), thus constraints are said to be associated with ranges of values rather than single points on a continuous ranking scale. The value used at evaluation is called the selection point and the value more often associated with a

8. The scope of the study is motivated by the nature of the available data that provide information about the acquisition of the standard variety in this dialect of Spanish. Future studies will have to examine the acquisition of the vernacular variety and its implications for formal analysis of variation.

9. Continuous ranking scales are also proposed in Zubritskaya (1997) where probabilistic weights are associated attached to individual constraints.

constraint is the ranking value (higher ranked constraints have higher ranking values than lower ranked ones). When the ranges covered by the selection points (constraint ranges) do not overlap, the result is categorical ranking (no variation). However, if the ranges overlap, there will variation in ranking and outputs, as a selection point for the lower ranked constraint could be selected toward the high end of the range, at the same time a selection point for the higher ranked constraint is chosen at the lower end of the range, thus effectively reversing the ranking. The closer the ranking value of two constraints, the greater the likelihood of ranking reversal (i.e. variation) (Boersma and Hayes 2001: 47–50). Probabilistic weights lower than 1 in the present account correspond to overlapping ranges in the GLA. The greater the weight, the smaller the overlapping range (i.e., the likelihood of the reverse ranking applying); weights lower than .5 indicate that the opposite ranking is more frequent.[10]

Alternatively, some authors have proposed a view of variation which is the result of multiple grammars (subgrammars or cophonologies) (Inkelas and Orgun 1995, Ito and Mester 1995, Paolillo 2002) that differ in the relevant rankings. One of the disadvantages of the cophonology proposal is that it makes the prediction that each subgrammar is independent, and hence that subgrammars can be radically different. This prediction is incorrect for sociophonetic variation, where outputs are similar and differ only in a minor respect (Kager 1999: 405) (see Kager for additional arguments against cophonologies).

In what follows we present the basic OT analysis first and then introduce modifications necessary to explain favoring factors affecting the relevant data. We argue for the superiority of a formal account of variation that can explain the unequal distribution/selection of alternative rankings.

The deletion of intervocalic [ð̞], as encountered in younger lower class children, is the result of the constraints and ranking shown in (2) and (3).

(2) Max Stressσ ð̞: a coronal approximant in the input must be present in the output, if in a stressed syllable
Max -# ð̞: a coronal approximant in word-initial position in the input must be present in the output
Max-ð̞: no deletion of ð̞
*Vð̞V: no coronal approximants in intervocalic position

(3) Max Stressσ ð̞, Max -# ð̞ >> *Vð̞V >> Max-ð̞

Max Stressσ ð̞ and Max-#ð̞ are positional faithfulness constraints (Beckman 1997) that require preservation of the coronal approximant in stressed and word-initial positions (high activation domains). Max -# ð̞ is a context-free constraint that bans deletion of [ð̞]. It stands in a stringency relation with the context-specific constraints

10. It may turn out that the more comprehensive GLA is more appropriate for accounting for the data presented here than a probabilistic weight account, however, an empirical comparison of both approaches is well beyond the scope of this paper. Our goal is not to argue for a particular analysis of variation within OT, but to show that variation can in fact be accounted for within an optimality-theoretic grammar.

(MAX Stressσ ð̞ and MAX -# ð̞); that is, violations of the context-specific constraints are a proper subset of the violations of MAX-ð̞. Since the effects of the context-specific constraints are visible, they must dominate MAX-ð̞. *Vð̞V is a cover term for a markedness constraint that penalizes approximants in intervocalic position. *Vð̞V is part of a hierarchy of constraints that relates onset and degree of stricture, reflecting the universal preference for onsets with maximal stricture (cf. stricture theory, Steriade 1993). Accordingly, onsets with greater stricture are less marked than those with a lesser degree of stricture or, in faithfulness terms, it is better to preserve to onsets with greater stricture than those with lesser stricture.

(4) MAX-ONSET (A_0): Onset segments with maximal stricture (non-continuants, stops, nasals and laterals) in the input must appear in the output.
MAX-ONSET (A_f): Onset segments with medium aperture (fricatives) in the input must be present in the output.
MAX-ONSET (A_{MAX}): Onset segments with maximal degree of aperture (approximants and vowels) in the input must be present in the output.

(5) MAX-ONSET (A_0) >> MAX-ONSET (A_f) >> MAX-ONSET(A_{MAX})

The faithfulness constraints in (4–5) work towards preservation of contrast; in conflict with contrast preservation is the drive to minimize effort captured by AGREE constraints. These constraints are responsible for assimilation, requiring adjacent segments to agree with respect to some particular feature. In the case of intervocalic approximants, this feature is stricture and the relevant constraint is therefore AGREE (stricture).

(6) AGREE (stricture): Adjacent segments must agree in degree of stricture.

The ranking in (7) indicates that intervocalic obstruents and non-continuant sonorants (liquids and nasals) cannot be deleted despite differences in stricture with respect to the flanking vowels. Approximants, however, are deleted to bring agreement in stricture in VV because AGREE (stricture) dominates the faithfulness constraint for the greatest degree of aperture — MAX-ONSET (A_{MAX}). The constraints and constraint ranking in (7) will be referred to throughout this paper by the cover term*Vð̞V.[11]

(7) MAX-ONSET (A_0), MAX-ONSET (A_f) >> AGREE (stricture) >> MAX-ONSET (A_{MAX})

(8) and (9) illustrate candidate evaluation and output selection for forms with coronal approximants in younger, lower-socioeconomic background children.

11. In note 1, we acknowledged the possibility of fricative realizations of the approximant. In an OT analysis, deletion of a fricative realization would reflect the domination of AGREE (stricture) over MAX-ONSET (A_f). In cases of retention, a fricative realization (vs. approximant) responds to the domination of the constraint against approximants in the onset *ONSET-APPROX (due to insufficient stricture) over AGREE (stricture) (the opposite ranking results in approximants).

(8) Deletion of [ð̞] in younger, lower-socioeconomic background children
/pueð̞e/ [pwé(e)] 'he/she can'

	Max Stressσ ð̞	Max -# ð̞	*Vð̞V	Max-ð̞
a. ☞ [pwé]				*
b. [pwéð̞e]			*!	

Given that [ð̞] is neither in a stressed syllable nor in word-initial position, the top-ranked constraints are trivially satisfied in (8). Candidate (b) loses to (a) because it violates *Vð̞V on account of the presence of an intervocalic [ð̞]; (a), with deletion, only incurs a violation of the lowest ranked constraint — Max-ð̞.[12] In (9), [ð̞] is both in a stressed syllable and in word-initial position, which makes the context-specific faithfulness constraints relevant. (b) violates both of them and is therefore ruled out when compared with (a) (only one violation of the low-ranked*Vð̞V).

(9) Retention of [ð̞] in younger, lower-socioeconomic background children
/me#ð̞uéle/ [með̞wéle] 'it hurts me'

	Max Stressσ ð̞	Max -# ð̞	*Vð̞V	Max-ð̞
a. ☞ [með̞wéle]			*	
b. [mewéle]	*!	*		*

According to what we know from previous research about lower-socioeconomic background adults, we can point out that they share the same preference for deletion in the same contexts as young children. Therefore, the ranking in (3) (i.e. (3) Max Stressσ ð̞, Max -# ð̞>> *Vð̞V >> Max-ð̞) also predicts the correct outcome for the adults.

In the case of the upper-socioeconomic background speakers retention results from the ranking constraint in (10). Candidate evaluation and output selection can be seen in (11) and (12).

(10) Max Stressσ ð̞, Max -# ð̞ >> Max-ð̞ >> *Vð̞V

(11) Retention of [ð̞] in upper-socioeconomic background (children and adults)
/pueð̞e/ [pwéð̞e] 'he/she can'

	Max Stressσ ð̞	Max -# ð̞	Max-ð̞	*Vð̞V
a. [pwé]			*!	*
b. ☞ [pwéð̞e]				*

(12) Retention of [ð̞] in upper-socioeconomic background (children and adults)
/me#ð̞uéle/ [með̞wéle] 'it hurts me'

	Max Stressσ ð̞	Max -# ð̞	Max-ð̞	*Vð̞V
a. [mewéle]	*!	*	*	*
b. ☞ [með̞wéle]				*

12. Note the merger of the two adjacent mid front vowels. We do not focus on this aspect of the output (see Baković, this volume, for an account).

Max-ð̞ is ranked above *Vð̞V ruling out deletion of intervocalic [ð̞] in upper-socio-economic background children and adults (11). In (12) the candidate with deletion also incurs additional violations of Max Stressσ ð̞, and Max -# ð̞. Older, lower-socio-economic background children showed increased retention of [ð̞] after starting school and being exposed to the upper socioecomic background variety. The increase in the levels of retention in their speech can be taken as evidence of their acquisition of the ranking in (10). Candidate evaluation and selection is shown in (13). It proceeds as in (11).

(13) Retention of [ð̞] in older, lower-socioeconomic background children (school variety in a more careful style)
/pueð̞e/ [pwéð̞e] 'he/she can'

	Max Stressσ ð̞	Max -# ð̞	Max-ð̞	*Vð̞V
a. [pwé]			*!	*
b. ☞ [pwéð̞e]				*

Thus, our analysis proposes two rankings (14–15) for the two varieties that emerged from the analysis of [ð̞] retention and deletion in the corpus examined. It must be noted, however, that, despite the acquisition of the ranking in (10), typical of upper-socioeconomic backgrounds, older, lower-socioeconomic background children do not abandon the vernacular ranking and are thus in possession of the two rankings proposed (14–15).

(14) Max Stressσ ð̞, Max -# ð̞ >> *Vð̞V >> Max-ð̞
[Younger, lower-socioeconomic class children; Older, lower-socioeconomic class children]

(15) Max Stressσ ð̞, Max -# ð̞ >> Max-ð̞ >> *Vð̞V
[Upper-socioeconomic class (children and adults); Older, lower-socioeconomic class children]

As we anticipated above, the analysis needs to somehow account for the probabilistic nature of the phenomenon for those speakers (older children of lower-socioeconomic background) whose grammars reflect two rankings. One of the weaknesses of formal analyses is that they cannot capture variation and assume that speakers are categorical in their treatment of linguistic phenomena. The advantage of taking into account the probabilistic nature of the phenomenon under consideration is that we are formally accounting for sociolinguistic variation that inherently never applies 100%. It has been long recognized that sociolinguistic variables (Cedergren and Sankoff 1974) do not apply categorically. This problem has been for a long time avoided in formal accounts by presenting a highly ideal account of linguistic phenomena. In the case of sociolinguistic variation, assuming categorical application of a phonological rule, ignoring its probabilistic nature, would be a contradiction of principles. In order to account for the variable (non-categorical) nature of [ð̞] retention and deletion, our analysis uses probabilistic weights associated with each of the partial orderings (rankings) of constraints. In other words, each ranking comes associated with a probabilistic weight (obtained from the logistic regression analysis) that determines the probability of its application versus the other rankings possible.[13] This idea is consistent with the proposal of Cedergren and Sankoff (1974) who maintain that probabilities explaining variation are part of our linguistic competence. Hymes (1974) also suggests that our competence goes beyond internal constraints and includes external constrains that are activated accordingly.

Table 2 shows the results of probabilistic analysis for socioeconomic class. Tables 3, and 4 present the probabilistic analysis of the interaction between *socioeconomic class* and *age*. In Table 3, 4.5 to 5.9 year-old lower-socioeconomic class children are grouped together and contrasted with any other group in the sample, whereas in Table 4, 3.5 to 4.4 year-old, lower-socioeconomic background children are grouped together and contrasted with any other possible combination. These two analyses make it possible to determine the probabilistic weight of application of the rankings given the external constraints *socioeconomic class* and *age* in interaction.

Table 2. Results of the socioeconomic class analysis (input probability = .850 (910/1092); sample size per factor in parentheses)

Factor group	Factors	No	%	Weight
Socioeconomic class	Upper	634/706	89	.609
	Lower	276/386	71	.308

Table 2 reveals that socioeconomic background is a significant predictor of retention of intervocalic [ð̞]. Upper-socioeconomic background children retain more than lower-socioeconomic background children. As explained in the literature review, this pattern is very similar to the one found in the adult model. We have to point that these data focus on the analysis of the effect of socioeconomic background and age in the variety of language spoken at school. In that sense, we are defining sociolinguistic variation within the group without analyzing individual variation. Future studies will have to consider different styles and registers to provide empirical data for proposing a formal analysis that includes those external factors. However, in order to differentiate between younger and older lower-socioeconomic background children and present the probabilities for each group, we need to examine the results for the interactions between socioeconomic background and age.

Table 3. Results of the interaction between socioeconomic class and age (Retention/older children) analysis (input probability = .851 (910/1092); sample size per factor in parentheses)

Interaction between *socioeconomic class* and *age*	4.5 to 5.9 years old, lower-socioeconomic class children	198/252	78	.677
	Other	712/840	84	.445

13. As we mentioned above, this is compatible with the GLA (Boersma 1998, Boersma and Hayes 2001), another proposal for dealing with variation within OT.

Table 3 shows the quantitative results when comparing 4.5 to 5.9 year-old children of lower-socioeconomic background with any other group. The weight obtained reveals that retention is favored by this older group of speakers as a consequence of the exposure to more formal varieties of language outside their immediate social context.

Table 4. Results of the interaction between socioeconomic class and age (younger children) analysis (input probability = .852 (910/1092); sample size per factor in parentheses)

Factor group	Factors	No	%	Weight
Interaction between *socioeconomic class* and *age*	3.5 to 4.4 years old lower-socioeconomic class children	78/134	58	.301
	Other	832/958	86	.529

In Table 4, one can observe that 3.5 to 4.4 year-old, lower-socioeconomic background children disfavor retention in contrast with any other group.

Table 5. Results of the interaction between socioeconomic class and age (Deletion/older children) analysis (input probability = .149 (910/1092); sample size per factor in parentheses)

Interaction between *socioeconomic class* and *age*	4.5 to 5.9 years old, lower-socioeconomic class children	54/252	21	.323
	Other	128/840	15	.555

Table 5 presents the probabilistic weight for deletion in the group of 4.5 to 5.9 year-old lower-socioeconomic class children. As shown, this group of children disfavors deletion of intervocalic [ð̞] after exposure to the school variety. Basically, the probability of application of the ranking favoring deletion (i.e. [Max Stressσ ð̞, Max -# ð̞ >> *Vð̞V >> Max-ð̞]$^{.323}$) would correspond to .323 according to the statistical analysis of the interaction between socioeconomic class and age.

For the reader's convenience we reproduce the tableaux corresponding to the synchronic grammar of older children of lower-socioeconomic background with the probabilistic weights attached to the rankings. It is important to recall that the probabilistic weights indicate likelihood of application of a particular ranking, which favors a specific optimal candidate based on external constraints.[14] When the probabilistic weight is less than 1, the opposite ranking is also active, although less likely to apply. For instance, in (16) and (17), older, lower-socioeconomic background children are more likely to exhibit retention, thus the ranking Max-ð̞ >> *Vð̞V (probabilistic weight = .677); however, deletion (i.e. *Vð̞V >> Max-ð̞) also occurs, although less frequently (probabilistic weight = .323). The same concept applies to retention and deletion in upper-socioeconomic background children (with the most likely ranking being Max-ð̞ >> *Vð̞V and *Vð̞V >> Max-ð̞, the less likely); to retention and deletion in

14. We do not enter into the probabilistic weights of each ranking for each situation (formal and casual/vernacular) given that the empirical section of this study was not designed to obtain those data. We focus only on the general likelihood that older lower-background children will resort to one ranking or the other.

younger lower-socioeconomic background children (most frequent ranking = *Vð̞V >> Max-ð̞; less frequent ranking = Max-ð̞ >>*Vð̞V); and to retention/deletion in high activation domains in general, where the most common ranking is Max Stressσ ð̞, Max -# ð̞ >> *Vð̞V >> Max-ð̞, * although Vð̞V >> Max Stressσ ð̞, Max -# ð̞, Max-ð̞ also applies (retention is not categorical).[15]

(16) Older, lower-socioeconomic background children
/pueð̞e/ [pwé(e)] 'he/she can'
[Max Stressσ ð̞, Max -# ð̞ >> *Vð̞V >> Max-ð̞].323

	Max Stressσ ð̞	Max -# ð̞	*Vð̞V	Max-ð̞
a. ☞ [pwé]				*
b. [pwéð̞e]			*!	

(17) Older, lower-socioeconomic background children
/pueð̞e/ [pwéð̞e] 'he/she can'
[Max Stressσ ð̞, Max -# ð̞ >> Max-ð̞ >>*Vð̞V].677

	Max Stressσ ð̞	Max -# ð̞	Max-ð̞	*Vð̞V
a. [pwé]			*!	*
b. ☞ [pwéð̞e]				*

5. Conclusions

The present investigation reveals that positional faithfulness constraints interact with extralinguistic variables such as socioeconomic class, age, indicating the acquisition of sociophonetic variation. Younger lower-socioeconomic background children present a pattern that favors deletion of intervocalic [ð̞] which is consistent with the informal variety spoken in the immediate community. However, this favorable tendency toward deletion is overruled when intervocalic [ð̞] is located in high activation domains such as stressed syllable and word-initial position. Our analysis provides a way to combine the quantitative findings and reflect the probabilistic nature of the constraint rankings by incorporating the probabilistic weight within it. Furthermore, since the probabilistic weight is based on the role played by sociolinguistic factors such as socioeconomic

15. In terms of the GLA, the ranking value of Max-ð̞ is higher than that of *Vð̞V for retention-favoring, upper-socioeconomic background children, while for lower-socioeconomic background children, who favor deletion, the ranking value of *Vð̞V is higher than that of Max-ð̞. In both cases Max-ð̞ and *Vð̞V have close, overlapping ranking values, so that there is deletion in retention-favoring children (upper-socioeconomic background) and retention in deletion-favoring children, although much less frequently. Regarding acquisition, as the lower-socioeconomic background children become older and are exposed to the retention variety through schooling, the ranking values of Max-ð̞ and *Vð̞V are reversed, but closer together than in the grammar of upper-socioeconomic background children, making ranking reversal (i.e. likelihood of taking one selection point from the higher end of the range of values for Vð̞V and one from the lower end of the range for the dominating Max-ð̞) more frequent than for upper-socioeconomic background children.

class and age, the analysis is able to include in the formal model the interaction that is found in the speech sample examined for this investigation.

The older lower-socioeconomic background children have fewer instances of deletion, when compared to younger ones of the same socioeconomic status. Our analysis shows that older children acquire the ranking [Max Stressσ ð̞, Max -# ð̞ >> Max-ð̞ >>*Vð̞V].677 after being exposed to the variety of language spoken at school in which retention of intervocalic [ð̞] is favored. This ranking gets activated as consequence of external constraints such as *socioeconomic class*, *age*, and *style*. The statistical analysis clearly shows these tendencies described above. In summary, the analysis reveals that older lower-socioeconomic background children show evidence of acquiring a new variety as a result of their exposure to more formal style spoken at school. Furthermore, high activation domains interact with variable sociolinguistic phenomena. The high ranking of Max Stressσ ð̞, MAX-ð̞ disfavors deletion in positions such as stressed syllable and word-initial position overruling external constraints such as *socioeconomic class*, and the interaction between socioeconomic background and *age*.

References

Anttila, A. and Cho, Y.Y. 1998. Variation and change in optimality theory. *Lingua* 104: 31–56.

Archangeli, D. and Pulleyblank, D. 1994. *Grounded Phonology*. Cambridge MA: The MIT Press.

Alderete, J., Beckman, J., Benua, L., Gnanadesikan, A., McCarthy, J. and Urbanczyk, S. 1999. Reduplication with fixed segmentism. *Linguistic Inquiry*: 327–364.

Baković, E. 1994. Strong onsets and Spanish fortition. *MIT Working Papers in Linguistics*: 21–39.

Barlow, J. 2003. The stop-spirant alternation in Spanish: Converging evidence for a fortition account. *Southwest Journal of Linguistics*: 51–86.

Barlow, J. and Gierut, J. 1999. Optimality theory in phonological acquisition. *Journal of Speech, Language and Hearing Research* 42: 1482–98.

Bermúdez-Otero, R. and Börjars, K. 2006. Markedness in phonology and in syntax: The problem of grounding. In *Linguistic Knowledge: Perspectives from Phonology and from Syntax*, P. Honeybone and R. Bermdez-Otero (eds). *Lingua*: 116(5). (Special issue).

Bernhardt, B.H. and Stemberger, J.P. 1998. *Handbook of Phonological Development: From the Perspective of Constraint-based Nonlinear Phonology*. San Diego CA: Academic Press.

Beckman, J. 1997. *Positional Faithfulness.* PhD dissertation, University of Massachusetts, Amherst.

Boersma, P. 1998. *Functional Phonology: Formalizing the Interaction between Articulatory and Perceptual Drives*. The Hague: Holland Academic Graphics.

Boersma, P. and Hayes, B. 2001. Empirical tests of the gradual learning algorithm. *Linguistic Inquiry* 32: 45–86.

Bybee, J. 2002. Word frequency and context of use in the lexical difusión of phonetically conditioned sound change. *Language Variation and Change* 14: 261–290.

Cedergren, H. and Sankoff, D. 1974. Variable rules: Performance as a statistical reflection of competence. *Language* 2:333–355.

Cedergren, H. 1979. La elisión de la /d/: Un ensayo de comparación dialectal. *Boletín de la Academia Puertorriqueña de la Lengua Española* VII:19–29.

D' Introno, F. and Sosa, J.M. 1986. Elisión de la /d/ en el español de Caracas: aspectos sociolingüísticos e implicaciones teóricas. In *Estudios sobre la fonología del español del Caribe*, R. Nuñez Cedeño, I. Páez Urdaneta and J.M. Guitart (eds), 135–163. Caracas: Casa de Bello.

Díaz-Campos, M. 2001. *Acquisition of Phonological Structure and Sociolinguistic Variables: A Quantitative Analysis of Spanish Consonant Weakening in Venezuelan Children's Speech.* Columbus OH: The Ohio State University.

Díaz-Campos, M. 2004a. Acquisition of sociolinguistic variables in Spanish: Do children acquire individual lexical forms or variable rules? In *Laboratory Approaches to Spanish Phonology*, T. Face (ed), 221–236. Berlin: Mouton de Gruyter.

Díaz-Campos, M. 2004b. La adquisición de patrones de variación sociofonológica en el habla infantil. In *Actas XIII Congreso Internacional de la Asociación de Lingüística y Filología de América Latina*, V. Sánchez Corrales (ed.), 255–266. San José: Universidad de Costa Rica.

Díaz-Campos, M. 2005. The emergence of adult-like command of sociolinguistic variables: A study of consonant weakening in Spanish-speaking children. In *Studies in the Acquisition of the Hispanic Languages: Papers from the 6th Conference on the Acquisition of Spanish and Portuguese as First and Second Languages*. Somerville MA: Cascadilla.

Díaz-Campos, M. In press. La adquisición de la estructura fonológica y de la variación sociolingüística: Un análisis cuantitativo del debilitamiento consonántico en el habla de niños caraqueños. In *Estudios lingüísticos. Homenaje a Paola Bentivoglio*. Caracas: Universidad Central de Venezuela.

Docherty, G.J., Foulkes, Tillotson, P.J. and Watt, D.J.L. 2006. On the scope of phonological learning: Issues arising from socially structured variation. In *Papers in Laboratory Phonology 8*, C.T. Best, L. Goldstein and D.H. Whalen (eds). Berlin: Mouton de Gruyter.

Fasold, R. 1972. *Tense Marking in Black English*. Arlington VA: Center for Applied Linguistics.

Foulkes, P., Docherty, G.J. and Watt, D.J.L. 2005. Phonological variation in child directed speech. *Language* 81: 177–206.

Guy, G. 1980. Variation in the group and the individual: The case of final stop deletion. In W. Labov (ed.), *Locating Language in Time and Space*. New York NY: Academic Press.

Hale, M. and Reiss, C. 1998. Formal and empirical arguments concerning phonological acquisition. *Linguistic Inquiry* 29: 656–683.

Hayes, B. 1999. Phonetically-driven phonology: The role of optimality theory and inductive grounding. In *Functionalism and Formalism in Linguistics* 1: *General papers*, M. Darnell, E. Moravcsik, F.J. Newmeyer et al. (eds), 243–285. Amsterdam: John Benjamins.

Inkelas, S. and Orhan Orgun, C. 1995. Level ordering and economy in the lexical phonology of Turkish. *Language* 71: 763–93.

Itô, J. and Mester, A. 1995. The core-periphery structure of the lexicon and constraints on reranking. In *University of Massachusetts Occcasional Papers in Linguistics* 18: *Papers in Optimality Theory*, J. Beckman, L. Walsh and S. Urbanczyk (eds), 181–210. Amherst MA: GLSA.

Jakobson, R. 1941. *Kindersprache, Aphasie und allgemeine Lautgesetze*. Uppsala: Almqvist & Wiksell.

Kager, R. 1999. *Optimality Theory.* Cambridge: CUP.

Kiparsky, P. 1993. Variable rules. Handout distributed at the Rutgers Optimality Workshop (ROW1).

Hymes, D. 1974. On communicative competence. In *Sociolinguistics*, J.B. Pride and J. Holmes (eds), 269–293. Harmondsworth: Penguin.

Kerswill, P. and Williams, A. 2000. Creating a new town koine: Children and language change in Milton Keynes. *Language in Society* 29: 65–115.

Labov, W. 1964. Stages in the acquisition of standard English. In *Social Dialects and Language Learning*, R. Shuy, A. Davis and R. Hogan (eds), 77–104. Champaign IL: National Council of Teachers of English.

Labov, W. 1972. *Sociolinguistic Patterns*. Philadelphia PA: University of Pennsylvania Press.

Labov, W. 1989. The child as linguistic historian. *Language Variation and Change* 1: 85–98.

Levelt, W. 1989. *Speaking: From Intention to Articulation*. Cambridge MA: The MIT Press.

Levelt, C.C. and van de Vijver, R. 2004. Syllable types in cross-linguistic and developmental grammars. In *Fixing Priorities: Constraints in Phonological Acquisition*, R. Kager, J. Pater and W. Zonnenveld (eds), 204–218. Cambridge: CUP.

McCarthy, J. 2002. *A Thematic Guide to Optimality Theory*. Cambridge: CUP.

McCarthy, J. and A. Prince. 1994. The emergence of the unmarked. In *Proceedings of the North East Linguistic Society* 24, Mercè Gonzàlez (ed.), 333–79. Amherst MA: GLSA.

McCarthy, J. and A. Prince. 1993a. *Prosodic Morphology* I: *Constraint Interaction and Satisfaction.* Report no. RuCCS-TR–3. New Brunswick NJ: Rutgers University Center for Cognitive Science.

McCarthy, J. and A. Prince. 1993b. Generalized alignment. In *Yearbook of Morphology*, G. Booij and J. van Maarle (eds), 79–153. Dordrecht: Kluwer.

Nagy, Naomi and W. Reynolds. 1997. Optimality theory and variable word-final deletion in Faetar. *Language Variation and Change* 9: 37–55.

Paolillo, John. 2002. *Analyzing Linguistic Variation: Statistical Models and Methods*. Stanford CA: CSLI.

Prince, A. and Smolensky, P. 1993. *Optimality Theory: Constraint Interaction in Generative Grammar.* Report no. RuCCS-TR-2. New Brunswick NJ: Rutgers University Center for Cognitive Science.

Reynolds, W. 1994. Variation and Phonological Theory. PhD dissertation, University of Pennsylvania.

Roberts, J. 1994. Acquisition of Variable Rules: (-t,d) deletion and (-ing) production in preschool children. PhD dissertation, University of Pennsylvania.

Roberts, J. and Labov, W. 1995. Learning to talk Philadelphian. *Language Variation and Change* 7: 101–112.

Sankoff, D. 1998. Variable rules. In *Sociolinguistics*: *An International Handbook of the Science of Language and Society,* U. Ammon, N. Dittmar and K.J. Mattheier (eds), 984–997. Berlin: Mouton de Gruyter.

Samper-Padilla, J.A. 1996. El debilitamiento de la -/d/- en la norma culta de Las Palmas de Gran Canaria. In *Actas del X congreso internacional de la Asociación de Lingüística y Filología de la América Latina*, 791–796. Veracruz: UNAM.

Shiro, M. 1996. *Competencia narrativa de niños en edad escolar.* Caracas: Universidad Central de Venezuela.

Stemberger, J.P. and Bernhardt, B.H. 1999. The emergence of faithfulness. In *The Emergence of Language*, B. MacWhinney (ed.) 417–446. Mahwah NJ: Lawrence Erlbaum.

Steriade, D. 1993. Closure, release and nasal contours. In *Phonetics and Phonology*, M. Huffman and R. Krakow (eds), 401–470. San Diego CA: Academic Press.

Wolfram, W. 1969. *A Sociolinguistic Description of Detroit Negro Speech*. Washington DC: Center for Applied Linguistics.

Zubritskaya, K. 1997. Mechanism of sound change in optimality theory. *Language Variation and Change* 9: 121–148.

Sonority scales and syllable structure

Toward a formal account of phonological change

Javier Gutiérrez-Rexach
The Ohio State University

This paper develops an analysis of syllable-structure changes from Latin to Proto-Romance and Spanish within the framework of recent developments in the formal treatment of OT. Some aspects of the transition in syllable structure from Classical Latin (CL) to Vulgar Latin (VL) and Spanish will be discussed and shown to lead to the following general question: Which principles guide margin-structure transformations in a particular language? After characterizing the syllable structure (the set of possible margins: onsets and codas) of Classical Latin and Vulgar Latin/Proto-Romance/Spanish, it is claimed that structural transitions from Latin to Vulgar Latin show a general tendency to create more harmonic or sonorous structures (margins). This sonority-based treatment maximizes the impact of sonority scales on syllabification, going beyond standard generative treatments combining derivational rules and sonority constraints such as the Sonority Sequencing generalization.

Keywords: sonority, sonority distance, sonority scale, sonority transition, model theory, Latin, Vulgar Latin, margins, extrasyllabicity, phonological change, hierarchies, harmony, prominence, alignment, onset, coda, regressive gemination

0. Introduction

In recent years, Optimality Theory (Prince & Smolensky 1993[2004]; McCarthy 2002) has considerably extended its range of inquiry from theoretical phonology to areas such as syntax, pragmatics and language acquisition (cf. Dekker, van der Leeuw & van de Weijer 2000; Legendre, Grimshaw & Vikner 2001; Blutner & Zeevat 2003). One of the most successful domains of application for Optimality Theory (OT) has arguably been the theoretical analysis and reconstruction of certain phonological aspects of language variation and change (Jacobs 1995; Anttila 1997, 2002; Anttila & Cho 1998; Holt 1997, 2003; etc.) Within the OT framework, language change can be viewed as the selection of a sequence of grammars from an inventory of possible grammars, i.e. from a

grammar lattice, in Anttila & Cho's (1998) terminology. The members of this sequence (the "evolving" grammars) differ in two properties: their respective sets of active or operational constraints and, more critically, how these constraints are ranked. Thus, the model of constraint promotion and demotion seems particularly fit to capture the mechanics of language change in a non-derivational fashion. In general, the impact of an optimality-theoretic analysis along these lines is deeper than the mere substitution of a derivational rule-based framework by a non-derivational constraint-based one. Among other things, OT raises intriguing questions for grammar modeling, such as the following ones: How can constraints be used to successfully model the learning and computation of human language?; What is the role of constraints in predicting actual and potential outputs?; What hierarchy types should be acceptable?;
Is a continuous model superior to a discrete one?; How do considerations related to language evolution and change impact our understanding of debated theoretical constructs such as constraint aggregation or conjunction?, etc.

In this paper, syllable-structure changes from Latin to Spanish will be analyzed within the framework of recent developments in the formal treatment of OT. Some aspects of the transition in syllable structure from Classical Latin (CL) to Vulgar Latin (VL) and Spanish will be discussed and shown to lead to the following general question: Which principles guide margin-structure transformations in a particular language? After characterizing the syllable structure (the set of possible margins: onsets and codas) of Classical Latin and Vulgar Latin/Proto-Romance/Spanish, it will be claimed that structural transitions from Latin to Vulgar Latin show a general tendency to create more harmonic/more sonorous structures (margins).

This sonority-based treatment maximizes the impact of sonority scales on syllabification, going beyond standard generative treatments combining derivational rules and sonority constraints such as the Sonority-Sequencing Generalization (Selkirk 1984). In these treatments, the notion of "extrasyllabicity" has come into being because the syllable theory of the time when they were developed crucially relied on the existence of a syllabification algorithm and ordered rules. Depending on the specific theory of choice, either hybrid onsets and codas that violate Sonority Sequencing are created "on the surface" or extrasyllabic consonants are adjoined to some higher unit such as the phonological word, where no co-occurrence restrictions are defined. The concept of extrasyllabicity has several shortcomings. One overt problem is the entailed prediction that a language could well support two, five, eleven or thirty-six extrasyllabic consonants in a row. Since everything that is not parsable by the syllabification algorithm is left astray, and since the ulterior integration into the prosodic hierarchy does not obey any co-occurrence restrictions, a string such as [fdgltprkot] should be perfectly well-formed in a language that allows for extrasyllabicity (/fdgltpr-/ being an extrasyllabic cluster). As a matter of fact, such monster-clusters do not occur at edges of any natural language. Second, an OT-based account can exploit the potential in Sonority Sequencing without resorting to ad-hoc rules of adjunction that apply only to certain "deviant" sequences, such as complex onsets of decreasing sonority beginning with the segment /s/. A sophistication of sonority-based constraints eliminates the need for adjunction rules in general and allows for a uniform constraint-based approach.

1. A formal theory of sonority within a model-theoretic approach

Recent research within OT has focused on the formal foundations of constraint ranking and its logic (Karttunen 1998; Samek-Lodovici & Prince 1999; Prince 2002). The logical approach treats constraints as functions from sets of candidates into sets of candidates. This view also lends itself to a formalization of rankings as a type of function composition. Potts & Pullum (2002) present a model-theoretic approach to OT and characterize phonological candidates as a class of structures, which allows to establish a logical description language for the statement of constraints over that class. The adoption of this perspective proves to be extremely useful in showing which constraints require more complex classes of structures and are more problematic (such is the case with output-output correspondence and sympathy constraints). In this paper, a similar methodological philosophy will be adopted, with several changes in the technical details. Unlike Potts & Pullum's approach, the description language that will be used here is not of a modal nature, since a standard first-order logic with measurement parameters suffices for our purposes.[1] Additionally, no constraints of higher complexity will be adopted and, in general, no constraints derived from Correspondence Theory (McCarthy & Prince 1995).[2]

Let $\mathbf{M} = \{M_i: 1 \leq i \leq n\}$ be the class of sets M_i having as segments /λ/, pairs of segments /λ+τ/, and possibly triples of segments /λ+τ+μ/. A set $M_L \in \mathbf{M}$ is the set of possible margins of given language L. We are interested in two subsets of M_L: O_L and C_L. O_L is the set of possible onsets of L, and C_L is the set of possible codas of L. These two sets satisfy the following constraints:

(1) a. $\forall$L(anguage), $\forall M_L \in \mathbf{M}$, $M_L = O_L \cup C_L$
b. $O_L = C_L$ or $O_L \neq C_L$

The claim (1a) states that the set of possible margins of a language consists of its possible onsets and codas. The claim (1b) states that these subsets may be not identical, although not necessarily disjoint. In fact, non-identity is the most common situation

1. A modal description language includes modal operators, such as the "Box" operator (necessity) and the "Diamond" operator (possibility).

2. Correspondence Theory is the branch of phonology studying the nature of conditions that measure the similarity of two related forms (such as input and output, base and derivative, base and reduplicant). It originates in the pre-OT period when several conditions were formulated mandating input recoverability or similarity between related forms. Correspondence has become a central part of phonological theory with the advent of OT. Within OT, this theory has the primary function of defining the limits within which markedness constraints will affect an input. Nevertheless, a formalization problem is that this is a theory of a higher complexity. Which pairs of forms stand in a correspondence relation is decided in a non-deterministic fashion (for instance, a root may stand in correspondence with its immediate derivative or with all of its derivatives). Thus, in this paper we will use the constraints from P&S (1993) and not those that supersede them in later developments within Correspondence Theory. For example, instead of PARSE and FILL, Correspondence Theory uses MAX and DEP. Also, PARSE(FEATURE) is replaced by IDENT, PARSE(SEGMENT) by MAX, and FILL(SEGMENT) by DEP.

in the world languages and it is true in the languages that will be studied here. For the purposes of this paper, the *phonological structure*, P, of a language L is defined as a pair $<S_L, \mathbf{F}>$, where S_L is a set of segments and $\mathbf{F} \in [S_L{}^* \rightarrow S_L{}^*]$ a set of functions from the set of finite strings of segments into itself. P is the closure of S_L under **F**. We assume that the members of S_L (the segments) are structured objects in the sense that they can be conceived as sets of phonological features. For example, the segment /a/ is defined as the set of features { [+low], [+back], [−round] }, etc. In general, this highly-abstract view of the phonological structure of a language as the closure of a set under a certain number of operations (including the basic generating function Gen and the relevant active constraints) is consistent with algebraic conceptions of grammar, such as the Bare Grammar proposal defended by Keenan & Stabler (2003).

Let π be a function from S_L to the set of natural numbers ($\pi: S_L \rightarrow \mathbb{N}$). We say that π is a *sonority assignment*, i.e. a function which associates segments to natural numbers. It is widely agreed on that the minimal sonority distance between members of a syllabic constituent may vary crosslinguistically but the sonority hierarchy is typically assumed to be the same for all languages. There are also several controversies about which version of the hierarchy is more consistent with crosslinguistic data, and some authors may prefer to assume a simplified version of the hierarchy, originally proposed by Jespersen (1904), when nothing in the phenomena under consideration hinges on the details. In essence, the default position is that sonority assignments are parametric. We implement this idea by making the function π language-specific: different languages may differ in the values they assign to each segment. Some languages collapse distinctions and seem to use a coarse-grained sonority scale (Steriade 1982). Following the convention in Prince & Smolensky (1993[2004]), henceforth P & S, we use $|\lambda|$ or π_λ to denote the value of λ under π. Although π is language specific, all sonority scales satisfy the following constraint (P & S):

(2) Prominence Alignment 1: $\forall\pi$, $|a| \geq |i| \geq \ldots \geq |l| \geq \ldots \geq |d| \geq |t|$,
or equivalently: $a \succ i \succ \ldots \succ d \succ t$.

Let L be a language and P_L, M_L be subsets of S_L ($P_L, M_L \subseteq S_L$). The set of margins M_L is $O_L \cup C_L$. The set P_L is the set of possible peaks in L, defined as $P_L \subseteq \{ /\lambda/, /\lambda+\tau/ : \lambda,\tau \in S_L \}$. We define a *sonority structure* in a language L as a tuple $<S_L, \kappa, \pi, CON>$, where S_L is the set of segments of L; κ is a syllable construction, i.e., a function $\kappa: (O_L \times P_L \times C_L)^* \rightarrow (O_L \times P_L \times C_L)^*$; π is a sonority assignment; and CON a set of constraints on $\pi \bigcirc \kappa$.[3]

The following constraint is also quasi-universal (P & S):[4]

(3) Prominence Alignment 2: Given a language L, $\forall\lambda \in P_L$, $\forall\tau \in M_L$, $|\lambda| > |\tau|$

3. Notation: * is the Kleene star operator and (AxBxC)* is the set of finite strings over the cartesian product of A, B and C. The symbol ○ represents function composition: f ○ g denotes the composition of the functions g and f.

4. There is a well-known exception: In Imdlawn Tashlhiyt Berber, /k/ can be a peak, and /i/ can be a margin, so (3) is not intended to be viewed as a true universal.

What (3) states is that peaks are generally more sonorous than margins. There are more constraints in the sonority structure of a given language. Some of them are true universals, others instantiate general trends, and finally others are language-specific (Clements & Keyser 1983). These constraints determine the syllable structure of a language, restricting the sonority properties that possible peaks and margins must meet. We assume with P & S that constraints are ordered by an ordering relation of dominance (>>). Let C_1, C_2 be constraints. Then, in a given language $C_1 >> C_2$, i.e. C_1 is ranked higher than C_2, if and only if the generated strings of that language incur in fewer violations of C_1 than of C_2.

Let L_1, L_2, L_3 be languages genetically and chronologically related as follows: $L_1 < L_2 < L_3$, where < denotes here a temporal ordering relation (L_1 is prior to L_2). A basic OT-approach to sonority-related language change would rely on a simplified working hypothesis along the following lines:

(4) Let L_1, L_2, L_3 be language (stages) such that $L_1 < L_2 < L_3$. Let CON_{Lx} be the set of constraints on the sonority structure of Lx. Then, it is the case that for L_1, L_2, L_3 the following fact holds: $CON_{L1} = CON_{L2} = CON_{L3}$, but the ordering relations >> over CON_{L1}, CON_{L2}, CON_{L3} are different and $\pi(Lx)$ may also be different.

The main claim in (4) is that changes in the basic syllable construction of a language are due to changes in the constraint hierarchies and to changes in the sonority assignment of the language. We may label this approach a strictly formalist or purely-phonological approach (see Bermúdez-Otero 2005 for discussion). Nevertheless, there are alternative approaches to phonological change in OT that downplay the role of strict constraint re-ranking and add data-reanalysis considerations. As a reviewer points out, this tension between formalist and mixed or reanalysis-based approaches can be traced back to rule-ordering models. The formalist rule-based standpoint was that rules were added or orders were reversed, so that the language was viewed as an autonomous rule system that users made small changes to. The "mixed" standpoint of that period was that speakers may indeed add rules or reverse orders, but that language-acquiring children subsequently "reanalyze" the language data with a new grammar that is optimal for describing the data. This reanalysis can completely restructure a grammar, when compared to that of the previous generation, which children have no direct access to. Within the OT framework, the formalist standpoint is that constraints are promoted or demoted, and language is viewed as an autonomous constraint-ranking system that users make small changes to. The mixed standpoint is that speakers may indeed promote or demote constraints, but that language-acquiring children subsequently reanalyze language data, with possible complete restructuring. See Ohala (1992), McMahon (2000) or Blevins (2004), among others, for discussion. This position is defended to different degrees in several recent works on phonological change (Holt 1997, most papers in Holt 2003, and Gess 2003). For example, Gess (2003) argues that some instances of change have their origins in production-oriented phonetic innovations, and cue preservation constraints might provide a better format for the expression of innovations related to perceptual salience.

For the purposes of this paper, the formalist re-ranking model is sufficient and adequate for our explanatory goals. It is simpler, more elegant and theoretically parsimonious, since mixed approaches have to rely on external assumptions about acquisition, production, perception and phonological parsing. These concerns, albeit reasonable and justifiable on their own grounds, are extrinsic to the goals of a model-theoretic account. They also need to rely on cognitive assumptions that are still under intense debate.[5] On the other hand, whereas it is true that a model-theoretic account does not rely on assumptions of this sort, it is also clear that it is not incompatible with them. A hypothesis such as (4) is certainly compatible with a range of assumptions about how speakers activate, deactivate or rerank constraints, as well as with subsequent or related reanalyses of the available data.

2. Syllable construction and sonority in Optimality Theory

We will follow here the fundamental aspects of an OT theory of syllable structure, as established by P & S (1993: part II, especially in Chapter 8).[6] Two types of constraints on syllable structure can be distinguished: basic syllable constraints and form/definition constraints.

(5) Basic Syllable Constraints:
- ONS: Syllables must have onsets.
- *CODA: Syllables must not have a coda.
- PARSE: Underlying segments must be parsed into syllable structure.
- FILL: Syllable positions must be filled with underlying segments.

(6) Syllable Form Constraints:
- NUC: Syllables must have nuclei.
- *COMPLEX: No more than one C or V may associate to any syllable position node.
- *M/V: V may not associate to Margin nodes (Onset and Coda).
- *P/C: C may not associate to Peak (Nuc) nodes.

5. These are some of the issues that "mixed" approaches have to tackle: How phonology is grounded in phonetics; the relationship between language knowledge and language use; how constraint conflict is resolved probabilistically rather than deterministically, due to the indeterminate position of constraints within or between speakers (Anttila & Cho 1998; Boersma & Hayes 2001); how language-acquisition models can be insightful for the diachronic domain when evidence about actual individuals is not available, etc. The goals of a model-theoretic account are more modest indeed, but the theoretical burden to carry and justify is also considerably lighter.

6. The main ideas in P & S are grounded to some extent on previous research by Jakobson (1962), Clements & Keyser (1983), Steriade (1982), and many others. P & S do not adopt moraic syllable theory (Hayes 1989) and I will follow them in not using it either, although an implementation of the moraic approach into OT syllable theory is conceivable (Kirchner 1993). For the impact of foot-based changes in syllable structure, another factor not considered here, see Lleó (2003).

According to P & S, basic syllable structure is governed by the constraints in (5) and (6). They are ranked in language-particular hierarchies that will assign to each input its optimal structure, which is the output of the phonology. In addition to the basic constraints above, syllable structure is constrained by what P & S call the "ordinal construction of C/V", i.e. the sub-hierarchies associated with sonority:

(7) Margin Hierarchy: *M/a >> *M/i >> …>> *M/d >> *M/t
Peak Hierarchy: *P/t >> *P/d >> … >> *P/i >> *P/a

As a consequence of (7), the following associational harmony is established:

(8) Associational Harmony:
M/t ≻ M/d ≻ … ≻ M/i ≻ M/a, where $\lambda \succ \tau$ if $|\lambda| < |\tau|$.
P/a ≻ P/i ≻ … ≻ P/d ≻ P/t, where $\lambda \succ \tau$ if $|\lambda| > |\tau|$.

According to (8), the more sonorous a segment is, the more harmonic it becomes as a peak (nucleus) and, conversely, the less sonorous a segment is, the more harmonic it is as a margin. The prominence scales in (7) and (8) are universally aligned, as were the ones in (2) and (3). It can also be inferred that if a certain segment is a possible nucleus, then so are all segments that are more sonorous in the alignment. The converse is true for onsets:

(9) Harmonic Completeness (Possible Onsets and Peaks):
If $|\lambda| > |\tau|$ and λ is a possible onset, then so is τ.
If $|\tau| > |\lambda|$ and λ is a possible peak, then so is τ.

In a given language, segments can be associated only to margins, only to peaks or to both structural positions in the syllable. When a segment λ is more harmonically associated to the Peak position, we say that it is *peak preferring*. Thus, the association of a segment to Peak or to Margin in terms of relative affinity can be defined as follows:

(10) Syllable Position Affinity: If in a given language it is the case that P/λ ≻ M/λ or, equivalently, *M/λ >> *P/λ, then λ is a *peak-preferring* segment; otherwise λ is *margin-preferring.*

Finally, from (7) and (10) the following theorem can be derived:

(11) The Affinity Cut Theorem:
Suppose $|\lambda| > |\tau|$. Then, if τ is peak-preferring, so is λ. If λ is margin-preferring, so is τ. Thus, there is a cut in the sonority scale, above which all segments are peak-preferring and below, margin-preferring. The only parameter of cross-linguistic affinity variation is the sonority level λ_{Aff} of this cut point.

The determination of the set of possible onsets and the set of possible peaks in a given language is governed by two parameters: the sonority cut points λ_{Ons} and λ_{Peak}.

(12) Let L be an arbitrary language. Then, $O_L = \{\lambda : |\lambda| \leq \lambda_{Ons}\}$ and $P_L = \{\tau : |\tau| \geq \lambda_{Peak}\}$

The association of the above theory of syllable structure and the general program presented in the first section is clear. Model-theoretic OT is also a theory of sonority structures in the sense that it provides a specification of the set CON of constraints that govern syllable construction and how they restrict the class of potential candidates.

3. Latin syllable structure

3.1 From Latin to Romance: Some problems

The purpose of this section is to apply the theoretical framework sketched in the previous sections to a model of the changes in margin configurations of a given language (Latin). These changes, besides many others that are not being analyzed here, yield the stages of evolution known as Vulgar Latin and Proto-Romance, finally resulting in the family of Romance Languages as we know them today. The chronological and linguistic definition of the intermediate stages between the initial stage (Latin) and the final one (Romance languages) is still a matter of controversy, and we are not going to enter in that debate here (see Väänänen 1963; Corominas & Hoffman 1958; etc). The period normally denominated Vulgar Latin is perhaps not a stage in this evolution, but rather a variant of the Spoken or Familiar Latin predating it. Additionally, the sources for its study are scarce and in some cases altered. The same problem arises in the case of Proto-Romance. It is more likely a theoretical reconstruction that can be put together on the basis of certain documented phonological transitions than a clear-cut language spoken in the Romania. Nevertheless, all these factors are not a great disadvantage for the present study, since it will only focus on some phonological changes that are sufficiently documented and studied. Moreover, these data provide an excellent basis for the study of changing constraint hierarchies and prominence alignments and, in my view, show that OT could be a useful tool for the understanding of historical processes in phonology.[7] On the other hand, the study of language change helps us in testing general statements such as (4), which obviously are of evident significance to the general theory of optimality in phonological structure.

3.2 Latin margin structure

The system of Latin consonants is normally described as consisting of two series of stops -one voiced and one voiceless- two nasal consonants, two liquids, a labial fricative and a voiceless spirant. There are no affricates or palatal consonants.[8]

7. The scarcity and poverty of available data sources would be one more additional reason to be skeptical about the superiority of mixed cognitive-based approaches. The evidence is just not there to make sufficiently grounded claims on users' acquisition and parsing strategies.

8. I am assuming a feature specification language mostly based on passive articulator features. For a feature classification of Latin consonants in SPE terms, see Mignot (1975).

(13)

	labial	dental/alveolar	velar
Voiceless stops:	p	t	k
Voiced stops:	b	d	g
Fricatives:	f	s	
Liquids:		r, l	
Nasals:	m	n	

The status of the labiovelars /k^w/ and /g^w/ has been the subject of much debate (see Devine & Stephens 1977). In some cases, /k^w/ behaves like a single consonant with a secondary articulator. Nevertheless, the subsequent development of these groups in Romance leads one to favor their interpretation as /k/ and /g/ plus a glide. The exact phonetic realization of /s/ is not known for sure, and the liquid /l/ varied noticeably in articulation depending on its position in the syllable and perhaps on the preceding vowel too (Nandris 1965).

The members of the sets of Latin onsets ($O(nset)_{LAT}$) and Latin codas ($C(oda)_{LAT}$) can be specified as follows:

3.3 Latin onsets: The set O_{LAT}

All consonants and glides (*volui*[volwi], *jam*) can be simple onsets. Complex onsets of type CC and CCC are allowed but obey strong restrictions, as described in Steriade (1987). CC onsets can be divided in two groups, represented in (14) and (16) below.

(14) [obstruent] + [liquid] onsets:
pr-: *pratum, primus, promittere*
tr-: *tres, trans, trahere*
kr-: *credere, crudelis, crux*
br-: *bracchium, brevis*
dr-: *draco*
gr-: *grandis*
fr-: *frater, frons*
pl-: *placere, plenus, plebs*
kl-: *clamare, clarus*
bl-: *blandus, blitum*
gl-: *gladius, gloria*
fl-: *flos, fletus*

Exceptions to this generalization are the clusters #tl-, #dl-, which are not allowed in Latin, as pointed out in Steriade (1987):[9]

(15) #tl- → l: #*tlatos* > *latus*
#dl- → (ll) → l: #*dlongos* > *longus*

9. Notice that /sr/ and /sl/ are are not well-formed onsets and should be included in the list of exceptions with /tl/ and /dl/. An alternative option would be to limit the possibilities of the Latin onset system to /stop+liquid/ and consider /fl/ and /fr/ as exceptions. The onset /gn/ is not allowed either. Zirin (1970: 26) observes that *gn* was an archaism preserved only in literary usage, and the actual pronunctiation was /n/ or /nn/: #gn → nn → n: #*gnixus* → *nixus*.

The second group of CC onsets can be described as follows:

(16) /s/ + [stop][−voiced] onsets:
sp-: *spes, speculum, spatium*
st-: *stare, stella*
sk-: *scala, scopa, scire*

Steriade (1982) observes that these onsets are only allowed word-initially, since the same sequences are heterosyllabic in intervocalic position: *es.tis, pos.tulare*. She proposes a rule of stray adjunction that incorporates an initial non-syllabified /s/ to the first syllable. The account of these data that will be offered in §5 is obviously different, since no derivational rules are allowed within an OT account.

For CCC onsets, only the following pattern is attested:[10]

(17) /s/ + [+stop][−voice] + [liquid]:
spr-: *spretor*
str-: *stringere*
skr-: *scribere*
spl-: *splendere*

CCC onsets can only occur word-initially, as was the case with the CC clusters in (16). In intervocalic position, the pertinent syllabification patterns are: *as.tra, as.pera, res.plendeo*.

3.4 Latin codas: The set C_{LAT}

All consonants (except /f/)[11] and glides (*au.geo*) can be simple codas. The set of CC codas is more restricted:

(18) a. [nasal] + [obstruent]: *amant, iunctus, empsi*
b. [liquid] + [obstruent]: *fert, vult, est, ars, ar[ks], cal[ks]*
c. [obstruent] + /s/: *inops, no[ks]*

Codas in group (18c) are attested word-finally (with some exceptions: [eks.tra]). Groups (18a) and (18b) are unified as [sonorant] +[stop]. Another generalization for (18) would be to describe these sequences as [+son]+[−son,−cont] consonants, noting that /s/ can be added as an appendix to a single ([ars]) or complex coda ([arks]).

10. An alternative option would be to describe the set of CCC onsets as the combination of a well-formed complex onset + /s/.

11. The distribution of /f/ seems to be even more restricted. Kent (1945) points out that word-medial /f/ onsets are only found after a prefix or in dialectal borrowings: *defero, rufus*.

4. Constraint Interaction on Latin margins

As was described above, all consonants and glides behave as margins under normal conditions, so it seems reasonable to propose that π_{glide} sets the cut point for peak/margin preference. From the affinity cut theorem in (11), the following can be inferred:

(19) Latin Margins and Peaks. Let M_{LAT} and P_{LAT} be the set of possible margins and possible peaks in Latin. The sonority-based definition of this set is as follows:
$M_{LAT} = \{\lambda : |\lambda| \leq \pi_{glide}\}$
$P_{LAT} = \{\tau : |\tau| > \pi_{glide}\}$

The inventories of possible margins provided in the previous section lead us to another sonority-based generalization: complex onsets are formed by segments of increasing sonority, and segments in complex codas are of decreasing sonority. Let us provisionally assume the following *minimal sonority assignment* function π for Latin:[12]

(20) $\pi_{Vowel} = 3$
$\pi_{Approximant} = 2$
$\pi_{Nasal} = 1$
$\pi_{Obstruent} = 0$

This assignment is minimal in the sense that only four values have been included in the range of the function π. The resulting sonority groupings are rather coarse-grained: segments that do not behave uniformly in many respects are grouped together. Nevertheless, this minimal assignment can be more predictive than a finer-grained one, since if it is proven that certain aspects of syllabification depend on (20), it will follow that a minimal set of basic distinctions in sonority can account for sonority-based aspects of syllabification. On the other hand, it might be the case that some aspects of syllable structure are governed by π(20), and others require a finer-grained function. This possibility has to be empirically determined (some possible options are suggested below).

The function π allows us to compare segments with respect to their sonority. The alignments introduced in (2) and (3) induce a pre-order between segments. All the segments can also be compared in a binary fashion, via the following notion:

(21) Sonority distance: $\forall$ λ, τ, the sonority distance between λ and τ, $\delta(\lambda,\tau)$, is the $n \in \mathbb{N}$ such that $||\lambda| - |\tau|| = n$.

The sonority distance between two segments is then the absolute difference between their sonority values, e.g. the sonority distance between a vowel and a nasal is 2. The Peak-Margin distinction in (3) can be reformulated now in terms of the notion of distance:[13]

12. The segments /i/ and /u/ would be members of two sets (Vowel and Approximant), and they would receive two different values under the π function.

13. More specific claims can be made on the basis of empirical data. For example, there is ample evidence that most languages require a maximal rise in sonority between the members of the onset and

(22) Theorem (Peak-Margin distance): Given a L(anguage), $\forall \lambda \in P_L, \forall \tau \in M_L$: $\delta(\lambda,\tau) > 0$
Proof: From (3) we have that $|\lambda| > |\tau|$ and then, from def. 15, $||\lambda| - |\tau|| > 0$.

This theorem states that peaks and margins cannot be equal in sonority. It holds cuasi-universally or, in OT-theoretic terms, it can be formulated as a highly-ranked constraint. Let us adopt the following notational conventions: a dot (.) between segments indicates a syllable boundary, and a stress after a segment (') indicates that it is the syllable peak. Consider now, as an example, two alternative parses of the word *captum*: [ca'.pt'.u'm] and [ca'p.tu'm]. The parsing [ca'.pt'.u'm] will be generated by Gen (i.e., it is a possible syllabification). But in the syllable /pt'/ we have that $|p| = |t| = 0$, so it will not be the case that $|t| > |p|$, and then $\delta(p,t) = 0$. The following constraint tableau shows that the parse [ca'.pt'.u'm] loses because it violates the constraint on Peak-Margin distance (P/M-δ):[14]

(23)

	P/M-δ	ONS	*CODA
a. ☞ ca'p.tu'm			**
b. ca'.pt'.u'm	*!	*	*

The notion of sonority distance is also useful to determine which sequences of segments are allowed as margins. A sequence of segments /λ+τ/ is said to be *sonority increasing* if and only if $|\lambda| < |\tau|$. A sequence /λ+τ/ is *sonority decreasing* if and only if $|\lambda| > |\tau|$. The following proposition can be now formulated:

(24) Fact: Under π(14), $\forall \lambda,\tau \in M_{LAT}$, $/\lambda+\tau/ \in O_{LAT}$ iff $\pi_\lambda = 0$ & $\pi_\tau = 2$
$/\lambda+\tau/ \in C_{LAT}$ iff $\pi_\lambda = 1,2$ & $\pi_\tau = 0$
Proof: By inspection over the strings in §3.3 and §3.4 above.

(25) Corollary: Under π(14), if $/\lambda+\tau/ \in O_{LAT}$ then it is increasing & $\delta(\lambda,\tau) = 2$;
if $/\lambda+\tau/ \in C_{LAT}$ then it is decreasing & $2 \leq \delta(\lambda,\tau) \leq 1$

The fact in (24) is a constraint on possible complex onset/codas in Latin, and not a universal fact for all sequences $/\lambda+\tau/ \in M_{LAT}$. It asserts that Latin onsets tend to form increasing sequences, and the sonority distance between the segments in the onsets is 2. Latin codas tend to form decreasing sequences and the distance between segments in codas may be 1 or 2, since we allow that either λ has the feature [nasal] or λ is speci-

a minimal drop between the members of the coda, as reflected in the Sonority-Dispersion Principle (see Clements 1990).

14. A reviewer observes that, although the constraint P/M-δ is assumed to be crucial in selecting the winning candidate, in fact it seems to be redundant since the same candidate would be selected by the interaction of ONS and *CODA. This conclusion is not clear, given that the sonority distance constraint is as high as the structural constraint and, as is being argued here, sonority constraints should be given more prominence, since they allow for the elimination of unwanted adjunction rules. A claim that could be certainly argued is that what is behind the distance constraint is a peak affinity (preference) consideration: The candidate [ca'.pt.u'm] would be ruled out by the arguably high ranking of *P/t. This is nevertheless a more specific constraint, whereas a sonority distance constraint applies uniformly.

fied as [liquid]. The effects of the Sonority Sequencing Generalization (Selkirk 1984) would follow from these statements.

Some of the onsets in §3.3 and §3.4 fail to satisfy (24) and (25). An account of this apparent contradiction can be straightforwardly provided within OT. A violation of (24) shows that the constraints FILL and PARSE are ranked higher than the constraint in (24). Let us call this constraint ONS-δ/CODA-δ. Consider a constraint tableau for the word *stare*, which includes the constraints *P/s, PARSE, FILL, *COMPLEX, *CODA and the new constraint ONS-δ. The tableau in (26) will help us elucidate the respective ranking of these constraints.[15]

(26)

	*P/s	PARSE	FILL	ONS-δ	*COMPLEX	*CODA
a. ☞ sta’.re’				*	*	
b. s’.ta’.re’	*!					
c. <s>.ta’.re’		*!				
d. □ ’s.ta’.re’			*!			*

First, it is evident that in the syllabification [sta’.re’] the constraint ONS-δ is violated, since $\pi_s = 0$ and $\pi_t = 0$, so $\delta(s,t) = 0$. In Classical Latin, the violation of ONS-δ in [sta’.re’] cannot be resolved either by inserting an epenthetic vowel (FILL violation) or by deleting the problematic segment /s/ (PARSE violation). This shows that ONS-δ is lower than FILL and PARSE in the hierarchy. As will be shown in §5 and §6, Vulgar Latin will rank these constraints differently. An alternative explanation might be found by highlighting the fact that possible violations of ONS-δ/CODA-δ always involve the segment /s/: /s+stop-/, /s+CC-/, /-s+stop/, /-stop+s/. Then, it can be hypothesized that the function π(20) is partial and that it does not assign any value to /s/. The sequences above would not violate ONS-δ/CODA-δ, since /s/ is not assigned a sonority value and would not count in the computation of sonority distance. That would also explain why CCC onsets in Latin are only possible when the first segment is /s/. This alternative solution would be very much in the spirit of the stray adjunction rule in Steriade (1982) mentioned before. This rule incorporates an unsyllabified or extrasyllabic initial /s/ to a syllable. It seems that both explanations are complementary in that they represent two different approaches to a single fact. The constraint in (24) can be formulated as a constraint allowing violations or as a logical proposition to prove. When the proof involves all segments in the inventory, no violations should arise because this would

15. This is an important point. The relevant argument here is not that the new constraint (ONS- δ) plays a critical role in determining the winning candidate in the tableau. Rather, we are presenting a mere ranking argument. The tableau helps us determine how the onset sonority distance constraint is ranked with respect to the faithfulness constraint. One reviewer claims that, if ONS- δ is to play any role at all, it cannot be ranked under all faithfulness constraints because its role would be obscured. According to this reviewer, if ONS- δ is ranked below PARSE and FILL (the only faithfulness constraints at play here), then any combination of two segments would surface in the onset regardless of what ONS- δ states, allowing unwanted onsets such as /pt/, /kp/, /tl/, /gn/, etc. I fail to see the logic of this proposal. These unwanted onsets are indeed violations of faithfulness and are not related to onset sonority, a fact that actually reinforces our ranking argument.

lead to logical contradiction. From an OT point of view, the first line of explanation would always be preferable, since it would allow us to dispense with a derivational rule such as stray adjunction.

A refinement of the constraint-based approach to (24) is still possible in the sense that the constraint can be formulated in a fashion such that it becomes stronger. Complex onsets in Latin can be viewed as the mirror image of complex codas, except for the cases involving nasals. The sequence /[nasal]+[obstruent]/ is a possible coda in Latin, but /[obstruent]+[nasal]/ is not a possible onset. The occurrence of /n/ is very restricted. The sequence /[+nasal]+[+obstruent]/ is a good coda only if it is in word-final position or precedes other consonant: *amant, volunt, trans, punctus, deun*[*ks*]. Moreover, when the sequence /n+obstruent+C/ can be parsed as [n.obstruent + C], this option is preferred to [n + obstruent.C]. Consider, for instance, that the parse [i'n.tra'] is possible in Latin but the parse [i'nt.ra'] is not. What these data suggest is that the cases involving /-n+obstr./ are probably violating the CODA-δ constraint, but they surface in order to prevent a violation of PARSE and FILL, as was shown before with respect to /s/. If this is so, nasals can be excluded from the inventory of optimal λ segments, as was done in the case of /s/ in onset position, thereby unifying the sonority requirements for complex onsets and complex codas.

Let us formulate a more general *sonority distance constraint on Latin margins* (M-δ):

(27) Under π(20), $\forall \lambda,\tau \in M_{LAT}$, $/\lambda+\tau/ \in O_{LAT}$ iff $\pi_\lambda = 0$ & $\pi_\tau = 2$;
$/\lambda+\tau/ \in C_{LAT}$ iff $\pi_\lambda = 2$ & $\pi_\tau = 0$
Proof: By inspection over the strings in §3.3 and §3.4 above.

(28) Corollary: Under π(20), if $/\lambda+\tau/ \in M_{LAT}$ then $\delta(\lambda,\tau) = 2$;
if $/\lambda+\tau/ \in O_{LAT}$ then it is sonority increasing;
if $/\lambda+\tau/ \in C_{LAT}$ then it is sonority decreasing

Words like *amant*, and *dant* violate now M-δ, since the following sonority assignments result: $\pi_n = 1$, $\pi_t = 0$, and then $\delta(n,t) = 1$. Why are these words optimal outputs? Consider the following tableau:

(29)

	*P/t	PARSE	FILL	M-δ	*COMPLEX	*CODA
a. ☞ da'nt				*	*	*
b. da'.nt'	*!					
c. da'n.t'	*!					*
d. da'n<t>		*!				*
e. da'n.Ø't			*!			*

The above tableau shows that the resistance of /t/ to be a peak (*P/t), PARSE and FILL are ranked higher than the constraints M-δ, *COMPLEX and *CODA. Then, [da'nt] is the optimal solution among all the alternatives generated by the function Gen. Notice that M-δ is ranked lower than the faithfulness constraints, so it would not be possible for the input /dant/ to surface as [da'rt], for example, even if the latter does not violate the sonority distance requirement and the former does. The same holds for the rest of the cases. Let us compare the critical case in (30), where a choice between [n + obstruent.C] or [n.obstruent + C] is involved:

(30)

	M-δ	*COMPLEX	*CODA
a. ☞ i'n.tra'		*	*
b. i'nt.ra'	*!	*	*

The above tableau shows that the margin distance constraint (M-δ) is ranked higher in the hierarchy than basic syllable constraints such as *COMPLEX, *CODA and ONSET. Thus, whenever constraints higher than M-δ are not at stake, the coda configuration /n+[obstruent]/ is not an optimal output. Note that this tableau would illustrate the general principle of Onset Maximization which may also be encoded in the definition of ONSET and CODA. One could derive the same results by assuming a split of the *COMPLEX constraint into onset and coda-related variants. Then, for this specific case one would need to assume that *COMPLEX(CODA) is ranked above *COMPLEX(ONSET). Nevertheless, the sonority-based analysis seems more appealing in that it precisely motivates most cases of Onset Maximization as a by-product of sonority-distance requirements. This does not mean that the specializations of the *COMPLEX constraint are not active. They can be used to explain winning parses such as [u'l.tra'] over the alternative [u'lt.ra'], which would respect M-δ but incur in a violation of *COMPLEX(CODA). In the same vein, the order between the constraints ONSET and *COMPLEX can also be determined. This ranking becomes critical in the determination of the syllabification of certain intervocalic clusters. For example, the genitive form of *pars*, *partis*, is syllabified in Latin as [pa'r.ti's], and not as [pa'rt.i's], as shown in (31):

(31)

	M-δ	ONSET	*COMPLEX	*CODA
a. ☞ pa'r.ti's				**
b. pa'rt.i's		*!	*	**

The most interesting point in this tableau is that the syllabification [pa'rt.i's] does not violate M-δ, since $\pi_r = 2$, $\pi_t = 0$, and $\delta(r,t) = 2$, so $/r+t/ \in C_{LAT}$ (*-rt* is a possible Latin coda). Thus, M-δ is not filtering out the parse [pa'rt.i's]. The relevant difference between the two parses is that [pa'rt.i's] involves a violation of ONS (the second syllable lacks an onset). Given that violations of *COMPLEX and *CODA were not fatal for the candidate [i'n.tra'] in the previous tableau, we can conclude that the pertinent ranking is: M-δ >> ONS >> {*COMPLEX, *CODA}. If higher constraints are added, the following hierarchy emerges:

(32) Latin Constraint Hierarchy (1st version):
{*P/α, *M/α, PARSE, FILL >> M-δ >> ONS >> {*COMPLEX, *CODA}

It is also evident that PARSE and FILL are ranked higher than ONS, since the form [a'rs] is an optional parse, but [Øa'rs] is not (violation of FILL), nor is any possible violation of PARSE. The constraints PARSE and FILL can be violated in Latin, although systematic or widespread violations are not found. This is coherent with their relatively high position in the hierarchy. If the general constraint PARSE is decomposed, and the subconstraint PARSE[FEATURE] is adopted, gemination would result as a violation of this specialized constraint.

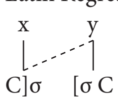
Latin margins undergo in some circumstances a process called "regressive germination": A consonant assimilates to the following one in heterosyllabic clusters. Steriade (1987: §4.1) studies the environments in which this process takes place, distinguishing three types of heterosyllabic clusters: (a) clusters of decreasing sonority, (b) clusters of increasing or equal sonority of the form /[−coronal, αsonorant, αnasal] + [+coronal, αsonorant, αnasal]/, and (c) all other heterosyllabic clusters. Steriade observes that gemination takes place in clusters belonging to group (c), both in sequences of equal sonority (sf → ff, cp → pp, nm → mm, rl → ll), and in sequences of increasing sonority (dm → mm, br → rr, dr → rr, dl → ll). Compare the examples in (33) and (34), where the words in (33) cannot undergo regressive gemination, whereas the ones in (34) can:

(33) *rursus* → **russus*
alter → **atter*
inter → **itter*

(34) *subripio* → *surripio*
adloquor → *alloquor*
adnuo → *annuo*
sitcus → *siccus*
disfero → *differo*

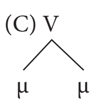
As was observed above, regressive gemination only takes place in heterosyllabic clusters. Steriade proposes the following rule:

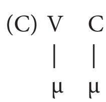
(35) Latin Regressive Gemination



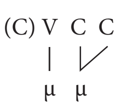
unless: (a) y is of lower sonority than x or
(b) xy is [−cor,αson,αnas][+cor,αson,αnas]

In Latin, heavy syllables are those having a long vowel or a coda. A heavy syllable is linked to at least two moras. There are two possible schemas for heavy syllables:

(36) a.


b.


When gemination takes place, the information related to the place node of the preceding syllable's coda is lost. On the other hand, moraic information is still preserved, as (37) shows:

(37)


Translating these facts into OT, it can be said that regressive gemination entails a violation of PARSE[FEATURE], since the place features of the coda are not parsed. The constraint PARSE[μ] is not violated, so the ranking: PARSE [μ] >> PARSE [FEATURE] can be inferred. There is an additional condition on Latin regressive gemination, which is basically related to sonority: If the first segment is more sonorous than the second, the first one does not assimilate to the second. This fact can be explained with the proposal that there is an additional constraint on sonority, which acts as an instruction favoring parses that maximize sonority. We will label this constraint MAXπ. Formally:

(38) MAX π: Let $\lambda, \tau, \mu \in M_{LAT}$. If $/\lambda+\tau/, /\mu+\tau/ \in S^2_{LAT}$ (the sets of sequences of two segments in Latin), and $|\lambda| > |\mu|$ under π(14), then no $f \in \mathbf{F}$ (i.e. no function in Gen) in P (the phonological structure) substitutes $/\mu+\tau/$ for $/\lambda+\tau/$ in any string $\sigma \in S^*_{LAT}$.

What (38) states is that no phonological process of Latin (formally: a function f in the phonological structure P defined in §1.1) may substitute a segment μ for a segment λ in any consonant cluster if μ is less sonorous than λ under the sonority assignment in (20). This last condition is very important, since the transition in (39) would violate (38), if a maximal sonority assignment were used distinguishing, for instance, voiced and voiceless stops.

(39) *obcupo* → *occupo*

On the other hand, under π(20), the values $\pi_b = 0$ and $\pi_c = 0$ are assigned, i.e. it is not the case that $|b| > |c|$, so the sequence /c+c/ can substitute for the sequence /b+c/ without violating MAXπ. Consider now some examples belonging to groups (a) and (b) in Steriade (1987). The clusters in these words do not undergo regressive gemination:

(40) *arbos* → **abbos*
impero → **ippero*
pelvis → **pevvis*

Take, for instance, *arbos*. We have the sonority assignments $\pi_r = 1$, and $\pi_b = 0$, so $|r| > |b|$. Thus, no phonological process can substitute /b/ for /r/, deriving the sequence /b+b/, since this violates MAXπ. Segments of equal sonority under π(20) do not constitute possible violations of MAXπ. This is the reason why they undergo regressive gemination in some cases and, in others, they do not (when they form a /[−cor, αson, αnas]+[+cor, αson, αnas]/ cluster). This variation seems not to be sonority governed. Notice that MAXπ is a syllable-contact constraint and not a syllable-internal constraint. The formulation in (38) is tentative and, as a reviewer suggests, it could be conceivable and even desirable to reformulate it as the local conjunction (Smolensky 1995) of existing coda and onset constraints (see Gouskova 2002).

From this brief discussion of regressive gemination, the following sub-hierarchy emerges: {MAXπ, PARSE[μ]} >> PARSE[FEATURE]. When it is ranked with respect to the constraints in (32), the following hierarchy obtains:

(41) Latin Constraint Hierarchy (2nd version):
{*P/α,*M/α,PARSE,FILL} >> M-δ >> ONS >> {MAXπ,PARSE[μ]} >>
PARSE[FEATURE] >> {*COMPLEX, *CODA}

The insertion of the sonority sub-hierarchy in the general constraint hierarchy is based on the following rankings: (a) M-δ >> MAXπ, and (b) MAXπ >> *CODA. Ranking (a) comes from the fact that regressive gemination takes place only in heterosyllabic clusters. The cluster /b+r/ undergoes gemination in *subripio* → *surripio*, but not in *brevis* → **rrevis*. This indicates that the constraint on margin distance is higher than the trend to maximize sonority in sequences of segments, i.e. complex onsets must satisfy M-δ. Ranking (b) follows from the fact that [su'r.ri'.pio'] is the winning parse instead of [su'.rri'.pio']. Hence, it can be concluded that gemination cannot eliminate a coda. Ranking (a) can also be viewed as a corollary of the following theorem:

(42) Latin Margin Inalterability: $\forall$ f $\in$ $\mathbf{F}_{LAT}$, $\forall$ /λ+τ/ $\in$ M_{LAT}, f cannot change the sonority sequencing of /λ+τ/.

5. Vulgar Latin margin structure

In this section, the sonority-related changes in Latin margin structure will be schematically presented, deliberately ignoring many other processes that occurred in the transition from Classical Latin to Vulgar Latin (See the general introductions by Väänänen 1963; Grandgent 1962; and Löfstedt 1959). It is also worth noticing that these changes do not reflect a uniform situation in this language, i.e. they are not iron-law processes. In fact, forms derived from most of them coexist with the original unaltered word. Other processes reflect conflicting tendencies. Nevertheless, this unstable scenario may also be interpreted as a reflection of the interplay between alternative constraint hierarchies, and this is precisely the most interesting aspect from an optimality-theoretic point of view.

As was done above in the case of Classical Latin, the members of the sets of Vulgar Latin onsets ($O(nset)_{VLAT}$) and Vulgar Latin codas ($C(oda)_{VLAT}$) are specified as follows:

5.1 Vulgar Latin onsets: The set O_{VLAT}

There are two classes of C onsets:

(43) a. [stop][−voiced] → [stop][+voiced] / V _ V :
triticum → *tridicum* (Väänänen (1963: §106)
immutavit → *imudavit* (Menéndez Pidal (1941: §40) (2nd century)
Pacatus → *Pagatus*
b. [stop][+voiced] → [fricative][+voiced] / [+voiced] _ [+voiced]:
iubente → *iuvente* (2nd century) (Menéndez Pidal (1941: §34.1)
"*albeus* non *alveus*" (App.Prob.}

In some cases the process of lenition ends in deletion:

(44) *magister* → *maester* (Väänänen (1963: §108)
viginti → *vinti*
"*calcostegis* non *calcosteis*" (App.Prob.)

Sequences of CC onsets also follow two different patterns:

(45) a. [obstruents]+[liquid] onsets are preserved. Sometimes the first consonant is voiced: "*plasta* non *blasta*" (App.Prob.).
b. /s/ + [stop][−voiced] onsets are not preserved. The sequence undergoes epenthesis of a vowel: *Hispania, historia, hispatium, explendi* (Väänänen (1963; §83))

The generalization in (45b) also applies to /sm-/ onsets:

(46) *Smyrna* → *Ismurna* (Pompei); *Izmara(g)dus* (Väänänen (1963: §82) (2nd century)

CCC onsets are not preserved, since they undergo the same process as (45b):

(47) *scripta* → *iscripta*

5.2 The set C_{VLAT}

CC codas are simplified as follows:

(48) a. [nasal] + [obstruent] → [nasal]:
unctus → *untus*, *uncsi* → *unsi*, *lancterna* → *lanterna* (2nd century), *quinctus* → *quintus*. (Väänänen 1963: §116).
b. [liquid] + [obstruent] → [liquid]:
ulctus → *ultus*, *ulcsi* → *ulsi*, *farctus* → *fartus* (Väänänen 1963: §114).

6. Constraint Interaction and Vulgar Latin Margins

The transitions from Latin to Vulgar Latin described above show a general tendency to create more harmonic/more sonorous structures (margins). A significant case in this respect is the prothesis of /i/ or /e/. Recall that our analysis of /s+C-/, /s+CC-/ onsets in Latin treats them as violations of the constraint M-δ, in order to prevent a violation of the higher ranked PARSE/FILL. The situation changes in Vulgar Latin. The constraint M-δ is ranked higher than PARSE/FILL, because the optimal output is the one that inserts an empty slot Ø (violating FILL) and preserves M-δ. Consider the tableau for *historia*:

(49)

	*P/s	M-δ	FILL	*CODA	*COMPLEX
a. ☞ Ø's.to'.ria'			*		
b. sto'.ria'		*!			*
c. s'.to'.ria'	*!				

The parse [sto'.ria'] is not the optimal one in Vulgar Latin, as the ulterior evolution in the majority of Romance Languages shows. The transition from Latin to Vulgar Latin involves a promotion of the M-δ constraint. Consequently, the following hierarchy emerges: *P/s >> M-δ >> FILL. The constraint M-δ does not undergo an internal change and still operates in the terms stated in (32), since /[obstruent]+[liquid]/ onsets do not undergo variation. The first segment of the sequence becomes voiced in some occasions. Nevertheless, this process does not affect the constraint M-δ, because it is governed by π(20), which assign 0 to all obstruents.

We have evidence for the hypothesis that at least in Vulgar Latin, π(20) is still effective, as the discussion above shows. Nevertheless, the changes in §5.1 seem to require a finer-grained sonority assignment. This leads us to assume that in Vulgar Latin two sonority assignment functions operate: π(20) and the following finer-grained or "maximal" assignment:

(50) Maximal sonority assignment:

$\pi_{\text{voiceless stop}} = 0$ $\quad \pi_{\text{liquid}} = 4$
$\pi_{\text{voiced stop}} = 1$ $\quad \pi_{\text{glide}} = 5$
$\pi_{\text{fricative}} = 2$ $\quad \pi_{\text{vowel}} = 6$
$\pi_{\text{nasal}} = 3$

A constraint on sonority transition (πTRANS) can be now proposed, viewed as similar in nature to MAXπ in (38). Abrupt sonority transitions are less optimal than softer ones, and the winning option is always the more sonorous output involving a soft transition between segments. Formally:

(51) π(50)TRANS: let $\lambda,\mu,\nu,\tau \in S_{VLAT}$. Then, if $7 \leq |\lambda| \leq |\tau| \leq 5$ and $|\nu| = |\mu| + 1$, the sequence $<\lambda,\nu,\tau> \in S^*_{LAT}$ is preferred to $<\lambda,\mu,\tau> \in S^*_{VLAT}$.

Take, for instance, the transitions *triticum* → *tridicum*, *albeus* → *alveus*. They reflect the patterns /iti/ → /idi/, /lbe/ → /lβe/. In the first case, the sequence /idi/ is preferred to /iti/, since $|i| = 7$, and $|d| = |t| + 1$. In the second one, $|l| = 5$, $|e| = 7$ and $|\beta| = |b| + 1$, so /lβe/ is preferred to /lbe/. Cases like *maestre* or *vinti* imply that πTRANS becomes stronger and weakens the requirement $|\nu| = |\mu| + 1$. It is obvious that the following hierarchy is now operative: π(50)TRANS >> PARSE [FEATURE].

The explanation of the phenomenon of coda simplification does not require the maximal assignment π(50). The minimal one π(20) seems to be sufficient. The relevant constraint here is MAXπ, in one of its possible forms:

(52) Theorem: (*COMPLEX CODA). If $/\lambda+\tau/$, $/\lambda/ \in C_{VLAT}$ and, given a syllable σ, both /λ+τ/ and /λ/ are possible codas of σ, then /λ/ is preferred to /λ+τ/.
Proof: Since CC codas satisfy M-δ, then $|\lambda| > |\tau|$. Hence, by MAXπ in (38), $/\lambda+<>/$ is preferred to $/<>+\tau/$.

Consider the Latin word *farctus*. Both [far<c>.tus] and [fa<r>c.tus] could be possible parses in Vulgar Latin, since $/r/,/c/ \in C_{VLAT}$. But the theorem in (52) correctly predicts that *fartus* is the optimal output. The constraint *COMPLEX(CODA) interacts with PARSE in Vulgar Latin in the inverse ranking to Classical Latin: {*COMPLEX(CODA), MAXπ} >> PARSE. Obtaining a more sonorous coda is more optimal than parsing its second segment (the less sonorous one), as shown in (53):

(53)

	*COMPLEX CODA	MAX π	PARSE
a. fa'rc.tu's	*!	*	
b. ☞ fa'r<c>.tu's			*
c. fa'<r>c.tu's		*!	

7. Conclusions and prospects

In this paper, an OT-account of certain changes in syllable structure from Classical Latin to Vulgar Latin and Spanish has been developed in detail. The main purpose of this account is to show, not only that a non-derivational approach to these changes is possible, but also that generalizing the use of sonority-based restrictions allows for an elimination of extrasyllabicity/segment-adjunction rules. The empirical issues raised in this paper and their analysis also lead to emerging questions of a more general theoretical nature, which I will list here without any pretension of exhaustivity:

1. Substantive order and constraint order. The existence of "sonority hierarchies" with different specifications indicates that segments are associated with a substantive order of an algebraic nature given by a mapping from each segment to their sonority value. Languages might instantiate a finer-grained sonority scale or a coarser one. The notion of sonority distance has been introduced in this paper as a measure of how certain processes affect segments in a sonority range that may increase or decrease with time. Also, constraints on sonority transitions penalizing abrupt sonority transitions have been proposed. For example, wide or abrupt transitions are less optimal than softer ones, and the winning option seems to always be the more sonorous output involving a soft transition between segments. This set of constraints on sonority distance can be used to effectively model the transition in syllable structure from Latin to Vulgar Latin, and to Proto-Romance and Spanish, especially in the case of regressive gemination.
2. Hierarchies. In Prince & Smolensky's (1993[2004]) constraints are organized in discrete strict hierarchies. Nevertheless, the type of constraints that are being proposed here in order to analyze sonority transitions and the associated emerging orders lend themselves to hierarchical arrangements of a non-discrete or dense nature. In this vein, it seems pertinent to explore alternative models of constraint hierarchies based on constraint aggregation procedures (Eisner 1997; Harbour & List 2000) or dense/stochastic models (Boersma & Hayes 2001; Jaeger 2003). The potential adoption of these models also leads to some interesting prospects in analytic issues pertaining language change, evolution and variation (the latter being a point strongly argued in recent developments within stochastic OT).
3. Model-theoretic insights. Potts & Pullum (2002) develop a description logic for stating the content of constraints, in the spirit of Samek-Lodovici & Prince (1999) and Prince (2002). This logic specifies the class of structures that are models of (satisfy) the constraints in Con. It has been argued that output-output correspondence constraints (Benua 1997) and sympathy constraints (McCarthy 1999) are

of a higher complexity in that the structures that would model them require the addition of a considerable number of assumptions. This property makes them less desirable and elegant and less cost-effective from a theoretical standpoint. It can be argued that sonority distance and sonority-transition constraints do not entail the addition of more complex structures in the model, so their inclusion also makes sense from a theory-internal point of view.

References

Anttila, Arto. 1997. Deriving variation from grammar. In Variation, Change, and Phonological Theory, F. Hinskens, R. van Hout, and L. Wetzels (eds), 35–68. Amsterdam: John Benjamins.

Anttila, A. 2002. Variation and phonological theory. In The Handbook of Language Variation and Change, J. Chambers, P. Trudgill and N. Schilling-Estes (eds), 206–243. Oxford: Blackwell.

Anttila, A. and Cho, Y. 1998. Variation and change in optimality theory. Lingua 104: 31–56.

Benua, L. 1997. Transderivational Identity, PhD dissertation, University of Massachusetts.

Bermúdez Otero, R. 2005. Phonological change in optimality theory. In Encyclopedia of Language and Linguistics, K. Brown (ed.) Oxford: Elsevier.

Blevins, J. 2004. Evolutionary Phonology: The emergence of sound patterns. Cambridge: CUP.

Blutner, R. and Zeevat, H. (eds). 2003. Optimality Theory and Pragmatics. New York NY: Palgrave.

Boersma, P. and Hayes, B. 2001. Empirical tests of the gradual learning algorithm. Linguistic Inquiry 32: 45–86.

Clements, G.N. 1990. The role of the sonority cycle in core syllabification. In *Papers in Laboratory Phonology* 1, J. Kingston (ed.). Cambridge: CUP.

Clements, G.N. and Keyser, S.J. 1983. CV Phonology. Cambridge MA: The MIT Press.

Corominas, J. and Hoffmann, J.B. 1958. El Latín Familiar. Madrid.

Dekker, J., van der Leeuw, F. and van de Weijer, J. (eds). 2000. Optimality Theory. Phonology, syntax, and acquisition. Cambridge MA: The MIT Press.

Devine, A.M. and .Stephens, L.D. 1977. Two Studies in Latin Phonology II: The Latin consonant clusters [Studia Linguistica et Philologica 3]. Saratoga CA: Anna Libri.

Eisner, J. 1997. What constraints should OT allow? Rutgers Optimality Archive — 204

Gess, R. 2003. On re-ranking and explanatory adequacy in a constraint-based theory of phonological change. In Optimality Theory and Language Change, E. Holt (ed.), 67–90. Dordrecht: Kluwer.

Gouskova, M. 2002. Syllable contact as a relational hierarchy. *Proceedings of WCCFL* 2. Somerville MA: Cascadilla.

Grandgent, C.H. 1962. An Introduction to Vulgar Latin. New York NY: Hafner.

Harbour, D. and List, C. 2000. OT and the problem of constraint aggregation. MIT Working papers in Linguistics and Philosophy 1: 175–214.

Hayes, B. 1989. Compensatory lengthening in moraic phonology. Linguistic Inquiry 20.

Holt, E. 1997. The Role of the Listener in the Historical Phonology of Spanish and Portuguese: An optimality-Tteoretic approach. PhD dissertation, Georgetown University.

Holt, E. (ed.). 2003. Optimality Theory and Language Change. Dordrecht: Kluwer.

Jacobs, H. 1995. Optimality theory and sound change. Proceedings NELS 25: 219–232.

Jaeger, G. 2003. Simulating language change with functional OT. Ms.

Jakobson, R. 1962. Selected Writings I: Phonological studies. Mouton: The Hague.

Jespersen, O. 1904. Lehrbuch der Phonetic. Leizpig/Berlin: Teubner.

Karttunen, L. 1998. The proper treatment of optimality in computational phonology. Proceedings of the International Workshop on Finite State Methods in Natural Language Processing. Ankara.

Keenan, E. and Stabler, E. 2003. Bare Grammar. A study of language invariants. Stanford CA: CSLI.
Kent, R.G. 1945. The Sounds of Latin. Baltimore MA: LSA.
Kirchner, R. 1993. Turkish vowel harmony and disharmony: An optimality theoretic account. Paper presented at Rutgers Optimality Workshop I.
Legendre, G., Grimshaw, J. and Vikner, S. (eds) 2001. Optimality-Theoretic Syntax. Cambridge MA: The MIT Press.
Lleó, C. 2003. Some interactions between word, foot, and syllable structure in the history of Spanish. In Optimality Theory and Language Change, E. Holt (ed.), 249–283. Dordrecht: Kluwer.
Löfstedt, E. 1959. *Late Latin*. Oslo.
McCarthy, J. 1999. Sympathy and phonological opacity. Phonology 16: 331–399.
McCarthy, J. 2002. A Thematic Guide to Optimality Theory. Cambridge: CUP.
McCarthy, J. and Prince, A. 1995. Faithfulness and reduplicative identity. In University of Massachusetts Occasional Papers in Linguistics 18: Papers in Optimality Theory, J. Beckman, S. Urbanczyk and L. Walsh Dickey (eds), 249–384.
McMahon, A.M.S. 2000. *Change, Chance, and Optimality*. Oxford: OUP.
Menéndez Pidal, R. 1941. Manual de gramática histórica española. Madrid: Espasa Calpe.
Mignot, X. 1975. Phonologie Pragoise et phonologie générative dans la description du latin. BSL 70: 203–31.
Nandris, O. 1965. Le probleme de l (ll) en latin et dans les langues romanes. Congr. ILPR X(3) : 925–43.
Ohala, J.J. 1992. What's cognitive, what's not, in sound change. In *Diachrony within Synchrony: Language history and cognition,* G. Kellermann and M.D. Morrissey (eds), 309–355. Frankfurt am Main: Peter Lang.
Potts, C. and Pullum, C. 2002. Model theory and the content of OT constraints. Phonology 19: 361–393.
Prince, A. 2002. Entailed ranking arguments. Rutgers Optimality Archive — 500.
Prince, A. and Smolensky, P. 1993.[2004] Optimality Theory: Constraint interaction in generative grammar. Oxford: Blackwell.
Samek-Lodovici, V. and Prince, A. 1999. Optima. Rutgers Optimality Archive –393.
Selkirk, E.O.1984. On the major class features and syllabic theory. In Language Sound Structure: Studies in phonology presented to Morris Halle by his teacher and students, M. Aronoff and R. Oehrle, (eds). Cambridge MA: The MIT Press.
Smolensky, P. 1995. On the internal structure of the constraint component of UG. Rutgers Optimality Archive — 86.
Steriade, D. 1982. Greek Prosodies and the Nature of Syllabification. PhD dissertation, MIT.
Steriade, D. 1987. Gemination and the proto-romance syllable shift. In Advances in Romance Linguistics, D. Birdgsong and J.P. Montreuil (eds), 371–410. Dordrecht: Foris.
Väänänen, V. 1963. Introduzione al Latino Vulgare. Bolonia: Patron.
Zirin, R.A. 1970. The Phonological Basis of Latin Prosody. The Hague: Mouton.

Foot, word and phrase constraints in first language acquisition of Spanish stress

Conxita Lleó and Javier Arias
University of Hamburg

The present paper provides an analysis of stress acquisition in Spanish, within the framework of Optimality Theory, focusing on the earliest utterances by two monolingual Spanish children. The Spanish stress algorithm exhibits right-headedness both at word and phrase level. Leaving aside some peripheral cases which call for moraic trochees, we assume that the main core of the Spanish system relies on the syllabic trochee as the basic prosodic pattern. The children's first twenty one-word utterances made up of trochaic patterns were phonetically analyzed for the values of amplitude, pitch, and duration. The same analysis was carried out for word combinations comprising two trochaic-shaped words, as well as for some multisyllabic words present in our corpus. All vowels were analyzed with *Pitchworks*. Our results show that Spanish children master the constraint hierarchy responsible for word and phrasal stress assignment from very early on; however, they may produce prominence in a non-standard fashion, because their command of the acoustic parameters responsible for an adult-like phonetic implementation is not yet under control. Moreover, they tend to overgeneralize the trochaic pattern to some iambic-shaped words. We suggest that all these phenomena are to be construed in terms of constraint ranking.

Keywords: Language acquisition, prosodic acquisition, monolingual children, Spanish, Optimality Theory, stress, primary stress, secondary stress, nuclear stress, trochees, iambs, stress errors, phonetic implementation, representation, exhaustivity, HeadRight

0. Introduction

Stress is one of the most controversial aspects of Spanish phonology. Debates go back to the sixties, when phoneticians and phonologists defined Spanish stress as being phonetically implemented by means of intensity (see Navarro Tomás 1963:182) or by means of pitch (Bolinger & Hodapp 1961, Contreras 1963, 1964). Although among phonologists the latter position seemed to be more convincing than the former, within the tradition of Spanish grammar, stress is still nowadays characterized as an "acento de intensidad" (RAE 1973). In fact, it is still an unsettled question by which means native speakers judge what syllable receives stress: is it the most prominent in intensity, in duration or in pitch? The answer to this question is relevant for acquisition, because children must acquire the means for stressing the right syllables. The topic has recently been brought up again in the light of finer-grained evidence (Ortega-Llebaria & Prieto 2005, within the framework proposed by Beckman 1986, van Heuven & Sluijter 1996, and Sluijter, & van Heuven 1996a, 1996b). Nevertheless, since our focus lies on phonology, in the realm of phonetic realization we will assume what has been most convincingly claimed in the literature, namely, we will assume that word stress is manifested as follows: (a) primary stress is realized by means of duration, by higher amplitude and by a falling F0 contour; (b) secondary stress is mainly realized by amplitude and a falling F0 contour, duration playing hardly any role at all (see e.g. Prieto & van Santen 1996, Bolinger 1962). As for phrasal stress, the following characteristics are added to those of word stress: (a) nuclear stress shows more amplitude than pre-nuclear stress, and phrase-final vowel lengthening; (b) pre-nuclear stress has been reported to have a rising contour, the well-known L*H pitch accent of Spanish (Navarro Tomás 1945, Sosa 1999, Face 2002).

A further still unresolved debate relates to phonological aspects like: (a) is stress assignment in Spanish quantity sensitive? That is, do we have to resort to moraic trochees as the fundamental feet in the language, or does an analysis which takes the syllabic trochee suffice? (b) What is the locus of stress-assignment: the root? the stem? the prosodic word? These issues go beyond the scope of this paper, and we will thus take a few assumptions for granted. In the first place, given pairs of words with stress on an open syllable, in spite of the presence of a closed syllable in the word, like *cantó* [kan'to] "(he/she) sang" vs. *lápiz* ['lapiθ] "pencil", or *ventana* [ben'tana] "window" vs. *Frómista* ['fɾomista] "name of a town" (as well as loan words like *Washington*, nowadays stressed on the antepenultimate by most Spanish speakers ['wasinton]), we do not think that quantity sensitivity can be reasonably defended for Spanish. It is beyond doubt that Spanish has inherited an important part of the stress assignment mechanisms of Latin and that it shows some properties that may be related to quantity sensitivity (see Harris 1983), but in our view they are just relics, which do not justify a quantitative treatment. On the other hand, and in agreement with its quantity insensitivity, we will assume that the syllabic trochee is the basic foot structure of Spanish. We will further assume that stress is assigned at the level of the foot and the prosodic word.[1]

A third point of debate relates to the model used for the analysis. Many treatments of Spanish stress have been done from a Principles and Parameters standpoint, and this model has also been applied to the acquisition of stress by infants.[2] Although such

1. There is no reason to believe that at the stage of development considered in the present study children's representations differentiate stems from roots and Terminal Elements or Word Markers, as postulated for the adult language (Harris 1991).

2. The first and most complete analysis of acquisition of stress has been done for Dutch: see Fikkert (1994).

treatments have shed some light on many issues related to acquisition, they must make assumptions about the alleged universality of certain values that are not justified: e.g. trochees, and right to left directionality are assumed as default parameter settings. Besides, they are compelled to assume very complex systems. Thus the child acquiring Dutch begins with a system where (a) feet are constructed from right to left, (b) feet have their head on the left side, (c) feet are not iterative, (d) feet are binary, and (e) there is no extrametricality; this system must then go into a stage, in which iterativity of foot formation is set, and into a subsequent stage, in which main stress, i.e. the head foot of the word, is on the right side, and in which extrametricality occurs.

In the present study we will favor an OT-based description of stress, because, as it will be shown all along the paper, it has the advantage of being simpler: along the lines of the OT framework, constraints are assumed to be innate, their order being fixed by the child on the basis of the information provided by the target language data. Constraints like those requiring that prosodic constituents have a Head do not preclude that the Head aligns to the Left or to the Right; this information will be provided by the data, and the Constraint Hierarchy will also be provided by the data.

The paper is organized as follows. After presenting a brief description of the Spanish stress system in OT terms (section 0.1) and the corresponding research questions (section 0.2), the acquisition data to be analyzed (Section 1), and the results of the analysis (Section 2), as well as an OT interpretation (Section 3.1), are presented; we will then compare the child system to the adult system, and we will discuss the consequences that such an analysis has for a treatment of stress assignment in Spanish (Section 3.2). A brief conclusion closes the paper (Section 4).

0.1 The Spanish stress system: Brief OT description

Spanish has word and phrase stress, both with right-headed prominence. The basic foot in Spanish is the syllabic trochee, and if there are several feet within the prosodic word or several prosodic words within the phrase, the trochee to the right is always selected as the most prominent. However, the Spanish lexicon presents a certain set of items which can be viewed as peripheral to the basic system, their structure being alien to the common core represented by the syllabic trochee. To that set belong monosyllables (crucially those like *tren* "train", where the coda may be argued to occupy another mora beside the nucleus) and iambic-shaped words such as *ratón* "mouse". In order to account for those items in a unitary way, the moraic trochee may be postulated as being part of the Spanish stress pattern, albeit playing a marginal role. Examples of a long word could be *mariposa* 'butterfly', stressed as [[(ˌmaɾi)(ˈposa)]],[3] and of a phrase *otra mano* [[(ˌotɾa)] [(ˈmano)]] "(the) other hand", transcribed [ˈˀɔtʰɔˈmɔɳɔ̰ˀ] with level stress for José (1;10,3) or *bebe leche* [[(ˌbeβe)][(ˈletʃe)]] "(he) is drinking milk", transcribed [ʋeβəˈlɛteh] for Miguel (1;8,23), where only primary stress has been marked. An example of an unfooted syllable can be represented by *bañando* [[ba(ˈɲando)]]

3. Secondary stress is marked below the following segment, primary stress above, and feet appear in parentheses; unfooted syllables, as well as irrelevant syllables are left out of foot parsing.

"taking a bath", produced [ba('nano)] by José (1;11,25), where the initial syllable is unfooted both in the target word and in the child pronunciation.

We assume the following constraints to account for some of the crucial aspects of stress in Spanish:

(1) FtTroch: Feet are left headed.

We thereby assume that feet correspond to the syllabic trochee.[4]

(2) Parse-σ: Syllables are parsed into feet.

This constraint is an instantiation of the Exhaustivity Constraint, by which syllables must be parsed into the next higher prosodic category (see Prince & Smolensky 1993: 58).

(3) HeadRight: Heads are aligned with the rightmost Foot.

Both, in the Prosodic Word and in the Phonological Phrase Spanish has primary and nuclear stress respectively on the right side. This accounts for the three syllable window as regards word stress and for the selection of final stress as regards phrasal stress. The last constraint was introduced in McCarthy & Prince (1993: 98) as AlignHead, to account for the so-called *End Rule*, which in Prince & Smolensky (1993: 35) was formulated as Edgemost. In the original formulations, AlignHead referred only to the Prosodic Word. Here, we are extending it to the Phonological Phrase, as well.

(4) Align(Ft,R,PW,R): the right edge of all Ft must be aligned with the right edge of a PW

As shown in Lleó (2002), this constraint, AlignRight, declares as optimal prosodic words comprised of one single foot, and it is relatively dominant in Spanish at the first stages, when children utter *mariposa* "butterfly" as [ʻposa] or [pa'posa], i.e., substitute two target feet by a single foot, or by a single foot preceded by an unfooted syllable.

(5) Align(PW,L,Ft,L,): all PWs must have their left edge aligned with a Ft.

This constraint, AlignLeft, precludes the presence of material preceding the foot. However, the preference for productions like [pa'posa] for *mariposa* or [no'nino] for *conejo* "rabbit" from very early on, provides evidence that such a constraint is non-dominant in Spanish child language (Lleó 2002).

The constraints we have just introduced are markedness or structural constraints, which impose certain limitations on the types of constituents that can be built: they constrain the form of feet, and the form of Prosodic Words, as well as the position of stress on these several layers. We also need faithfulness constraints, which guarantee the maintenance in the output of all syllables and segments of the input. The following constraint will just be a cover-term for them:

4. According to Hayes (1995), it can also correspond to the moraic trochee, which is only available in quantity-sensitive systems. Note that this constraint is a cover-term that includes several constraints, like FtBin and HeadLeft.

(6) Max-IO: All elements of the input must be maintained in the output.[5]

In addition to being subject to constraints both on the form of prosodic constituents and on position, stress has to be manifested phonetically, in the sense that the stressed syllable is more prominent than unstressed ones. Since we have established that prominence in Spanish seems to be manifested primarily by duration, and also by intensity and by a falling pitch accent in the case of a nuclear stress, and a rising pitch accent in the case of prenuclear stress, we assume constraints of a phonetic type, which following Hanson & Kiparsky (1996) we call realization constraints.[6] Firstly, Spanish clearly has final lengthening, which takes place at the level of the Phonological Phrase (Navarro Tomás, 1917).

(7) FinalLength: Final syllables of a phrase must be lengthened.

Secondly, as already mentioned, the stressed syllable is lengthened and has greater amplitude. This effect is reminiscent of the constraint Stress-To-Weight within the framework of Metrical Stress Theory, but since we are not considering Spanish a quantity-sensitive system, we prefer a more neutral term than "weight", which we thus express by means of the following constraint:

(8) a. Stress-To-Length: The stressed syllable of the PW/PPh must have greater length.
b. Stress-To-Ampl: The stressed syllable of the PW/PPh must have greater amplitude.

We will see later (see Section 3.1) that the fact that children do not master the phonetic parameters target-like, producing trochaic-shaped words with greater length on the unstressed vowel, those words being nonetheless still rendered as actual trochees, can be accounted for resorting to the three constraints we have just introduced.

Finally, the raising pitch accent of pre-nuclear phrases and the falling pitch accent of nuclear ones will be expressed by means of alignment constraints, in the sense of alignment of melody and text, along the lines of Metrical and Autosegmental theory of intonation:

(9) Align(Pre-nuc-Ph, L*H): Align Pre-nuclear Phrase with the contour L*H

(10) Align(Nuc-Ph, H*L): Align Nuclear Phrase with the contour H*L

The fullfilment of these phonetic (or realization) constraints gives us important information about prominent syllables in Spanish. However, they are subordinate to the structural constraints defined above, relating to stress assignment, which determine

5. It is well established that this constraint bars deletions, whereas its counterpart Dep-IO prevents insertions. We do not discuss this latter constraint in the text, as it will hardly play any role in the analyses presented below.

6. We are aware of the fact that the realization constraints of Hanson & Kiparsky are of a different nature, but we believe that their characterization, which allows for different stages of phonetic implementation both diachronically and synchronically, is still relevant for our purposes.

what syllables are prominent. The phonetic constraints are universal, but they also put the idiosyncratic articulatory/acoustic information on place.

0.2 Aims of the study and research questions

The main aim of our study is to find out how Spanish children acquire stress and the various phenomena related to it in their first language. As regards acquisition of stress, there are not too many studies dealing with this topic in an exhaustive manner, and many assumptions have been taken for granted that might not stand empirical proof. It is commonly believed that children begin by producing single feet, which are then enlarged to include more complex constituents, namely concatenated feet and unfooted syllables. It is furthermore taken for granted that, at first, words and phrases are produced with level stress, and that phrasal stress is acquired rather late, much later than word stress. By observing how stress assignment is acquired in Spanish, we want to address most of these issues. Concretely, we want to ask:

1. When do children acquire word stress in Spanish?
2. When do children acquire phrasal stress in Spanish?
3. Is stress learned on a lexical basis or by means of a general algorithm?
4. Do Spanish children produce prominence target-like?

Other relevant questions will not be dealt with here or will be dealt with only indirectly, either because they are beyond the scope of this paper, or because they have already been relatively well-settled as for the acquisition of Spanish. For instance, we know that Spanish children go through a very short stage of truncation, and that they soon enlarge the production of single feet by adding initial unfooted syllables, directly attached to the Prosodic Word, whereas children acquiring a Germanic language tend to enlarge their one-foot productions by adding one more foot first (Lleó 2002 for Spanish and German, Demuth & Fee 1995 for English and Dutch). This topic will only be dealt with peripherally. Moreover, we can assume that Spanish children have a preference for trochaic feet (but see Hochberg 1988a), because we take it to be the basic foot in Spanish (see above), and because it has been shown to be the preferred foot in infancy, at least for those children acquiring a language with predominance of trochees. Such an assumption will be borne out by the data, as it will be seen below.

1. Data and methodology

1.1 Subjects and data

First word productions and word combinations by two monolingual Spanish children, José and Miguel, at ages 1;0–2;0, were selected for our study; a preliminary analysis of stress errors was carried out for an additional time span until 2;6. The children had been audio and video-recorded approximately once a month in their homes in unstructured play situations, while spontaneously interacting with one of the parents and/or a researcher. The data belong to the project PAIDUS, conducted in the nineties in Hamburg and Madrid by the first author, in collaboration with Antonio Maldonado.[7] All sessions were glossed and phonetically transcribed and all utterances were further digitized with a sampling rate of 44.1 KHz by means of Sound Studio, and entered into a computer database.

Twenty one-word utterances comprised of trochaic stress patterns were selected for each child. In order to conduct an analysis of phrasal stress parameters, 20 further utterances consisting of two trochaic words each were included per child. All 80 utterances belonged to the declarative broad-focus type. Trisyllabic and quadrisyllabic words stressed on the penultimate, once they were produced with the target number of syllables, provided important information for our analysis, in order to establish whether word stress had been acquired. That is, if word stress was already mastered, trisyllabic words (of the form WSW) should have a very weak initial syllable and a most prominent 2nd syllable, and quadrisyllables comprised of two feet should show a more prominent 2nd than 1st foot. Unfortunately, such words were not very numerous in the data, especially quadrisyllables. They were selected as well and analyzed following the same method.

1.2 Theoretical background and methods

In order to answer the research questions posed in section 0.2, it is necessary to determine which syllable is more prominent in the child's utterances, and how prominence is realized. From what has been said above, in Spanish the most prominent foot should be the last one, both in a long word (comprising more than one foot), in the Phonological Phrase and certainly in the Intonational Phrase. As to the phonetic realization of prominence, we assume that vowel length is not a phonological feature of Spanish, but the vowels of primarily stressed syllables are slightly longer than those of unstressed syllables (Navarro Tomás 1916, 1917, Quilis 1971, 1981, 1997); as it has already been pointed out in the Introduction, in final phrases there is lengthening of the final syllable (Navarro Tomás 1917). Stressed syllables are not necessarily higher in pitch, at least in non-final phrases with pre-nuclear stress, as Spanish has a L*H pitch accent, which turns a non-final pre-nuclearly stressed syllable into a rising pitch (Navarro Tomás 1945, Sosa 1999, Face 2002; but see Quilis 1971). As far as final syllables are concerned, since they are produced with a falling pitch, they are generally not higher than previous unstressed syllables. More prominent syllables manifest more intensity than the non-prominent ones (Navarro Tomás 1963, 1964). Concerning secondarily

7. The Spanish data were collected with the support of the DAAD-Program "Acciones Integradas" and together with the German part of the project received also the support of the DFG. Presently, these data are being further analyzed together with bilingual data in the Research Center on Multilingualism, at the University of Hamburg, with the support of the DFG. We want to express our gratitude to all these institutions. Our gratitude goes to the other research assistants of the project, as well, Imme Kuchenbrandt and Martin Rakow, and to the student Sandra Müller for her assistance with digitalization and acoustic analyses.

stressed syllables, the picture is less clear and has also been subject to debate (Bolinger 1962, Quilis 1971, 1997, Toledo 2002). According to one of the most recent treatments, based on acoustic analyses (Prieto and van Santen 1996), secondary stress is mainly realized by amplitude and a falling F0 contour, whereas duration plays hardly any role at all.

It has often been observed that our knowledge of the language may replace acoustics, superseding the phonetic cues present, in the sense that if we know that a certain syllable should be stressed, we tend to hear it as more prominent, even if the speaker has not produced prominence in the standard way. In order to properly tackle the question, two aspects should be taken into account. Firstly, which phonetic correlates are to be identified with stress in a given language. This question has been raised in work by Fry (1955), Mol & Uhlenbeck (1956), Morton & Jassem (1965), and Rossi (1967), among others, from a general perspective, whereas monographic papers have been written by Adams & Munro (1978) for English, Delattre (1938) for French, Fintoft (1965) for Norwegian, Lehiste (1961) for Serbo-Croatian, Lieberman (1960) for American English, Rann (1957–1958) for Estonian, and Sluijter & van Heuven (1996a, 1996b) for Dutch and English. Secondly, in which way do those phonetic cues trigger the perception of a vowel as being stressed? General pioneering literature on stress perception comprises authors like Fónagy (1965), Fry (1958), and Gay (1968). A cross-linguistic overview on the issue of stress perception can be gained by consulting Avram (1967) for Romanian, Rigault (1961) for French, Janota (1967) for Czech, Sluijter, van Heuven & Pacilly (1997) for Dutch, and Solé (1984), Enríquez, Casado & Santos (1989), Llisterri, Machuca, de la Mota, Riera & Ríos (2003) for Spanish. In recent years, some attempts have been made to integrate both production and perception within a unitary constraint-based model of phonology (Pater 2004) and also the need for a separate grammar for phonological perception has been emphasized, in order to get rid of some analytical paradoxes (Boersma 1998, 1999). Even if thorough review of these issues goes beyond the scope of this paper, they cannot be overseen when confronted with our data.

Young children do not necessarily master yet the acoustic parameters of prominence of the target language, i.e., they may produce prominence in a non-standard, which leads to low degrees of inter-transcriber agreement (as for stress, reliability in our research group hardly reached 70%. Given these facts, pitch were measured on the vowels.[8] For words in isolation (i.e. trochees), we have examined both syllables of the trochee. For words in combination (i.e. phrases), we have focused on the first and second syllables corresponding to the first trochee (in the adult language, the prenuclearly stressed word) and on the first and second syllables from the second trochee (in the adult language, the nuclearly stressed word). Most of the utterances analyzed that comprised words in combination consisted of two trochees; in the few cases of

8. In the case of length measurements, it might be problematic to measure the vowel, because vowels in closed syllables tend to be shorter than those in open syllables. However, most of the syllables produced by the Spanish children at the ages relevant for this study are open syllables, which thus justifies measuring just the length of the vowel.

longer utterances, only those syllables building up the two trochees were acoustically analyzed (that is, if we had a sequence made up of a disyllabic word and a trisyllabic word with stress on the penultimate, the first syllable of the latter was not considered for our purposes).

2. Results

2.1 Single words (trochees)

The production of single words (Figures 1–2) shows that word stress, for words in isolation, has already been acquired. Most target trochees analyzed were produced as trochees (but see below for a few "stress errors"). Because words in isolation are at the same time (final) intonational phrases, they should follow a H*L pattern, and they might show final lengthening, i.e. lengthening of the final syllable (for a report on final lengthening and mean duration ratios in French and English, see Vihman, DePaolis & Davis, 1998). Both children's data show an effect of final lengthening: For José mean duration of final vowels amounts to 312 ms, whereas mean duration of non-final vowels amounts to 210 ms; in 16 out of 20 cases, the final vowel is longer than the stressed vowel. In only four cases, *mami* "mom", *coco* "coconut", *hola* "hello", and *oso* "bear", the first vowel is longer (mean 205 ms) than the final one (mean 177 ms), which means that the child might be trying to produce a longer stressed vowel, but that in most cases this enters in conflict with final lenthening. Miguel produces 10 out of 20 words with a longer first vowel (mean 215 ms); the final vowel amounts to a mean of 150 ms for these ten words. Nine words show final lengthening, and in one case, both vowels have

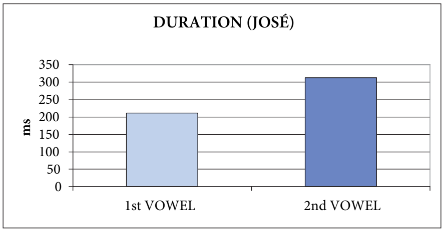


Figure 1a. Mean duration of stressed and unstressed vowel (final syllable) of single trochees for José.

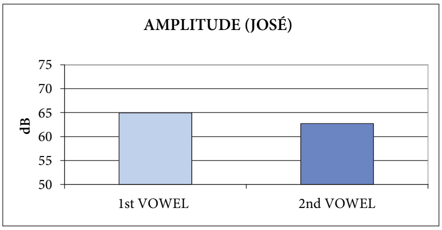


Figure 1b. Mean amplitude of stressed and unstressed vowel of single trochees for José.

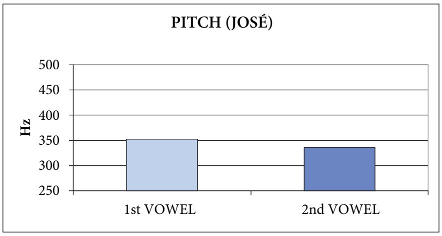


Figure 1c. Mean height in Hz of stressed and unstressed syllable of single trochees for José.

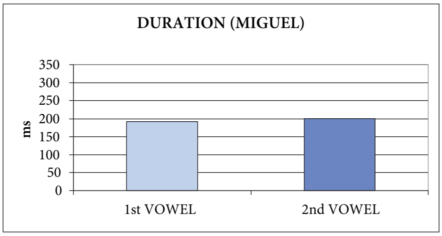


Figure 2a. Mean duration of stressed and unstressed vowel (final syllable) of single trochees for Miguel.

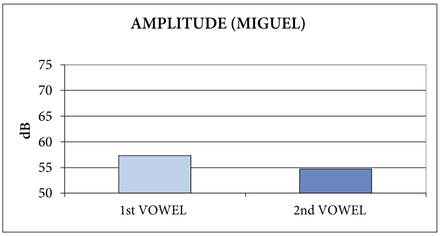


Figure 2b. Mean amplitude of stressed and unstressed vowel of single trochees for Miguel.

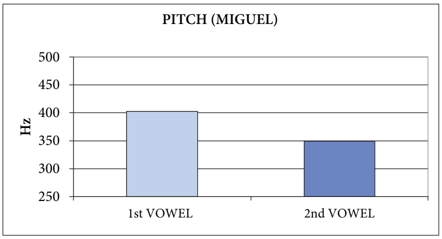


Figure 2c. Mean height in Hz of stressed and unstressed syllable of single trochees for Miguel.

the same length (mean duration of the first vowel in such words with final lengthening amounts to 192 ms and mean duration of the final vowel to 201 ms). These data seem to provide evidence for a ranking of realization constraints in which FinalLength outranks Stress-to-length. Given that target-like trochees are realized by the children, for the most part, with greater amplitude on the stressed syllable, as it will be attested in the next paragraph, we have been led to split the requisite that the stressed syllable of the PW/PPh receive greater phonetic values into two different constraints, (8a) and (8b), to let Stress-to-ampl outrank FinalLength, which in turn outranks Stress-To-Length.

There is a tendency to produce the stressed syllable with more amplitude than the final unstressed syllable: José has a mean value of 64.93 dB for the first and 62.78 dB for the final syllable; only in 5 cases is the final syllable slightly more intense than the first one. Miguel also produces more intense first syllables (mean of 57.3 dB) than final syllables (mean of 54.7 dB), and only in one case is the final syllable more intense than the first one.

The pitch pattern of these words in isolation is falling: accordingly, most of the stressed vowels (except 6 for José and 4 for Miguel) are higher in pitch than the final vowel: for José, the mean value for the F0 of the stressed syllable is 353 Hz and for the final syllable 336 Hz; for Miguel, the first syllable amounts to 403 Hz and the final to 349 Hz.

Two-tailed t-tests conducted on the various prominence parameters have lead to the following results: the difference in duration is highly significant for José ($p = 0.003$), but not significant for Miguel ($p = 0.6$). However, if we analyze the utterances with final lengthening separately (16 in the case of José and 10 in the case of Miguel), both children show a high degree of significance ($p = 0.00059$ for José, and $p = 0.00889$ for Miguel) for the final syllable being longer, which shows that final lengthening has already been acquired, especially by José. Pitch does show a significant difference for Miguel ($p = 0.023$), but not for José ($p = 0.419$). As for intensity, the standard t-tests do not show a statistically significant difference between the first and the second syllable ($p = 0.4$ for José and $p = 0.31$ for Miguel). However, according to Delattre (1966), the threshold for a difference in amplitude between stressed and unstressed syllables in Spanish is defined at 1.3 dB, which means that the mean difference of 2.1 dB obtained in José's data and the mean difference of 2.6 dB obtained in Miguel's data do reach significance. On an individual basis, 55 % of the words produced by José and 65 % of the words produced by Miguel have an amplitude difference between the first and the second syllable higher than 1.3 dB. In fact, only 5 cases in José's and 2 cases in Miguel's analyzed words showed the reverse pattern with a less intense initial syllable.

2.2 Single words (trisyllables and quadrisyllables with penultimate stress)

The few trisyllabic words with a final trochee that we have been able to analyze (three for each child) are shown in Figures 3–4. There is a clear tendency to produce a longer and higher-pitched second vowel for both children, whereas amplitude shows a lot of variation depending on the word. In the case of José, the mean length of the initial and final syllable is the same, and in the case of Miguel the last syllable is slightly longer than the first one, probably due to final lengthening.

Target quadrisyllables produced with four syllables are very scarce: José produces *cocodrilo* "crocodile" and *amarillo* "yellow" between 1;9 and 1;10, Miguel produces *mariposa* "butterfly" and *pececito* "little fish" between 1;7 and 2;0. These data are shown in Figures 5–6. In most cases there is a tendency to produce the first and third syllable

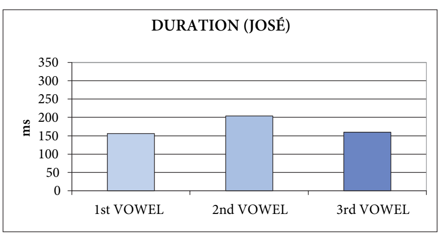


Figure 3a. Mean duration for each vowel in single amphibrachs produced by José.

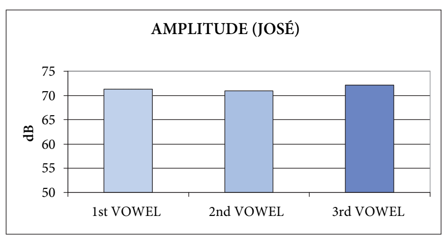


Figure 3b. Mean amplitude for each vowel in single amphibrachs produced by José.

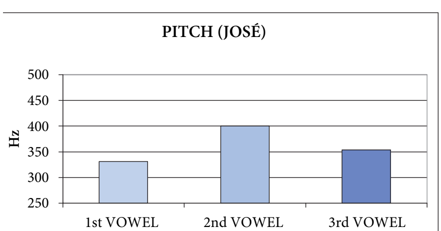


Figure 3c. Mean height in Hz for each syllable in single amphibrachs produced by José.

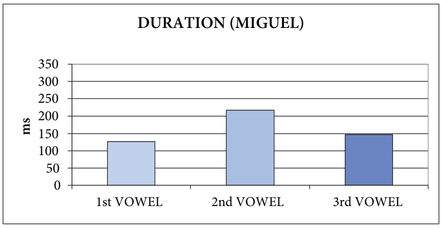


Figure 4a. Mean duration for each vowel in single amphibrachs produced by Miguel.

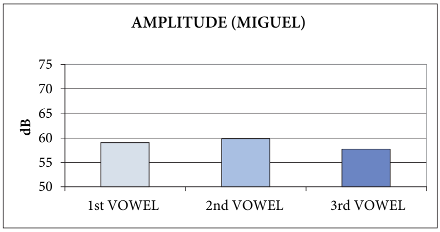


Figure 4b. Mean amplitude for each vowel in single amphibrachs produced by Miguel.

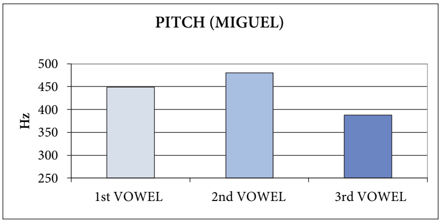


Figure 4c. Mean height in Hz for each syllable in single amphibrachs produced by Miguel.

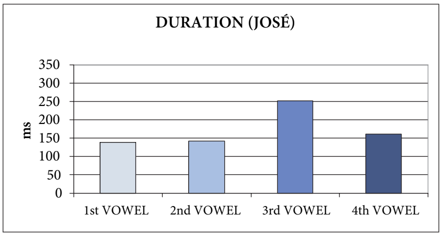


Figure 5a. Mean duration for each vowel in single quadrisyllables produced by José.

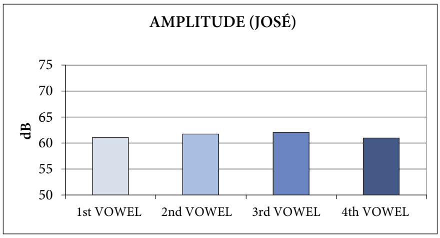


Figure 5b. Mean amplitude for each vowel in single quadrisyllables produced by José.

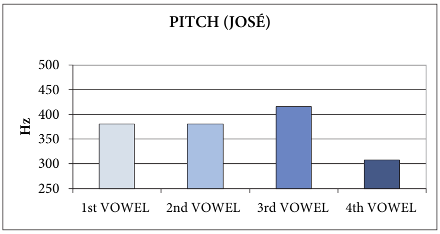


Figure 5c. Mean height in Hz for each syllable in single quadrisyllables produced by José.

with a longer and more intense vowel, and the H*L contour predominates in all final feet in the case of José, but not of Miguel; initial feet show both rising and falling pitch, without predominance of either one. Two-tailed t-tests conducted on the duration of the first and third vowel show that the difference is significant for both children ($p = 0.0002$ for José, and $p = 0.019$ for Miguel). Neither child reaches a significant difference in amplitude between the two syllables, but they reach the threshold of 1.3 dB difference proposed by Delattre (1966).

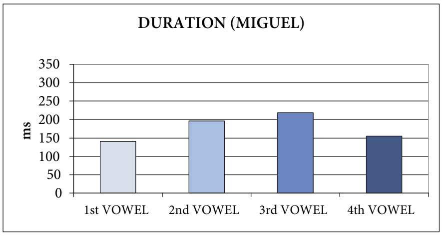


Figure 6a. Mean duration for each vowel in single quadrisyllables produced by Miguel.

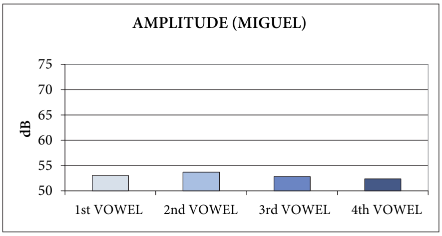


Figure 6b. Mean amplitude for each vowel in single quadrisyllables produced by Miguel.

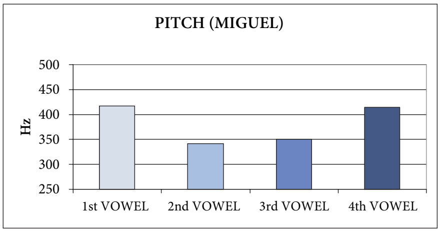


Figure 6c. Mean height in Hz for each syllable in single quadrisyllables produced by Miguel.

Summarizing the results of stress on longer words, whereas trisyllables show a tendency for the second syllable to have more duration and high pitch, quadrisyllables manifest a more prominent third syllable by means of a statistically significant lengthening of the vowel.

2.3 Phonological Phrases

If a child has already acquired phrasal stress, this should result in a differentiation between nuclear and pre-nuclear stress within the phrases produced. That is, if we find a difference between prominent and non-prominent syllables within the words, this will just confirm the acquisition of word stress; phrasal stress goes beyond differentiation of stressed and unstressed syllables of the word. Given the four syllables that we have analyzed in each complex utterance, the 1st and the 3rd syllables should be more prominent than the 2nd and the 4th respectively, because of word stress, and the 3rd should be more prominent than the 1st, because of phrasal stress. Measurements of word combinations appear in Figures 7–8.

For José, the mean values of vowel duration provide a relatively clear picture: the shortest vowel is the 2nd one (mean 148 ms), as expected, since it is the non-phrase-final unstressed syllable. The other three vowels do not show great differences among themselves with regard to duration, though: the longest vowel is the 3rd (mean 189 ms), followed very closely by the 4th (mean 181 ms), because of final lengthening, and then the 1st (mean 176 ms). Not all individual values for vocalic duration are consistent, as only in 11 cases is the vowel of the 3rd syllable longer than the vowel of the 1st; but after 1;7 there is a clearer tendency to having longer 3rd than 1st vowels,

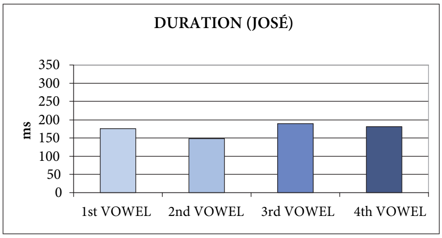


Figure 7a. Mean duration for each vowel in phrases (two trochees) produced by José.

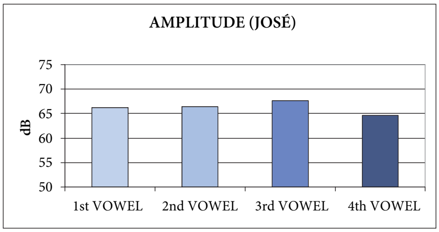


Figure 7b. Mean amplitude for each vowel in phrases (two trochees) produced by José.

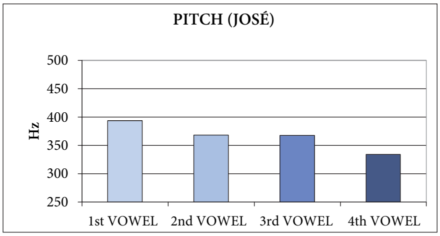


Figure 7c. Mean height in Hz for each syllable in phrases (two trochees) produced by José.

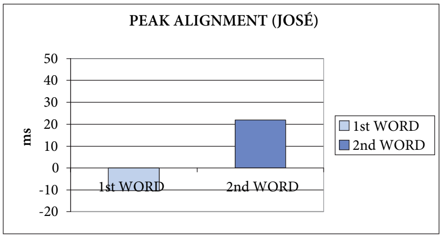


Figure 7d. Mean values of Peak Alignment in phrases (two trochees) produced by José.

which shows that the child is on his way to acquiring phrasal stress. Miguel's values are clearer, i.e. they show that this child clearly differentiates nuclear and pre-nuclear stress: the longest vowel is that of the 3rd syllable (mean 194 ms), followed by the 4th (mean 177 ms) because of final lengthening, then the 1st (mean 168 ms) and finally the 2nd, with a very similar value to the 1st (mean 165 ms). In 13 out of 20 utterances, the 3rd syllable is longer than the 1st, and this relation remains stable; it does not develop as in the case of José. Two-tailed t-tests conducted on the difference between the duration of the first and third syllables show no significance in the case of José ($p = 0.57$) and marginal significance in the case of Miguel ($p = 0.09$).

As far as intensity is concerned, comparing the mean values shows a slight tendency, both in José's as well as in Miguel's case, to producing stronger 3rd than 1st syllables: the mean difference in dB between the first and the third syllable is 1.44 for José and 1.54 for Miguel. Adopting the threshold proposed by Delattre (1966) for Spanish (1.3 dB), both differences indicate significance.[9] Even more revealing in this respect is the attempt at producing a remarkable difference in many of the individual examples: José produces 11 cases with a difference greater than 1.3 dB between the first and third syllables (at times much greater), and Miguel produces 8 cases, in which the third syllable has a greater amplitude than the first syllable of more than 1.3dB, and 4 further cases, in which the 3rd syllable has a greater amplitude than the first syllable, although the difference does not reach the threshold.

9. Although Delattre proposed this difference for stressed vs. unstressed syllables, we adopt it in order to characterize phrasal stress, i.e. nuclear vs. pre-nuclear stressed syllables.

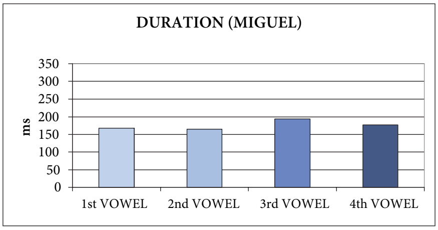


Figure 8a. Mean duration for each vowel in phrases (two trochees) produced by Miguel.

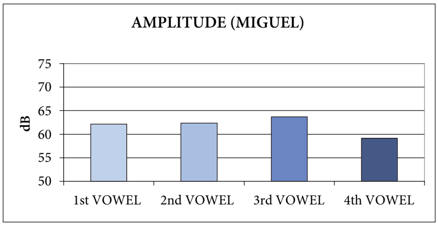


Figure 8b. Mean amplitude for each vowel in phrases (two trochees) produced by Miguel.

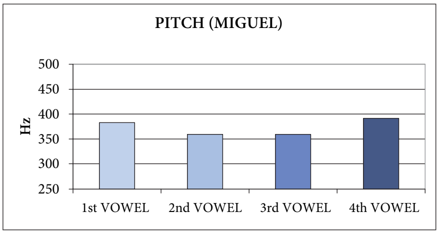


Figure 8c. Mean height in Hz for each syllable in phrases (two trochees) produced by Miguel.

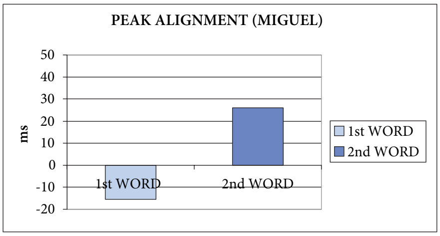


Figure 8d. Mean values of Peak Alignment in phrases (two trochees) produced by Miguel.

Looking at F0 and comparing its peaks and valleys may not deliver a clear picture, as it has often been shown that one of the characteristics of certain stressed syllables, especially the pre-nuclear ones, is its tonal transitional nature, i.e. the pre-nuclear syllable is often characterized as rising in Spanish. For this reason, we prefer to report on the peak alignment values, i.e. the distance in ms between the peak and the end of the stressed syllable. According to the target data, we would expect positive values in pre-nuclear position, corresponding to L*H, and negative values in nuclear or final position, corresponding to the H*L nuclear contour. In Lleó, Rakow & Kehoe (2004) we found the expected L*H pre-nuclearly, as the children were three years old. What we find in the present data, at a younger age, is shown in Figures 7d and 8d for José and Miguel respectively, namely the reverse pattern of what we expected: alignment of the peak in pre-nuclear position showing slightly negative values and in nuclear position slightly positive ones; these values are consistent in both children, and do not show any statistical significance ($p = 0.52$ for José and $p = 0.37$ for Miguel). Looking at the individual utterances, the peak of the pre-nuclear syllable is aligned with the posttonic syllable (in target-like fashion) 8 times in the case of José and 6 times in the case of Miguel; the peak of the nuclear syllable is aligned with the tonic syllable (in target-like fashion) 13 times for José and 9 times for Miguel. This means that as far as F0 is concerned, there is hardly any difference between pre-nuclear and nuclear stress.

Summarizing the results, we can say that at this particular stage, when children produce two-word utterances, they show clear signs of having acquired word stress, and certain signs of having acquired phrasal stress, although most of the values are not target-like. That is, there is a difference in length and amplitude between the 1st and the 3rd vowel, but the values are not as different as in the adult language, and thus less perceptible. The values for F0 do not provide clear evidence for differentiation between pre-nuclear and nuclear stress. The fact that the values are not yet target-like may account for the fact that transcribers tend to mark these phrases with level stress, which has often been corroborated in the acquisition literature (see e.g. Fikkert 1994: 203). The values reached by the children are not as clear as in the adults, and they may be interpreted as level stress when the child is in fact producing "immature" phrasal stress.

There were a few phrases comprised of one or more target trisyllables which were produced without truncation by the children. José produced *trompeta, trompeta* "trumpet, trumpet" at 1;9, *Alberto Pastrana "Name"* and *toca la guitarra* "plays the guitar" at 1;11. The first, pretonic syllable of these words was always produced shorter than the following stressed syllable, both within the first word as well as within the 2nd word, in the case of *trompeta* and *Pastrana*. Pitch was also target-like: the pretonic syllable was much lower than the following stressed syllable, and the stressed one was higher than the last one. As far as amplitude is concerned, the initial pretonic syllable had more amplitude than the following, whereas the pretonic syllable preceding nuclear phrasal stress clearly had less amplitude than the following stressed syllable. That is, in terms of amplitude, the nuclear stressed syllable bears maximal amplitude, with a much less intense preceding syllable, whereas the initial pretonic syllable of the phrase (corresponding to the pretonic pre-nuclear stressed word in the phrase) shows more amplitude than the following syllable, probably due to its initial status in the intonational phrase.

2.4 Stress Errors

A very small percentage of the target trochaic words comprised of single-word utterances were apparently not produced as trochees, as they were transcribed with level stress. These words were checked by further transcribers, and there was consensus that they had been produced with level stress by the children. Miguel produced six such words between 1;6 and 2;0, with a mean of one or two words per session. Most of these words show a relatively much longer 2nd vowel and/or a slightly more intense 2nd vowel. Pitch tends not to differ much between the two vowels. Final lengthening was found in many words above, which nevertheless were heard and transcribed as trochees: this seems to indicate that amplitude may counterbalance length to the point that both syllables are heard as equally prominent. Among the exceptional words, *nieve* was produced with a longer and higher 2nd syllable, and *lápiz* was produced with a longer and much higher 1st syllable, whereas the other syllables (the 1st syllable in *nieve*, and the 2nd syllable in *lápiz*) were produced with greater amplitude, which apparently leads to the perception of level stress, i.e. it brings the phonetic parameters responsible for prominence to a match. The role of amplitude thus seems to be quite important for the perception of stress in Spanish, as neither length nor pitch suffice to establish the prominent syllable of the word. The percentages of recorded errors and the number of acoustically analyzable cases is so small, though, that at this point in our research it would not be justified to dwell any longer on this issue.

Interestingly, though, at 1;9 for José and at 1;8 for Miguel, both children began to produce a "new stress error": iambic-shaped words were converted to trochees. It is important to notice that, before that age, some iambic words had been produced, in general as target-like (and in a few cases transcribed with level stress). For José, at 1;6 there are 30 potential iambic-shaped words (tokens), and at 1;7 there are 14, but none of them were produced as trochees; at 1;9, though, 22 out of 84 potential cases are produced as trochees, which amounts to 26%, at 1;10 three out of 21 cases, i.e. 14%, and at 1;11 five out of 27, i.e. 19%. For Miguel, at 1;6 there were 7 potential iambic-shaped words, and at 1;7 there were 19, but they were all produced target-like; at 1;8, though, 7 out of 36 iambic words are produced as trochees, which amounts to 19%. This pattern of development, parallel in both children, shows that both children develop a clear tendency to produce only trochaic words and a manifest ban against iambic-shaped word patterns. We will refer below to errors of this type as errors of representation, as they are very different from the errors discussed above, which presuppose inaccurate phonetic parameters.[10]

3. Analysis and Discussion

3.1 OT Analysis

Taking into consideration the constraints introduced above for the adult Spanish grammar, it is clear that these children satisfy FtBin and what we have characterized as FtTroch, i.e., the condition that feet be left-headed, since their preferred foot is the trochee. The latter must thus be a dominant constraint in their grammars. Given some of the constraints discussed earlier, and given that faithfulness is rather low in child language,[11] deletion of certain syllables take place; in the case of deletion of some syllables from the input, children normally keep the primary stressed syllables in their output. This means that a constraint like the following is also at work in child language, i.e. a constraint relating the stressed syllable in the input form with the stressed syllable of the output produced by the child:

(11) HeadMax: The (primarily) stressed foot/syllable of the input must be maintained in the output

It is well-known that at first children tend to equate feet and words, i.e., they produce words that are minimally and maximally the size of a foot (e.g. Demuth & Fee 1995, Lleó 1997, Pater 1997, Salidis and Johnson 1997). But as it has been shown in Gennari

10. An updated account of the stress errors in our corpus, which incorporates the results of their phonetic analysis for the three values of duration, pitch and amplitude, can be found in Arias & Lleó (2005).

11. That is not to say that a ranking within the family of Faithfulness constraints should not be taken into account. More precisely, given that deletion phenomena are found all across the board at the early stages, epenthesis hardly occurring, it seems clear that DEP-IO >> MAX-IO.

& Demuth (1997), and Lleó (1997, 1998, 2002), Spanish children very soon overcome the constraints leading to such limitation and produce longer words, generally a trochaic foot preceded by an unfooted syllable. At the stage we have analyzed in the present study, both José and Miguel already produce many of the Spanish trisyllabic words like *pelota* "ball", *trompeta* "trumpet" or *guitarra* "guitar" prosodically target-like, i.e. as a trochee preceded by a weaker unfooted syllable. The "weakness" of the unfooted syllable is manifested by its vowel being shorter, by being lower in pitch than the following stressed syllable (the head of the foot), and by generally having lower amplitude than the other two vowels of the word (see Figures 3–4 above). As for words longer than three syllables, like *mariposa* "butterfly" and *elefante* "elephant", at the point at which they are produced as quadrisyllables, we have seen that the values for length and amplitude (see Figures 5–6) are very limited in number to allow for strong generalizations, but they point in the right direction: the left-hand foot is weaker than the foot on the right-hand-side. This being the case, both children are also complying with HeadRight at the level of the word. This means that they already have the correct representation for these words, and the correct prosodic realization. At the point at which quadrisyllabic words are produced as quadrisyllables, constraints regulating foot structure (1) as well as those regulating word structure (3) are clearly dominant in the child system, whereas AlignRight (4), banning the presence of more than one foot within the prosodic word, has been demoted and outranked by a faithfulness constraint such as MAX-IO. As far as phonetic (or realization) constraints are concerned, they seem to already have a highly-ranked position as regards the manifestation of word stress, since they are generally satisfied, too (especially (7), (8a), and (8b)). The developing hierarchy of constraints is illustrated by means of three productions of the word *mariposa* "butterfly" a quadrisyllable in the target language, progressively produced by the child as disyllabic, trisyllabic and quadrisyllabic:

Tableau 1 for target /ˌmaɾiˈposa/ produced [(ˈboza)] by Miguel (1;8,23)[12]

/ˌmaɾiˈposa /	FtTroch	HeadMax	AlignRight	AlignLeft	Max-IO
☞ [(ˌboza)]					σσ
[(poˈsa)]	*!	*			σσ
[(ˈmaɾi)]		*!			σσ
[ma(ˈposa)]				σ!	σ
[(ˌmaɾi)(ˈposa]			*!		
[(ɾiˈpo)]	*!				σσ

12. The analysis presented in the following tableaux only includes reference to prosodic constraints. Segmental (non-)accuracy on the part of the child is not analyzed, as it is not relevant to the topic of this paper.

Tableau 2 for target /ˌmaɾiˈposa/ produced [pa(ˈbɔta)] by José (1;9,2)

/ˌmaɾiˈposa /	FtTroch	HeadMax	AlignRight	Max-IO	AlignLeft
[(ˈposa)]				σσ!	
[(ˌmaɾi)(ˈposa)]			*!		
[(ˈmaɾi)]		*!		σσ	
☞ [pa(ˈbɔta)]				σ	σ
[(ma) (ˈposa)]	*!		*	σ	

Tableau 3 for target /ˌmaɾiˈposa/ produced [(ˌmaɪ)(ˈtɔta)], i.e. prosodically targetlike, by José (2;0,3)

/ˌmaɾiˈposa /	FtTroch	HeadRight	Max-IO	AlignRight	AlignLeft
[(ˈposa)]			σ!σ		
☞ [(ˌmaɾi)(ˈposa)]				*	
[(ˈmaɾi)(ˌposa)]		*!		*	
[ma(ˈposa)]			σ!		σ
[(ma) (ˈposa)]	*!		σ	*	

All Tableaux show that FtTroch is dominant, as at every stage the only types of feet produced are trochees. In Tableau (1) Align constraints outrank faithfulness, so that deletion is preferred over violating the maximal structure of words, comprised of one single foot. HeadMax establishes that when the target word has two feet, the foot that survives is the right-hand foot, i.e., the Head. In Tableau (2) faithfulness against deletion has climbed over the AlignLeft constraint, that can now be violated in order to produce an initial unfooted syllable. At this stage, the production of two feet within one single word is not yet allowed, because AlignRight is still relatively dominant, and in order to satisfy this constraint, a violation of Max-IO is necessary; notice that the deletion of one single syllable is sufficient to satisfy AlignRight, provided that the retained syllable does not constitute a foot; the optimal candidate thus consists of one foot preceded by an unfooted syllable. Tableau (3) shows one important change: Max has further climbed over the next alignment constraint, i.e. AlignRight, allowing for the production of a second foot within one single word; that is, all the syllables of the target word can now be produced. This vacuously satisfies HeadMax, which is the reason why we have omitted it from Tableau 3, and have replaced it by HeadRight: Once all four syllables are produced, this latter constraint becomes crucial to determine the position of word-stress.

Target words consisting of iambic-shaped feet are at first reduced to one single syllable, the head syllable, but they are very soon produced target-like, i.e. with their two syllables and stressed on the final one (see Lleó 2002). This suggests that, although syllabic trochees are the preferred feet for these Spanish children, if the target model provides a sequence of syllables contradicting the main pattern, the child analyzes it by resorting to the moraic trochee.[13] It should be noted that at the time at which the children first produce the two syllables wholly prosodified, they are often led to reanalyze

13. A thorough analysis of words of this kind would go beyond the purpose of this paper.

the word as a trochee, since they still have not extended their feet beyond the structure that constitutes the common core of the system, i.e., the syllabic trochee, to allow yet for the moraic trochee.

After these constraints regulating the structure and representation of the words have done their work, phonetic constraints like (7–10) above enter the picture, and account for the relatively correct realization of stressed as opposed to unstressed syllables with regard to length, amplitude and pitch contour. The interplay of those realization constraints can be observed in the following example, which presents the trochaic-shaped word *tigre* [ˈtigɾe] "tiger" produced by José at age 1;6,0 as a trochee [jɪtø], but with final lengthening:

[jɪtø:]	First Vowel	Second vowel
Duration	240.8 ms	591.7 ms
Amplitude	71.02 dB	67.1 dB

Out of such conflicting cases, where not all the phonetic cues are brought together in a coherent fashion by the child and yet the word is rendered as a trochee by all accounts (transcription evidence as well as perceptual judgement by native speakers), the ensuing constraint hierarchy can be set up:

(12) Stress-To-Amplitude >> FinalLength >> Stress-to-Length

Our description of word-stress assignment attributes an important role to faithfulness to prosodic heads: that is, our analysis claims that at the stage at which the child produces only one foot, the foot that is kept is the head foot, while the other foot is truncated, and that this is regulated by HeadMax. Moreover, once both feet in *mariposa* "butterfly" are produced, the child assigns primary stress to the correct foot, because of HeadRight. Such scenario may be taken as evidence that the child learns words with the stress associated to them, an assumption with a lengthy discussion behind it in the field. The issue, as it is usually posed, refers to whether stress is learned in a piecemeal or lexical fashion, i.e., word by word (as proposed by Klein 1984), or by means of a general algorithm. There is evidence in the literature that stress in Spanish is learned by means of rules, as Hochberg (1987, 1988a, 1988b) refers to the general algorithm for stress assignment.[14] In fact, we have found stress errors of representation at a relatively late stage, as we have characterized them in Section 2.4, rather than errors of transcription. The fact that such errors appear rather late provides evidence in favor of an analysis, in which words are at first faithful to prosodic heads, but once the child masters stress assignment, he/she prefers syllabic trochees and bans iambic-shaped words (i.e. moraic trochees) for a certain period, and this shows that, at that point, FtTroch and HeadRight are at work. Moreover, the production of phrases with nuclear stress cannot be due to faithfulness, as phrases are spontaneously produced by the children, and there is no reason to believe that they are memorized as wholes. They

14. We do not want to refer to "rules" as our description is presented in terms of OT, so we prefer the more neutral term algorithm, which can also be spelled out in terms of constraints instead of rules.

are rather produced on line, and the fact that they receive stress on the final foot, as it has been shown above, is due to the fact that the child has already placed HEADRIGHT where it should belong in the hierarchy. That means that the position of phrasal stress is regulated by HEADRIGHT and not by HEADMAX, because the child already has his own stress assignment algorithm, that goes beyond the stress pattern offered by the individual target words of the input. We can illustrate the function of HEADRIGHT with the phrase *bebe leche* /ˌbeβeˈletʃe/ "(he/she) drinks milk", produced as [(ɒeβə)(ˌlɛteh)] by Miguel at 1;8,23.[15]

Tableau 4 for target *bebe leche* /ˌbeβeˈletʃe/ "(he/she) drinks milk", produced as [(ɒeβə)(,lɛteh)] by Miguel at 1;8,23.

/ˌbeβeˈletʃe/	FTTROCH	HEADRIGHT	MAX-IO
[(ˈlɛteh)]			PW!
☞ [(ˌɒeβə)(ˌlɛteh)]			
[(ˈɒeβə)(ˌlɛteh)]		*!	
[(ˌɒeβə)]			PW!

At the level of the Phonological Phrase, we already find a certain command of phrasal stress. It is clear that FTTROCH and HEADRIGHT are crucial constraints, which must be in a dominant position, once phrases are correctly stressed on the rightmost foot of the phrase, and on the leftmost syllable of the head foot. Concretely, phrases, if comprised of trochees, are more prominent on the penultimate syllable, and the pre-antepenultimate tends to also be more prominent than the antepenultimate. However, words stressed on the final syllable have a special status, as they require moraic trochees. Such words have to be marked in their lexical entry. Finally, the oscillations in the correct realization of values relating to length, amplitude and especially pitch, point to an incomplete mastery of the phonetic constraints, which are fulfilled or violated depending on the concrete situation. It is precisely those constraints which still do not allow us to say that the children have reached their target of development; as far as Tableau 4 is concerned, the constraint hierarchy might be construed as an already legitimate Spanish adult grammar. It is by its command that the children begin to level some iambs according to the trochaic pattern, which leads to what we have labelled "errors of representation" (Arias & Lleó 2005).

3.2 Discussion

Stress has two important dimensions. On the one hand, it organizes speech in a rhythmic fashion, in the sense that syllables are not produced "monotonically" but with differences in prominence; this structural organization of stress corresponds to its

15. Notice that in the transcription only nuclear stress was marked, which might be due to a non-target-like production of prenuclear stress (as discussed above), and possibly indicates that only nuclear stress was correctly produced by the child. Besides, it is to be noted that the exclusion of a candidate like [(ˌɒeβə)(ˌlɛteh)] does not necessarily require an outranking HEADMAX constraint at this stage. The additional initial nuclear stress can also be penalized by HEADRIGHT.

phonological dimension. On the other hand, (non)prominent syllables are produced according to some specific phonetic parameters, generally considered to be duration, amplitude and pitch of the syllables (or vowels), combined in specific ways according to the language. This articulatory realization of prominence corresponds to the phonetic, i.e. acoustic, dimension of stress. In order to be able to interpret a syllable as prominent or not in a specific utterance, certain acoustic constraints must be satisfied.

There is, however, more to the perception of prominence than acoustics. It has often been reported that listeners may hear a syllable as prominent, which when analyzed in acoustic terms does not seem to manifest the relevant acoustic properties. It is the case that the language (generally the L1) of the listener plays an important role in the perception of stress. It has been shown that e.g. French listeners are relatively "deaf" to hearing stressed syllables in other languages, due to the fact that French does not have word stress (Dupoux et al. 1997). That is, our knowledge of the phonology of the language may replace acoustics, in the sense that if we know that a certain syllable should be stressed, we tend to hear it stressed, even if the speaker has not really produced prominence in the standard way. Given these facts, we cannot judge prominence in child language just from listening to it. This is the reason why we have chosen to pursue acoustic analyses, along with analyses based on transcription. The latter, i.e. analyses based on perception, are important, but they must be complemented by acoustic analyses, since we cannot assume that the child is producing prominence in a standard manner, and certainly not the way the transcriber "hears" it.

This aspect of children's production is extremely relevant, because it entails that some of the child utterances that are tagged as "errors" by adults may correspond to two different phenomena: (a) they may be phonetic errors, violating realization constraints, and (b) they may be errors of "representation", as they have been characterized above, i.e., they may be produced with the prominent syllable in the wrong position. In our data, we have found both types of errors: they have been briefly reported in Section 2.4.

As it has often been claimed in the literature (Hochberg 1987, 1988b), the occurrence or absence of stress errors (of representation) in the language of the child should provide crucial evidence for the theoretical issue of whether in the early stages stress is acquired on a lexical basis or, on the contrary, is the result of rule-learning (as advocated by, among others, Hochberg 1988b, and Fikkert 1994). From a theoretical point of view, errors can only be construed as the outcome of overgeneralizations of an algorithm for stress assignment. A lexical approach fails to account for the occurrence of systematic stress errors or, in more general terms, deviations of the target adult pattern, since it renders it virtually impossible to learn a lexical entry without its correct stress specification. Accordingly, the occurrence of what we have termed representation errors in the children's data provides evidence against lexically-induced acquisition of stress.

As already mentioned above, the rejection of the lexical hypothesis does not necessarily lead nowadays to a formulation based on rules. One of the conclusions of our analysis is that from a certain point in time (at about 1;7 for Miguel and 1;8 for José) the child is already in possession of a general algorithm for assigning stress to the right syllable. This algorithm has been characterized above within the framework of Optimality Theory as largely expressed by means of the constraints FtTroch and HeadRight being assigned to a relatively dominant position.

Acquisition data provide evidence in favor of an OT treatment over a parametric theory of stress for the following reasons. On the one hand, as argued for in the Introduction, an OT treatment is simpler. On the other hand, it makes the right predictions, because it is capable of accounting for the U-shaped curve of stress acquisition. The initial correct production of words that do not follow the general pattern (as is the case of iamb-shaped words) is explained by faithfulness to the prosodic head of the input, whereas at the point at which the relevant constraint for stress assignment, HeadRight, takes its position in the hierarchy, errors may appear based on the fact that exceptions are treated as general cases (as trochees). The evolution of the child's grammar from a stage in which iamb-shaped words are first truncated, later produced correctly and even later produced as trochees cannot be expressed in a unified way in parametric theory, and the incomplete explanation has to use the complex machinery of "prosodic circumscription" (Fikkert 1994: 208). Moreover, OT allows for the same mechanism to account for both word and phrasal stress, as the same constraint, namely HeadRight, is responsible for both. To what extent the better suitability of OT for an interpretation of children's data necessarily calls for a reformulation of synchronic adult stress systems analyzed in parametric terms remains to be seen and is far beyond the scope of this paper.

Attention to the treatment of two-word utterances by the child led us to conclude that, even if a fully-fledged target-like phonetic realization of the three values being analyzed, namely, amplitude, pitch and duration, has not yet been achieved, there is enough evidence to support the idea that at the age considered both children have acquired phrasal stress. Interestingly, a qualitative analysis of the child Miguel based solely on transcriptions yielded the result that phrasal stress was not recognized by the child until age 1;10. The fact that a qualitative analysis was not able to find prominence at the level of the Phonological Phrase at ages 1;7 and 1;8 supports the view that non target-like phonetic values mislead the analyst in his/her interpretation of the child's prosodic knowledge. Because the phonetic realization does not match that of the adult, it is mistakenly assumed by the transcriber that no prosodic command of phrasal stress has yet been achieved by the child. Acoustic measurements of the stress data have resulted in a completely different picture of the child's prosodic abilities.

Finally, the issue of whether the child's grammar is built top-down or bottom-up deserves some attention. Our data is not decisive on this point, but it seems to offer some evidence that word stress comes in as soon as the child produces words, and that phrasal stress comes in as soon as the child produces phrases. Certainly, words come in before phrases, and one might thus think that word stress precedes phrasal stress. In this respect, if quadrisyllabic words are correctly stressed earlier than phrases (as the t-tests seem to show), then it would be correct to assume that the child proceeds bottom-up. However, we do not think that we have provided enough evidence yet to decide on this issue.

4. Conclusion

Analyses of early productions by two monolingual Spanish children have provided evidence that in general word stress as well as phrasal stress is correctly assigned from early on. However, young children do not yet have complete command of the phonetic parameters that constitute prominence, i.e. duration, amplitude and pitch, which can lead to adults not perceiving some effects of prominence that the child may be making in an "immature" way. Moreover, these children produce errors in the production of certain words; namely beginning at 1;7 or at 1;8 respectively, both children produce some iambic-shaped words as trochees. The evidence gathered in this study sheds light on the child stress grammar being based on syllabic trochees. The analysis of the acquisition data lead to the conclusion that Spanish children master the hierarchy of constraints that regulate word and phrasal stress assignment from very early on, but their mastery of phonetic parameters is still not yet under control. These conclusions have been made possible by means of an OT analysis, which not only provides the appropriate formal means for analyzing the data, but it is also simpler than an analysis in terms of Principles and Parameters theory. Moreover, lexical acquisition of stress finds no support on the basis of the data of this study.

References

Adams, C. and Munro, R.R. 1978. In search of the acoustic correlates of stress: Fundamental frequency, amplitude, and duration in the connected utterance of some native and non-native speakers of English. *Phonetica* 35: 125–156.

Arias, J. and Lleó, C. 2005. Stress errors in the acquisition of Spanish: Evidence from monolingual and bilingual children. Poster presented at the 2005 PaPI conference (Bellaterra, June 2005).

Avram, A. 1967. Sur le role de la fréquence dans la perception de l'accent en roumain. *Proceedings of the 6th ICPhS*, 137–140.

Beckman, M. 1986. *Stress and Non-stress Accent*. Dordrecht, Foris.

Boersma, P. 1998. Functional Phonology: Formalizing the interactions between articulatory and perceptual drives. PhD dissertation, University of Amsterdam. (LOT International Series 11. The Hague: HAG).

Boersma. P. 1999. On the Need for a Separate Perception Grammar. Manuscript. [ROA 358]

Bolinger, D.L. 1962. Secondary stress in Spanish. *Romance Philology* 15: 273–279.

Bolinger, D.L. and Hodapp, M. 1961. Acento melódico. Acento de intensidad. *Boletín de Filología de la Universidad de Chile* 13: 33–48.

Contreras, H. 1963. Sobre el acento en español. *Boletín de Filología de la Universidad de Chile* 15: 223–237.

Contreras, H. 1964. ¿Tiene el español un acento de intensidad? *Boletín de Filología de la Universidad de Chile* 16 : 237–239.

Delattre, P. 1938. L'accent final en français: accent d'intensité, accent de hauteur, accent de durée. *The French Review 12*, 3–7.

Delattre, P. 1966. A comparison of syllable length conditioning among languages. *Applied Linguistics* 4: 183–198.

Demuth, K. and Fee, E.J. 1995. Minimal prosodic words in early phonological development. Ms, Brown University and Dalhousie University.

Dupoux, E., Pallier, C., Sebastian, N. and Mehler, J. 1997. A destressing deafness in French? *Journal of Memory and language* 36: 406–421.

Enríquez, E.V, Casado, C. and Santos. A. 1989. La percepción del acento en español. *Lingüística Española Actual* 11: 241–269.

Face, T.L. 2002. A phonological analysis of rising pitch in Castilian Spanish. *Hispanic Linguistics* 11.

Fikkert, P. 1994. *The Acquisition of Prosodic Structure*. The Hague: HAG.

Fintoft, K. 1965. Some remarks on word accents. *Phonetica* 13: 201–226.

Fónagy, I. 1965. Electrophysical and acoustic correlates of stress and stress perception. *Journal of Speech and Hearing Research* 9: 231–244.

Fry, D.B. 1955. Duration and intensity as physical correlates of linguistic stress. *Journal of the Acoustical Society of America* 27: 765–768.

Fry, D.B. 1958. Experiments in the perception of stress. *Language and Speech* 1: 126–152.

Gay, T. 1968. Physiological and acoustic correlates of perceived stress. *Language and Speech* 21: 347–353.

Gennari, S., and Demuth, K. 1997. Syllable omission in Spanish. In *Proceedings of the 21st Annual Boston University Conference on Language Development*. 1, E.M. Hughes and A. Green (eds), 182–193 Somerville MA: Cascadilla.

Hanson, K. and Kiparsky, P. 1996. A parametric theory of poetic meter. *Language* 72: 287–335.

Harris, J.W. 1983. *Syllable Structure and Stress in Spanish: A Nonlinear Analysis*. Cambridge MA: The MIT Press.

Harris, J.W. 1991. The exponence of gender in Spanish. *Linguistic Inquiry* 22: 27–62.

Hayes, B. 1995. *Metrical Stress Theory. Principles and Case Studies*. Chicago IL: The University of Chicago Press.

Hochberg, J.G. 1987. Acquisition of word stress rules in Spanish. *Papers and Reports on Child Language Development* 26: 56–63.

Hochberg, J.G. 1988a. First steps in the acquisition of Spanish stress. *Journal of Child Language* 15: 273–292.

Hochberg, J.G. 1988b. Learning Spanish stress: Developmental and theoretical perspectives. *Language* 64: 683–706.

Janota, P. 1967. Perception of stress by Czech listeners. *Proceedings of the 6th ICPhS*, 457–462.

Kager, R. 1999. *Optimality Theory*. Cambridge: CUP.

Klein, H.B. 1984. Learning to stress: A case study. *Journal of Child Language* 11: 375–390.

Lehiste, I. 1961. Some acoustic correlates of accent in Serbo-Croatian. *Phonetica* 7: 114–117.

Lieberman, P. 1960. Some acoustic correlates of word stress in American English. *Journal of the Acoustical Society of America* 32: 451–454.

Lleó, C. 1997. Filler syllables, proto-articles and early prosodic constraints in Spanish and German. In *Language Acquisition: Knowledge, Proceedings of GALA '97*, A. Sorace, C. Heycock and R. Shillcock (eds.), 251–256.

Lleó, C. 1998. Proto-articles in the acquisition of Spanish: Interface between phonology and morphology. In *Modelle der Flexion: 18. Jahrestagung der Deutschen Gesellschaft für Sprachwissenschaft*, R. Fabri, A. Ortmann and T. Parodi (eds). Tübingen: Niemeyer.

Lleó, C. 2002. The role of markedness in the acquisition of complex prosodic structures by German-Spanish bilinguals. *International Journal of Bilingualism* 6: 291–313.

Lleó, C., Rakow, M. and Kehoe, M. 2004. Acquisition of language-specific pitch accent by Spanish and German monolingual and bilingual children in *Laboratory Approaches to Spanish Phonology*, T. Face (ed.), 3–27. Berlin: Mouton.

Llisterri, J., Machuca, M., de la Mota, C., Riera, M. & Ríos, A. (2003). The perception of lexical stress in Spanish. In M.J. Solé, D. Recasens and J. Romero (eds.), *Proceedings of the15th International Congress of Phonetic Sciences*, 2023-2026. Barcelona, UAB (Nr. 441).

McCarthy, J.J. and Prince, A.S. 1993. *Generalized Alignment*. Ms. University of Massachusetts, Amherst, and Rutgers University, New Brunswick. (Published in Booij, G. and van Marle, J. (1993), *Yearbook of Morphology*, 79–153. Dordrecht: Kluwer).

Mol, H. and Uhlenbeck, E.M. 1956. The linguistic relevance of intensity in stress. *Lingua* 5: 205–213.

Morton, J. and Jassem, W. 1965. Acoustic correlates of stress. *Language and Speech* 8: 159–181.

Navarro Tomás, T. 1916. Cantidad de las vocales acentuadas. *Revista de Filología Española* 3: 387–408.

Navarro Tomás, T. 1917. Cantidad de las vocales inacentuadas. *Revista de Filología Española* 4: 371–388.

Navarro Tomás, T. 1945. *Manual de entonación española*. New York NY: Hispanic Institute.

Navarro Tomás, T. 1963. *Manual de pronunciación española* (11th edition). Madrid: CSIC.

Navarro Tomás, T. 1964. La medida de la intensidad. *Boletín de Filología de la Universidad de Chile* 16: 231–235.

Ortega-Llebaria, M. and Prieto, P. 2005. Acoustic correlates of stress and accent in Spanish. Paper presented at the 2005 PaPI conference (Bellaterra, June 2005).

Pater, J. 1997. Minimal violation and phonological development. *Language Acquisition* 6: 201–253.

Pater, J. 2004. Bridging the gap between perception and production with minimally violable constraints. In *Constraints in Phonological Acquisition*, R. Kager, J. Pater and W. Zonneveld (eds). Cambridge: CUP.

Prieto, P. and van Santen, J. 1996 Secondary stress in Spanish: Some experimental evidence. In *Aspects of Romance Linguistics*, C. Parodi, C. Quicoli, M. Saltarelli and M.L. Zubizarreta (eds), 336–356. Washington DC: Georgetown University.

Prince, A.S. and Smolensky, P. 1993. Optimality Theory. Ms. (Published in 2004 by Blackwell).

Quilis, A. 1971. Caracterización fonética del acento en español. *Travaux de Linguistique et de Littérature* 9: 53–72.

Quilis, A. 1981. *Fonética acústica de la lengua española*. Madrid: Gredos.

Quilis, A. 1997. *Principios de fonología y fonética españolas*. Madrid: Arco Libros.

R.A.E (Real Academia Española). 1973. *Esbozo de una nueva gramática de la lengua española*. Madrid: Espasa Calpe.

Rann, A. 1957–1958. Word stress in Estonian. *Lingua* 7: 349–355.

Rigault, A. 1961. Rôle de la fréquence, de l'intensité et de la durée vocaliques dans la perception de l'accent en français. *Proceedings of the 4th ICPhS*, 735–748.

Rossi, M. 1967. Sur la hiérarchie des parameters de l'accent. *Proceedings of the 6th ICPhS*, 779–786.

Salidis, J. and Johnson, J. 1997. The production of minimal words: A longitudinal case study of phonological development. *Language Acquisition* 6: 1–36.

Sluijter, A. and van Heuven, V.J. 1996a. Spectral balance as an acoustic correlate of linguistic stress. *Journal of the Acoustical Society of America* 100: 2471–2485.

Sluijter, A.and van Heuven, V.J. 1996b. Acoustic correlates of linguistic stress and accent in Dutch and American English. *Proceedings of ICSLP 96*. Philadelphia PA: Applied Science and Engineering Laboratories, Alfred I. duPont Institute, 630–633.

Sluijter, A., van Heuven, V.J. and Pacilly, J.A. 1997. Spectral balance as a cue in the perception of linguistic stress. *Journal of the Acoustical Society of America* 101: 503–513.

Solé, M.J. 1984. Experimentos sobre la percepción del acento. *Estudios de Fonética Experimental* I. Universidad de Barcelona, 134–243.

Sosa, J.M. 1999. *La entonación del español. Su estructura fónica, variabilidad y dialectología*. Madrid: Cátedra.

Toledo, G. 2002. Reglas del acento en paroxítonos: el español peninsular. *Estudios filológicos* 37: 133–149.

van Heuven, V.J and Sluijter, A. 1996. Notes on the phonetics of word prosody. In *Stress Patterns of the World. Part* 1: *Background.* R. Goedemans, H. van der Hulst and E. Visch (eds), 233–269. The Hague: HAG.

Vihman, M.M., R.A. DePaolis & B.L. Davis (1998). Is there a "Trochaic Bias" in early word learning? Evidence from infant production in English and French. *Child Development* 69, 935-949.

Acquistion of syllable structure in Spanish

Alfonso Morales-Front
Georgetown University

This paper examines the emergence and gradual spreading of syllable structures in Spanish from the perspective of Optimality Theory. Data from five children of the CHILDES project is analyzed and it is found that the different syllabic structures emerge in a consistent pattern that describes four stages 1) V, CV, 2) VC, CVC, 3) CGV, CGVC, and 4) CCV. The descriptive analysis also points out that this process of acquisition is gradual and that the frequency of syllable structures in the ambient language influences the order of acquisition. For instance, onsetless syllables in the first stage instead of a period of CV-only syllables can be justified in Spanish by taking into account the frequency of these types of syllables in the adult model. The formal analysis is presented in two sections. One discusses the Constraint Demotion Algorithm according to which acquisition can be captured through constraint demotion. The fact that the Constraint Demotion Algorithm cannot account for the progression from emergence to acquisition, as well as the fact that there is variation during the same stage in general and in the same individual producing different outputs, is a weakness of the Constraint Demotion Algorithm and motivates proposing a new alternative analysis using the Gradual Algorithm Constraint. This model results in a better account not only of the gradual process of learning, but also the individual variation of the same individual in a given stage.

Keywords: acquisition of syllables, categorical rankings, CHILDES, constraint demotion, constraint demotion algorithm, cv-only stage, developmental stages, emergence of syllables, floating constraints, frequency in acquisition, gradual learning, gradual learning algorithm, mark cancellation, onsetless syllables, optionality, paths of acquisition, plasticity, variation

0. Introduction

This article focuses on the developmental stages described in the emergence and progression towards acquisition of syllable structure by children learning Spanish as their first language. The fact that children undergo similar paths of acquisition in learning syllable structures is well established (see Fikkert 1994, Demuth 1995, Fee 1995, Kappa

2002, Levelt, Schiller and Levelt 2000, Macken 1976, Rose 2000); but the general picture of the possible paths and the role of different factors such as individual variation or the influence from the ambient language is only starting to emerge. The present article aims at contributing new pieces to the puzzle in order to get a better sense at what is attested in different languages. Spanish data has played so far only a modest role in the discussion about the possibilities and factors that shape the acquisition of syllables. Notable exceptions are Macken (1976), Carreira (1991), and (Lleó 2003); but the prominence of Spanish data are far from what is currently available for English, Dutch, German, French, Greek, Portuguese or Catalan.

The proposed stages of emergence were determined by analyzing the different types of syllables used in the semi-orthographic transcripts of child and caretaker interactions. Following the model established in Levelt et al. (2000), when a syllable type was absent from the initial recordings, and then appeared more than once in a session, and its presence continued in the following transcripts, that session was considered the onset of a new stage. We found that in Spanish onsetless syllables are present from the earliest stages. This corroborates similar findings in Portuguese (Freitas 1996), and Catalan (Prieto and Bosch-Baliarda 2005). These findings undermine the validity of the claim that there is a universal CV-only stage. We also found that complex nuclei appear before complex codas and complex onsets. The latter were also found to emerge earlier than complex codas, in contrast to what is attested in German, English and to some extend Dutch. Due mainly to its low frequency in the target language, branching codas were in fact not attested by the end of the period under study and, consequently neither was the CCVCC syllable.

Regarding the factors that may influence the order of acquisition of syllables the usual suspects are: individual variables, morphological bootstrapping, complexity of structural representations, stress, word position, the acquisition of specific segments, and the frequency of a given structure in the target language. Of these factors we focus only on the last one because it has been found to be a key predictor of acquisition (see Levelt et al. 2000, Boersma and Levelt 1999, and Stites, Demuth, and Kirk 2004). Focusing on frequency not only keeps us from getting off-track with the main goal but gives us a complementary view of the stages proposed by marking the outset of use of a syllable type. By keeping track of how often each syllable type appears in the children utterances at different stages we can visualize the gradual incorporation of each structure into the child's repertoire. This view also allows us to have a better insight on the gradual spreading through the lexicon of new structures once they become licensed by the grammar.

In the first part of the paper stages are established following the method described above and some examples of the productions of the children from the outset of each stage are provided. Then the focus switches into frequency of use of each syllable type for one of the subjects. In the analysis section we compare the adequacy of an analysis based on the Constraint Demotion Algorithm (Tesar and Smolensky 1998 — original manuscript from 1993) with the predictions of one based on the Gradual Learning Algorithm (Boersma 1997), and found that the basic assumptions of the latter, besides maintaining all the positive aspects of the former, are able to provide a much realistic modeling of what actually goes on with the acquisition of syllable structure.

1. Materials and Method

The data used in this study is part of the Child Language Data Exchange System (MacWhinney 2000) and comes from five children learning Spanish as their first language: the Aguirre, Irene, Linaza, Montes (1987, 1992), and Ornat corpora. The children were normally recorded by their parents on a monthly or biweekly basis, for 30 to 45 minutes, while having conversations over meals, preparing for a bath, getting ready for bed etc. The spans covered by each corpus are: Irene 0;11–3.2, Emilio 0–11–2;11, Koki 1;7–2;11, María 1;7–2;11 and Mag 1;7–2;10. Four of the children were exposed to three different peninsular varieties of Spanish (Asturias, Madrid and Barcelona) and one to Mexican Spanish (Pazcuaro). They are all Spanish monolinguals but Koki had some limited exposure to English and Emilio to Catalan. Our analyses are based on the CHAT semi-orthographic transcriptions of these recordings. Spanish orthographic conventions are remarkably apt to represent actual pronunciation. Since we were only interested on the syllabic structures and not necessarily its phonetic detail the available transcriptions were deemed appropriate. The parents that produced these transcriptions were all linguists and did an excellent job at noting when words or segments were truncated in the child's utterances. Nonetheless even in Spanish and with linguists as parents there are obvious limitations to the strength of the claims that can be made working with orthographic transcription instead of a narrow phonetic transcription.

For each session the child productions were first extracted. This was unproblematic given that in the corpora child productions are always in separate lines that start with *CHI. Once we had only the child's utterances, words were separated by relaying on typographic spaces and other orthographic signs. Then each word was broken down into syllables. With the exception of a few glide/vowel sequences, determining the location of syllable boundaries at the word level is assumed to be a straightforward matter in Spanish. See Hualde (1999) for an algorithm of syllabification. Since syllabification was performed on isolated words it was not possible to take resyllabification across words into consideration. This limitation could be important if we were trying to claim statistical significance in our findings but this is not our goal. This limitation is less important in the initial stages due to the fact that in many cases word and utterance are actually coextensive. In the next step the extracted syllables were tabulated according to their structure (i.e. V, CV, VC, CVC, etc.). For these computations if a child produced a CV syllable it was counted as such irrespective of the actual target. The total number of syllables and the total for each syllable type were counted for each month and percentages were obtained. For instance, if in the sessions of a given month we have a total of 681 syllables of which 199 are classified as V type then 19900/ 681 gives us 29.22% of V syllables for that month. When more than one session from a single month was available they were combined in order to compute the averages for that month.

In order to establish the adult targets the same procedure was followed with the outputs of the adults interacting with the children in the sessions (i.e. word extraction, syllabification, tabulation and computation of percentages). The tabulated data was also used to determine when new structures started to show up in the data and this served to establish broad stages of development.

2. Stages

In the acquisition literature a form is normally considered acquired when accuracy rates (concerning the adult target) are higher than 80%. In this literature a difference is made between emergence and acquisition. In that sense, this section is strictly concerned with emergence stages. It is worth noticing though, that from the theoretical perspective of standard OT a form or structure can only emerge when the ranking of constraints allows it. In that sense we should assume that the fact that a candidate containing a CVC is selected as optimal by the grammar entails that the ranking allows CVC syllables. Theoretically the structure has been acquired and the OT grammar has little to offer in terms of accounting for the fact that in reality the accuracy level may be well below the 80% mark. Standard OT is then unable to separate emergence from acquisition. As we will discuss below this is one of the shortcomings of standard OT.

The following table compares the age at which the basic types of syllable structure start to appear in the transcriptions for each of the five children. A checkmark indicates that the structure is present from the earliest session. Age numbers mark the point at which a given form appears in the data more than once and keeps appearing in successive sessions. Finally, a crossed cell indicates that a given structure was not yet present in the data by the end of the period under consideration. Postvocalic glides preceding a consonant, or at the end of word, are considered part of the coda. Thus in the CVG.CV (e.g *reina*), the first syllable would be counted as an instantiation of the CVC structure.

(1)

	Irene 0;11–3;2	**Emilio 1;4–2:11**	**Koki 1;7–2;11**	**María 1;7–2;11**	**Mag 1;7–2;10**
CV	✓	✓	✓	✓	✓
V	✓	✓	✓	✓	✓
CVC	1;02.05	1;04.00	✓	✓	✓
VC	1;02.05	1;04.00	✓	✓	✓
CGV	1;06.01	1;07.11	✓	✓	✓
CGVC	1;06.01	1;07.11	✓	✓	✓
CCV	1;11.01	1;08.29	1;11.25	2;00	1;11
CCVC	1;11.13	1;09.19	2;01.29	2;00	1;11
CVCC	X	X	X	X	X
VCC	X	X	X	X	X
CCVCC	X	X	X	X	X

Although there are individual differences, these children follow essentially the same steps and incorporate new structures at roughly the same age. Based on the emergence data reported in this table we can infer the following general stages:

(2)

I)	II)	III)	IV)	V)	VI)
CV, V	CVC, VC	CGV, CGVC	CCV, CCVC	CVCC, VCC	CCVCC

In the first stage we can observe that V is available to the children from the first sessions. Notably this finding is in contrast with the more typical assumption of an initial CV-only stage. Codas start to appear early and although the CVC soon becomes more frequent than the VC syllable, these two structures emerge synchronically. Focusing on the acquisition of branching onsets and codas we see that complex onsets appear first. Although for some children the CCV syllable is recorded slightly before the CCVC syllable, the time gap is not wide enough to posit independent stages. Even though three of the children produce some CVCC targets in the period under study, their use is sporadic and doesn't meet the litmus test described above. Given the general low frequency of these structures in the target language, combined with the low probability of these words being part of the lexicon of a two-year-old, and then combined with the chances of catching one of these words in the monthly recordings, it is difficult to know whether they are not attested because they are not acquired, or because of the combined low probabilities.

The following tables offer some illustrative examples of target-faithful structures observed at each stage:

2.1 Stage I

For this stage we only have data from Irene. There are transcripts from Irene and Emilio from 0;11 but referential word production does not start until 1;01.25 for Irene and 1;04 for Emilio. Irene's initial stage has examples of real words, although the lexicon remains limited and the same words are used repetitively. Word production is quite accurate and there is little exploration of new structures. Only V and CV syllables are attested.

(3) Examples of CV syllables produced faithfully at this stage:

Irene	Target	Child	Age	Gloss
	[pa'pa]	[ta'ta]	1;01.25	'dad'
	['lili]	['lili]	1;01.25	'proper name'
	['nena]	['nena]	1;01.25	'baby'
	['tita]	['tita]	1;02.05	'proper name'

(4) Examples of V syllables:

Target	Child	Age	Gloss
['ola]	['ola]	1;01.25	'hello'
[a'i]	[a'i]	1;01.25	'there'
['ana]	['ana]	1;01.28	'proper name'
[a'upa]	[a'upa]	1;02.05	'take me up'

The CV-only stage has been reported for Dutch (Fikkert 1994, Levelt et al. 2000), English (Bernhardt and Stemberger 1998) and French (Rose 2000) among other languages, but it is not found in languages closely related to Spanish such as Catalan (Prieto and Bosch-Baliarda 2005), European Portuguese (Freitas 1996, Costa & Freitas, 1998 and

Freitas, 1997) and from Brazilian Portuguese (Bonilha, 2000). Even for the languages where this stage has been reported, it seems that the evidence is less than conclusive. In the case of Dutch, Pan and Snyder (2003) re-examine the same data used by Levelt et al. (2000) and argue that in fact the V and VC syllable are frequent in the early stages of word production. As they report only 3 of the 12 children participating in the study have a very short stage in which they avoid onsetless syllables. Similarly for English, Velten (1943), and Menn (1971) report that V syllables are already present in early words. Rose (2000) tracks the development of two children and only one of them shows traces of a short-lived stage of avoidance of onsetless syllables; but as he acknowledges "there are few data to permit a definitive characterization of this pattern".

The presence of onsetless syllables around the end of the first year of life is in fact well attested. As stated in Vihman (1996), "… first words may lack a true consonant (*hi* and *uh-oh* occur among the first five or six English words of several children; early words in other languages include French *ouah-ouah* 'bow-wow, ' Stonian *ei* 'no,' German *Wewe* 'weewee,' Japanese *hai* 'here,' *iya* 'no,' and *wanwan* 'doggie' and Swedish *oj* 'oh')." The presence of words lacking consonants can be seen as a continuation of the vocalic stage that precedes the reduplicated babbling (see Roug, Landberg and Lundberg 1989). Even when children reach the variegated babbling stage towards the start of the second year and well after the first words start to appear, vocalic expressions are commonly used by children to request attention and to communicate basic needs. It should not be then unexpected that when the ambience language affords a significant amount of onsetless syllables children are able to produce them from the outset.

2.2 Stage II

This is a stage characterized by great variability and the rapid expansion of the vocabulary. V, and CV syllables are abundant but not included in examples below because they were already the focus in the previous section. Coda consonants start to appear at this stage.

(5) VC syllables:

Irene	**Target**	**Child**	**Age**	**Gloss**
	['alβa]	['amba]	1;02.05	'proper name'
	['pamba]	['panda]	1;02.05	'panda'
	['anda]	['anda]	1;04.16	'come on'
	['es]	['es]	1;04.16	'is'
Emilio	**Target**	**Child**	**Age**	**Gloss**
	[es'ta]	[es'ta]	1;04.00	'done'
	[um'beɾ]	[um'beɾ]	1;04.00	'proper name'
	['este]	['este]	1;05.20	'this one'
	['dame]	['omme]	1;06.20	'give me'
	['un]	['un]	1;08.13	'one'
	[es'pera]	[es'pera]	1;08.13	'wait'

(6) CVC Syllables:

Irene	Target	Child	Age	Gloss
	[mu'ɲekas]	['kekas]	1;1.25	'dolls'
	[piter'pan]	['pan]	1;02.05	'Peter Pan'
	[ra'ton]	[la'ton]	1;04.16	'mouse'
	[es'ter]	[es'teɾ]	1;04.16	'proper name'
	[ta'pon]	[a'pon]	1;05.15	'plug'
Emilio	**Target**	**Child**	**Age**	**Gloss**
	['pan]	['pan]	1;04.00	'bread'
	[bo'ton]	[bo'ton]	1;04.00	'button'
	['ten]	['ten]	1;05.20	'there you have'
	['donde]	['donde]	1;06.20	'where'
	[pi'jin]	[pi'jin]	1;06.20	'little rascal'
	[re'βes]	[e'βes]	1;07.11	'backwards'

The most common coda consonants at this point are nasals. /l/ appears sometimes in the definite masculine article and there are very few examples of /s/ and /r/. The majority of closed syllables in the data are stressed corroborating the findings of Lleó (2003). Lleó (2003) also reports that medial codas precede final ones and that morphology does not seem to play an important role.

2.3 Stage III

In this stage branching nuclei are acquired. In the tables below only rising diphthongs preceded by a consonant in the onset are considered. It is normally assumed that in Spanish glides move to the onset when that position is available. For instance /ieɾba/ becomes [ʝeɾβa] and in some dialects [ʃeɾβa] as a result of a process of fortition. At the other end of the syllable a glide is normally assumed to be part of the coda as long as there is not another consonant occupying that position (see Hualde 1999). Finally VGC (eg. Australia) and CVGC (eg. beisbol) although possible, have a very low frequency and it is unlikely that they will end up being part of the initial lexicon of a two-year-old.

(7) CGV and CGVC Syllables:

Koki	Target	Child	Age	Gloss
	['susjos]	['nusjos]	1;07.20	'dirty plu.'
	['kjere]	['tjere]	1;07.20	'he/she wants'
	['pweδe]	['pweδe]	1;07.20	'he/she can'
	['bjen]	['bjen]	1;07.20	'well'
Maria	**Target**	**Child**	**Age**	**Gloss**
	['pje]	['pje]	1;07	'foot'
	['aɣwa]	['aɣwa]	1;07	'water'
	['gɾasjas]	['asjas]	1;07	'thanks'
	['pjes]	['pjes]	1;07	'feet'

Mag	Target	Child	Age	Gloss
	[ˈaɣwa]	[ˈaɣwa]	1;07	‘water’
	[ˈaβɾe]	[ˈabje]	1;07	‘thanks’
	[ˈbjen]	[ˈbjen]	1;08.01	‘well’
	[ˈpje]	[ˈpje]	1;08.01	‘foot’
Irene	**Target**	**Child**	**Age**	**Gloss**
	[ˈkjen]	[ˈkjen]	1;05.01	‘who’
	[ˈbjen]	[ˈbjen]	1;05.01	‘good’
	[aˈδjos]	[aˈδjos]	1;05.01	‘God’
	[eˈmiljo]	[ˈiljo]	1;06.01	‘proper name’
	[ˈgɾasjas]	[ˈgasjas]	1;06.01	‘thanks’
Mag	**Target**	**Child**	**Age**	**Gloss**
	[ˈten]	[ˈtew]	1;07.11	‘there you have’
	[ˈbjen]	[ˈbjen]	1;07.11	‘well’
	[ˈgɾaθjas]	[ˈgasjas]	1;06.01	‘thanks’
	[ˈkwento]	[ˈkwento]	1;06.01	‘tale’

2.4 Stage IV

By the end of the second year complex onsets start to creep into the transcriptions. Lleó and Prinz (1996) also report that in their data (German and Spanish) complex onsets were found as early as 1;05 in medial clusters and around 1;10 word-initially. Before this stage, complex onsets may be attempted but are consistently simplified by failing to parse the second, more sonorous, element (eg. *otro* [ˈoto] ‘another’). Other possible reduction strategies such as deletion of the first element (eg. *planta* [ˈlanta] ‘another’), or the substitution of the liquid by a glide (eg. *abre* [ˈabje] ‘open’), or the elimination of the whole complex onset (eg. *pobrecito* [poeˈθito] ‘poor dim.’) are only attested sporadically.

(8) Complex onsets:

Emilio	Target	Child	Age	Gloss
	[ˈambɾe]	[ˈambɾe]	1;08.13	‘hungry’
	[ˈaβɾo]	[ˈaβɾo]	1;08.29	‘I open’
	[ˈplanta]	[ˈplanta]	1;09.19	‘plant’
	[ˈfloɾ]	[ˈfloɾ]	1;10.19	‘flower’
Irene	**Target**	**Child**	**Age**	**Gloss**
	[ˈaβɾe]	[ˈaβɾe]	1;07.22	‘you open’
	[ˈgɾande]	[ˈgɾande]	1;09.10	‘big’
	[kaŋˈgɾeχo]	[kaŋˈgɾeχo]	1;10.29	‘crab’
	[ˈplaja]	[ˈplaja]	1;11.01	‘beach’

Mag	Target	Child	Age	Gloss
	[ˈaβɾe]	[ˈaβɾe]	1;07	'open'
	[ˈklaɾo]	[ˈklaɾo]	1;08.01	'of course'
	[ˈfloɾ]	[ˈfloɾ]	1;08.15	'flower'
	[ˈfɾia]	[ˈfɾia]	1;09.01	'cold'
Koki	**Target**	**Child**	**Age**	**Gloss**
	[ˈgɾoβer]	[ˈgɾoβer]	1;07.20	'proper name'
	[ˈotɾo]	[ˈotɾo]	1;07.20	'of course'
	[exploˈto]	[ploˈto]	1;07.20	'it bursted'
	[ˈgɾasjas]	[ˈgɾasjas]	1;07.20	'thanks'
Maria	**Target**	**Child**	**Age**	**Gloss**
	[ˈfloɾ]	[ˈflol]	1;09	'flower'
	[ˈsopla]	[ˈsoβla]	1;11	'you blow'
	[komˈpɾaɾ]	[komˈplaɾ]	2;00	'to buy'
	[ˈgɾande]	[ˈglande]	2;00	'big'

Spanish complex onsets are limited to the combination of an obstruent or /f/ followed by a liquid (with the exception of /tl/ and /dl/ in most dialects). Lleó and Prinz (1996) found that in German complex codas are acquired before complex onsets. For Dutch, Levelt et al. (2000) also found that nine of their subjects acquired codas before onsets, while the rest followed the opposite order. As argued in Kirk and Demuth (2003) the key factor in predicting the order of acquisition of these two structures is their overall frequency in the ambient language. In Spanish complex codas are very limited (to the point that it is not uncommon to read in the literature that they are disallowed). The fact is that although they have a very low frequency, combinations of a consonant (normally /n/ or /l/, but also /k/ and /b/) plus /s/ can constitute a branching coda (eg. *instituto* 'institute', *vals* 'waltz', *transporte* 'transport', *e[ks]amen* 'exam', *obstinado* 'obstinate'). Besides having a low frequency, these complex codas are typically reduced in informal speech (i.e. [istituto], [trasporte], [esamen]). Towards the end of the third year some of the children in this study seem to be able to reproduce complex codas. For instance, Irene is able at age 2;08.27 to say [siks] when asked about numbers in English, Emilio can utter [vols] 'do you want' in Catalan at age 2;08.28 and Mag can produce [monstruo] 'monster'at age 2;03. However these isolated productions do not rise to the minimum of more than one token in a session and then continued use of the structure in following sessions. The fact that Mag does not reduce the complex coda at 2;08.28 and the additional evidence from children minimally exposed to other languages much richer in complex codas, such as Catalan or English, suggest that the grammar is set to allow complex codas but the stated low frequency of these forms prevents us from seeing evidence in the sessions.

CCVCC syllables are presented in (2) above as a separate stage because none of the children produced a single token of this structure by the end of the period under study. However we do not know if this is because of their even lower frequency in the ambient language, or because the grammar needs to evolve to allow them. Future research focusing on more advanced stages of acquisition may shed some light into this issue.

3. Progress towards adult targets

Up to this point the focus has been on describing when each syllable structure starts to emerge. Now the focus turns towards frequency and gradual progress towards the adult target. That is, how often do these structures appear at different stages and how do these numbers compare to the adult norm? Frequency has been found in previous studies to be a key factor in determining order of acquisition (see Stites, Demuth and Kirk 2004).

Frequencies were obtained by counting the total numbers of syllables produced in a month and then dividing that total by the number of tokens of each syllable type. For these counts all the utterances of each child were included regardless of their communicative intent, or whether they were imitations, exclamations, vocalizations or onomatopoeic words. The goal was to asses the frequency of a given type of sonority pattern and to that end [gwaw] (the sound of barking but also a way to refer to dogs by children in Spanish) is as relevant as *perro* 'dog'.

To obtain the ambient language benchmarks the utterances of the adults participating in the sessions were submitted to the same type of quantitative analysis. In order to determine if the averages in the caregiver's talk were significantly different from the averages found in other types of texts, a set of 20 texts (of comparable length to that of the sessions in the corpora — around 1000 words in average) extracted from newspapers and 20 texts extracted from traditional children's tales stories like Snow White, Red Riding Hood, etc., were compared to the results obtained from the caregivers' transcripts. Table (1a) and (1b) below show the results of this comparison.

As expected, these results confirm that caregivers use a simplified speech when addressing children: the percentage of unmarked syllables (CV and V) goes up, while the numbers for more complex structures (CVC, CCV, VCC, CCVC, CVCC, CCVCC) go down. Other structures such as VC and CGV are unaffected. Somehow unexpected

Table 1a. Comparison of percentages in use of syllable types from three different types of texts.

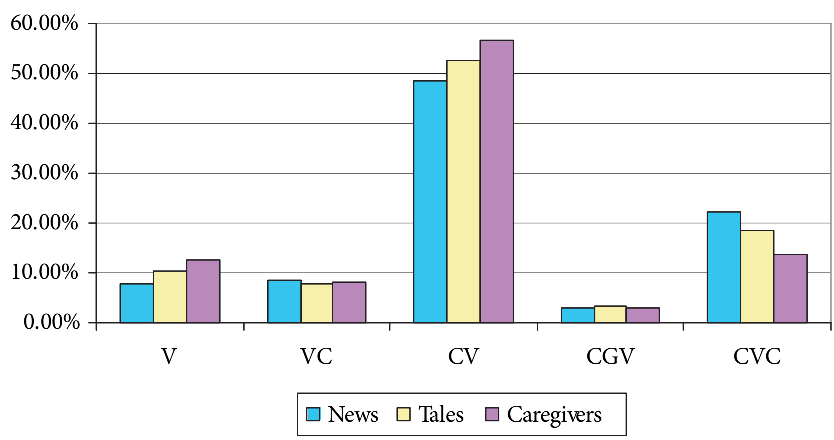
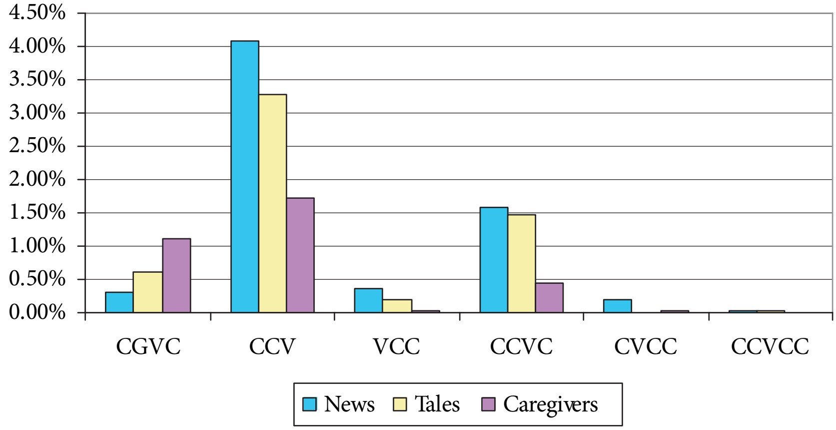


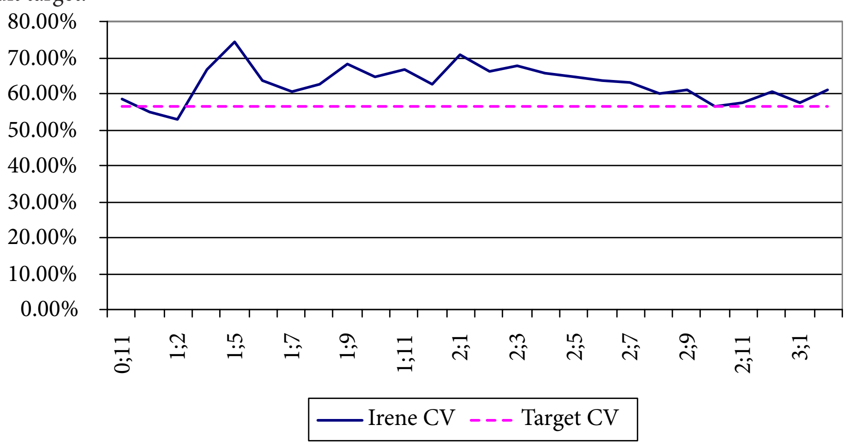
Table 1b. CONT. Comparison of percentages in use of syllable types from three different types of texts.



is the increase observed for the CGVC syllable. Accounting for this tendency falls outside the scope of this study, but it is possible that the weight of certain words that have a high frequency in children's speech such as *bien* 'well,' *buen* 'good,' *cuento* 'children's tale,' *duerme* 'go to sleep,' *adios* 'bye bye,' *pies* 'feet,' *sientate* 'sit down,' etc., have a warping effect on the otherwise general preference for simple syllabic structures.

In the tables below the figures obtained from the adapted caregiver speech are used since they constitute a more accurate reflection of the characteristics of the ambient language. In these tables only data from Irene is presented because she is the only child for whom we have enough data in the early months. The recordings for the other children start at 1;04 (Emilio) or 1;07 (the rest). On the one hand this is too late to trace the progression of the basic structures (CV, V, CVC) and, on the other, not having information about these crucial early months precludes us from using averages from

Table 2. Irene's frequency of use of CV syllables over the period of study compared to the adult target.

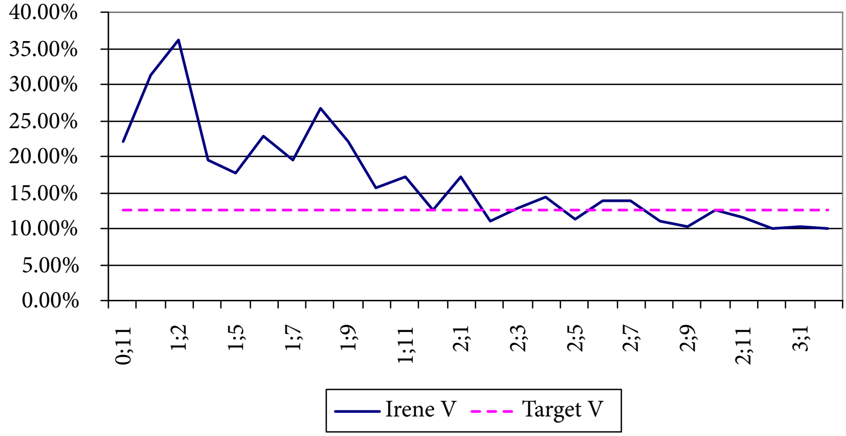


the five children. That said, nothing in the data or in the context where acquisition is taking place suggests that Irene's data is exceptional in any relevant way.

Irene was recorded biweekly and the span covered goes from 0;11 to 3;2.

Interestingly enough, the proportion of CV syllables is almost on target from the first sessions. There is a slight increase starting at 1;3 that lasts until 2;9, but this is far from the expected mighty dominance of the CV syllable. Not only there is no CV-only stage in the data but the CV syllable does not seem to be main beneficiary from the absence of other more complex types of syllables. Instead, as can be seen below, it is the V syllable that initially receives a boost in frequency well above the already augmented proportion observed in the caregiver speech.

Table 3. Irene's frequency of use of V syllables compared to the adult target.



By the second birthday this abundance of V syllables begins to fade as other more complex types of syllables start to appear. There are a number of factors that may help to explain why this type of syllable is so frequent in the initial stages. One of them seems to be segmental acquisition (e.g., *revés* 'reverse' pronounced [e'βes] c.f. Bonilha 2004). Also at age 0;11 Irene is just starting to learn her first words. At this point she still has to resort to exclamations and other sorts of vocalizations to communicate some needs. Although these vocalizations disappear soon from the transcripts, the higher-than-normal level of V syllables remains for some time. Even if these vocalizations are removed from the counts, the outcome is still a downward slope since many of the V productions are in fact, as expected, missed VC targets (eg. *el pato* [epa'to] 'the duck', *es papa* ['epa'pa] 'is daddy', *este* ['ete] 'this one'). Focusing now on the two tables below we see that coda consonants are gradually incorporated into the child's lexicon.

Table 4. Irene's frequency of use of VC syllables compared to the adult target.

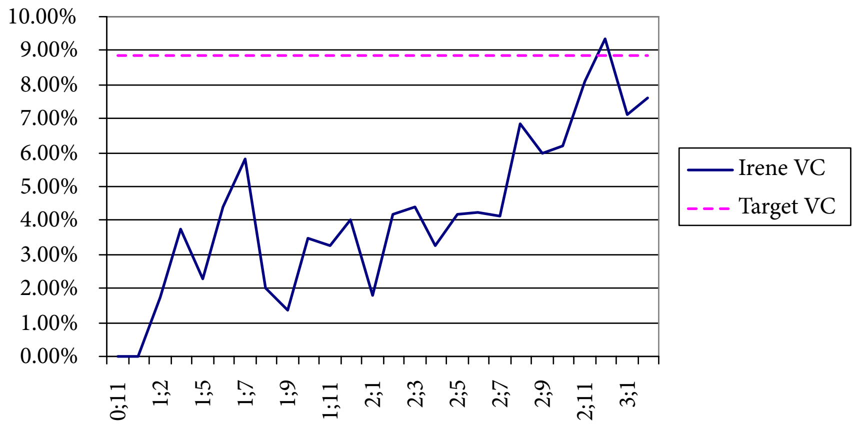
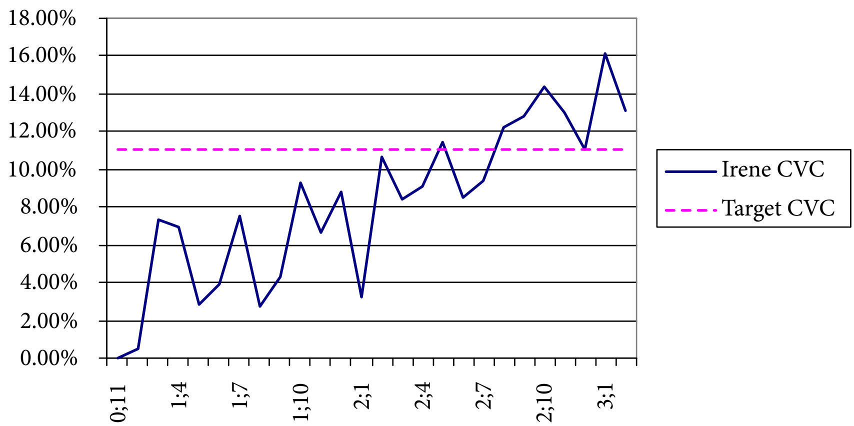
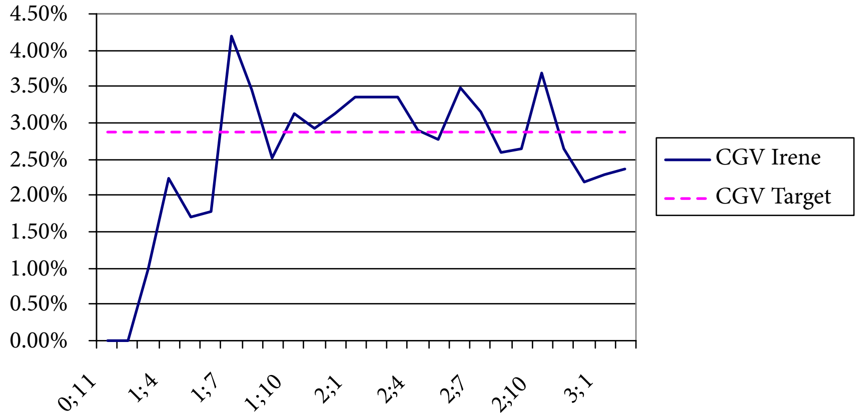


Table 5. Irene's frequency of use of CVC syllables compared to the adult target.



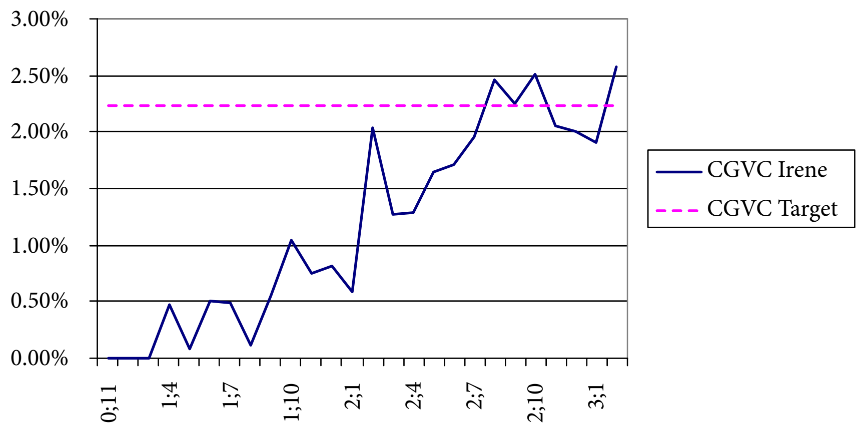
CGV rises early and quickly to the normal range suggesting that once the grammar is set to allow complex nuclei their use normalizes in a matter of three months.

Table 6. Irene's frequency of use of CGV syllables compared to the adult target.



The CGVC emerges at the same time as the CGV syllable but has a more gradual slope. Based on what we see in Table 6 for the CGV syllable and in Tables 5 and 4 for the CVC and VC, we must assume that this slower progression is due to the presence of a coda rather than to the markedness of the branching nucleus itself.

Table 7. Irene's frequency of use of CGVC syllables compared to the adult target.



Finally, the two tables below show that the spread of onset clusters through the child's lexicon happens also in a fairly short span that goes from 1;11 to 2;05.

Table 8. Irene's frequency of use of CCV syllables compared to the adult target.

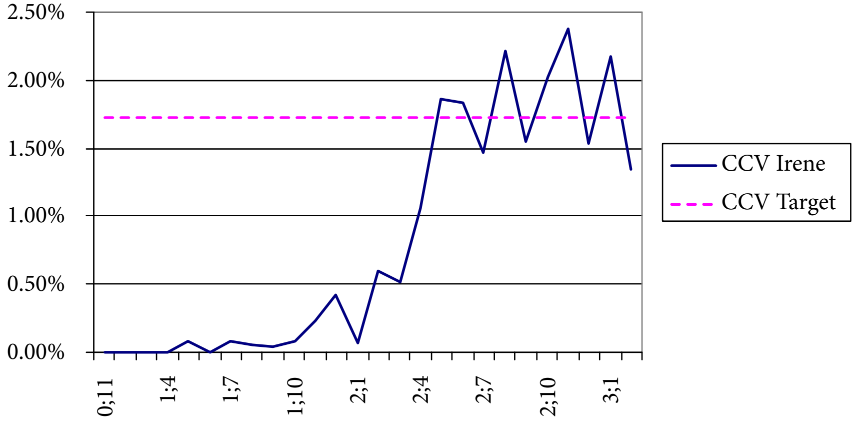
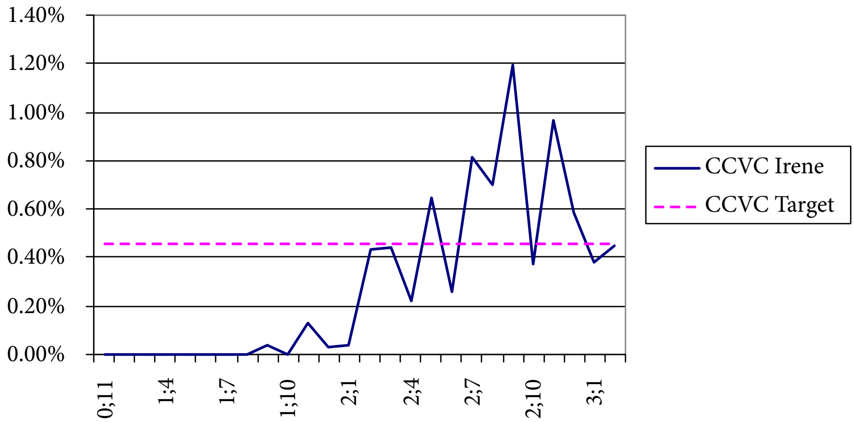


Table 9. Irene's frequency of use of CCVC syllables compared to the adult target.



Going now back to the earlier distinction between emergence and acquisition, these tables show that there is a progression from the emergence of a structure until the point at which that structure can be considered acquired — arguably the point at which frequencies fall in line with adult norms. Our data does not allow us to make specific claims about the statistical significance of these lines; nor does it let us put a numerical value to the degree of deviation that would allow to claim that a structure has been acquired, or to accurately determine for how long a range of variation needs to be maintained. These graphs simply show that there is progression in the incorporation of the structures being acquired. This is neither new nor unexpected but it is worth noticing that it is by no means a matter of turning on a switch.

4. An OT analysis based on the Constraint Demotion Algorithm (CDA)

The observed stages of acquisition can be easily described as the result of constraint demotion. Any valid theory of phonology must have a natural way to account for the observation that natural languages tend to prefer CV syllables, all languages have CV syllables, and there are languages that only have CV syllables. In OT, the privileged status of the CV syllable is captured in two simple constraints.

(9) *Coda Align (σ, R, V) (Itô and Mester 1994)
Typically formulated as syllables do not have codas.
Onset Align (σ, L, C) (Itô and Mester 1994)
Typically formulated as syllables have onsets.

We must also posit constraints preferring simple to complex syllabic structures.

(10) *Complex Complex onsets and codas are not allowed.

Since there are languages that allow complex onsets but not complex codas (Sedang, Mazateco, Arabela), and languages that allow complex codas but not complex onsets (Finnish), this constraint must in fact be divided into *Complex(Onset) and *Complex(Coda). Since there are languages that don't allow complex nuclei but this limitation doesn't necessarily correlate with an absence of complex codas or onsets a final member of the family, *Complex(Nucleus), is needed. Finally, we must posit at least two basic faithfulness constraints:

(11) Dep Every segment in the output has a correspondent segment in the input (no insertion)
Max Every segment in the input has a correspondent segment in the output (no deletion)

The constraints in (9)–(11) are the core constraints determining the basic structural possibilities of the syllable. As demonstrated by McCarthy and Prince (1994), syllable typology results from the rearrangement of these basic constraints.

For the "standard" OT analysis based on the CDA two basic assumptions are typically made: a) learning is a matter of constraint demotion and b) the initial state of the grammar has all markedness constraints dominating faithfulness constraints. Although according to the CDA the system will converge independently of the initial state, a common assumption is that in the initial state Markedness dominates Faithfulness (Gnanadesikan 1995). This assumption is based in the following observations:

a. Unmarked settings typically emerge in the data from the early stages of acquisition.
b. To demote a markedness constraint only positive evidence that the targeted marked structure exists is needed; to demote faithfulness constraints negative evidence is needed.

Leaving aside by now the subdivisions of *Complex, the following basic ranking of constraints constitutes the initial stage. Also for the purposes of this analysis Max and Dep will be combined into Faith:

(12) Onset, *Coda, *Complex >> Faith

When markedness is dominant, the prediction is that only the CV syllable can surface because all other syllable types have some degree of markedness.

(13)

CV	Onset	*Coda	*Comp	Faith
☞ .CV.				
.CVC.		*!		*
V.	*!			*
.VC.	*!	*		*
.CCV.			*!	*

CVC	Onset	*Coda	Faith
☞ .CV.			*
☞ .CV.CV.			*
CVC.		*!	
.V.	*!		*
.VC.	*!	*	*

VC	Onset	*Coda	*Comp	Faith
☞ .CV.				*
.CVC.		*!		*
.V.	*!			*
.VC.	*!	*		
.CCV.			*!	*

V	Onset	*Coda	*Comp	Faith
☞ .CV.				*
.V.	*!			
.VC.	*	*!		*
.CCV.			*!	**
.VCC.			*!	**

This is a theoretical stage that is not attested in our data but that has been identified in a number of previous accounts in other languages. In order to account for our actual first stage (recall that it admits V and CV syllables) Onset has to be demoted under Faith to avoid epenthesis in V targets:

(14)

CV	*Comp	*Coda	Faith	Onset
☞ .CV.				
.CVC.		*!	*	
V.			*!	*
.VC.		*!	*	*
.CCV.	*!		*	

CVC	*Coda	Faith	Onset
☞ .CV.		*	
☞ .CV.CV.		*	
CVC.	*!		
.V.		**!	*
.VC.	*!	*	*

VC	*Comp	*Coda	Faith	Onset
.CV.			**!	
.CVC.		*!	*	
☞ .V.			*	*
.VC.		*!		*
.CCV.	*!		***	

V	*Comp	*Coda	Faith	Onset
.CV.			*!	
☞.V.				*
.VC.		*!		*
.CCV.	*!		**	
. VCC	*!		**	

Next in the second stage *Coda must be demoted below Faith for coda consonants to be parsed faithfully, and to prevent CVC surfacing as CV.CV or CV:

(15)

CV	*Comp	Faith	*Coda	Onset
☞ .CV.				
.CVC.		*!	*	
V.		*!		*
.VC.		*!*	*	*
.CCV.	*!	*		

CVC	*Comp	Faith	*Coda	Onset
.CV.		*!		
.CV.CV.		*!		
☞ CVC.			*	
.V.		**!		*
.VC.		*!	*	*

VC	*Comp	Faith	*Coda	Onset
.CV.		*!*		
.CVC.		*!	*	
.V.		*!		*
☞.VC.			*	*
.CCV.	*!	***		

V	*Comp	Faith	*Coda	Onset
.CV.		*!		
☞.V.				*
.VC.		*!	*	*
.CCV.	*!	**		
.VCC.	*!	**		

At this early stage the initial distribution of markedness and faithfulness has been already reversed but only for the constraints under consideration. The *Complex family is still on top of the hierarchy. To accommodate the third stage *Complex(Nuc) must be demoted below Max.

(16)

CGV	*Comp	Faith	*Comp(Nuc)	*Coda	Onset
.CV.		*!			
☞ .CGV.			*		
GV.		*!			

Finally by demoting *Complex(Ons) below Max the child's grammar is set to produce faithfully complex Onsets.

(17)

CCV	Faith	*Comp(Ons)	*Comp(Nuc)	*Coda	Onset
.CV.	*!				
☞ .CCV.		*			
.V.	**!				

With the omission of many nitty-gritty details that would be a diversion from the focal point of this basic demonstration, this is the state of the grammar by the end of the period under study. In following steps *Complex(Coda) will be demoted below Max and with that, the final two stages proposed in (2) would be accounted for.

The analysis is not only simple and elegant but captures an important condition on formal grammars (see Pinker 1979): the underlying grammar assumed for children and adults is the same. Young learners are endowed with the constraints and the mechanisms of the grammar, and all they need to learn is the correct ranking in the ambient language of the same set of constraints available to adults. Since learning is attained only through the manipulation of universal constraints and crosslinguistic factorial typologies are also the result of the rearrangement of the same pool of constraints, the prediction is that the stages of acquisition will never fall outside the limits of what can be observed in natural languages (see Levelt and van de Vijver 1998). To a large extent this seems to be a correct prediction. Moreover, this analysis is based on an algorithm that we know is learnable and computationally tractable (see Tesar and Smolensky. 1998). Finally this kind of OT analysis can account for the fact that children tend to learn fast taking into account the "impoverished quality of the input," and is adequate to account for the fact that learning tends to follow a discrete number of developmental stages or states. All of these are strong points of standard OT that set it apart from previous attempts to account for children's data by ordered rules in a derivational grammar.

Nonetheless, there are important problems underlying this kind of analysis: First of all, as we will argue below, the CDA is too fast to pass the condition that acquisition must be in real time (cf. Pinker 1979). Second, it predicts that stages will be whole-sale and abrupt; but what was presented above were rather gradual changes. Finally it is inadequate to capture the real patterns of variation or optionality. The next section will be devoted to motivate and illustrate these shortcomings. Then Section 7 is devoted to argue that these problems can be adequately dealt with in OT with the assumption of a gradual learning algorithm such as the one proposed in Boersma (1997).

5. Problems of the CDA

As mentioned above one of the positive aspects of standard OT is that children and adults share the same basic grammar/constrains and learning consists only in determining the correct ranking. But, how does a learner acquire the specific ranking compatible with the syllables of his/her language? It can not be by trial and error: the possibilities are N! where N = number of constraints. Thus with a system of only 15 constraints the learner would have to test 2,004,310,016 different possibilities.

The CDA offers a more plausible hypothesis about the underlying mechanism that facilitates the fast completion of this complex task. According to the CDA, the function Gen produces a number of candidates from an input (I). From these candidates only one is optimal. This necessarily means that the rest are sub-optimal. Now, knowing that all except one are sub-optimal entails a good deal of negative evidence for any input-output pair. The basic idea behind the CD algorithm is that the learner can extract evidence from the sub-optimal candidates of what constraints need to be demoted in order to improve harmony between the target hierarchy and the learner's hierarchy.

There are different logical possibilities of implementing constraint demotion: Batch CD, On-line CD or I/O CD (for an explanation of how each of these options works see Tesar and Smolensky 1998). For the purposes of this illustration we will assume that one mark-data pair is processed at a time (the on-line version) and that the learner is trying to acquire a language that allows codas but requires the presence of onsets. In such a language even when the input is VC the correct output is CVC. This can only be the case if . CVC. is the best among the competing candidates. This information is contained in the set of pairs in (15) where » can be read as less harmonic:

(18) For an input VC

Sub-optimal		Optimal
.CV.	»	. CVC.
.V.	»	. CVC.
.VC.	»	. CVC.

Assuming that the learner has access to the constraints violated by the optimal and sub-optimal candidates, s/he has the information in (19).

(19) Loser and winner marks

sub-opt » opt	loser-marks	winner-marks
. CV. » . CVC.	{Max, Dep}	{*Coda, Dep}
.V. » . CVC.	{ Max, Onset}	{*Coda, Dep}
.VC. » . CVC.	{Onset, *Coda}	{*Coda, Dep}

From here the algorithm assumes the following steps:

a. *Mark cancellation:* For each occurrence of a mark in both loser-marks and winner-marks remove the mark from both sets. The results for our example are in (20):

(20) Loser and winner marks after cancellation

sub-opt » opt	loser-marks	winner-marks
.CV. » .CVC.	{Max}	{*Coda}
.V. » .CVC.	{Max,Onset}	{*Coda, Dep}
.VC. » .CVC.	{Onset}	{Dep}

Now the learner is ready to use this information for the ranking of constraints. Let's assume that initially all the constraints are ranked at the top of the hierarchy (although any initial ranking would do).

(21) Initial state of the hierarchy.

A constr »	B constr »	C constr »	D constr »	…
*Coda, Max, Onset, Dep	ø	ø	ø	ø

After mark-cancellation, *Constraint Demotion* can apply until no more demotion can occur:

b. *Demotion.* For each pair of loser-marks » winner-marks if the winner mark is dominated by the loser-mark nothing happens. Otherwise the winner-mark needs to be demoted. Applying demotion to the table in (21) and using the information in the hierarchy in (20) we get the following results:

(22) The hierarchy after processing the first pair of marks.

A constr »	B »	C »	D »	…
Max, Onset, Dep	*Coda	ø	ø	ø

(23) The hierarchy after processing the second pair of marks.

A constr »	B »	C »	D »	…
Max, Onset	Dep, *Coda	ø	ø	ø

The third pair is uninformative because the learner already knows that Onset dominates Dep. S/he will have to process other inputs to discover the actual ranking. This will happen when an input CVC that surfaces as .CVC. is encountered.

With such a datum, the learner knows that from an input CVC, the output .CVC. must be better than .CV., .CV.CV., .V., and .VC. With a new iteration of the CD algorithm this information can have an effect on the grammar.

(24) Mark preparation takes then place:

sub-opt » opt	loser-marks	winner-marks
.CV. » .CVC.	{Max}	{*Coda}
.CV.CV. » .CVC.	{Dep}	{*Coda}
.V. » .CVC.	{Onset, Max, Max}	{*Coda}
.VC. » .CVC.	{Onset, *Coda, Max}	{*Coda}

(25) After that mark cancellation applies:

sub-opt » opt	loser-marks	winner-marks
.CV. » .CVC.	{Max}	{*Coda}
.CV.CV. » .CVC.	{Dep}	{*Coda}
.V. » .CVC.	{Onset, Max, Max}	{*Coda}
.VC. » .CVC.	{Onset, Max}	

The first pair will ratify information already known: Max dominates *Coda. It is when considering the second pair that the algorithm demotes *Coda to the immediate stratum of the hierarchy.

(26) Learned syllabic hierarchy for an obligatory onset language.

A constr »	B »	C »	D »	…
Max, Onset	Dep	*Coda	ø	ø

This is already the target hierarchy. From this point on, the consideration of further inputs will not contribute any additional information for the ranking of these constraints.

The algorithm had to process only two tokens and go through two iterations to derive the correct ranking. This is not a realistic model of acquisition. With this algorithm at the base of an analysis it is possible to show what constraints need to be demoted to model specific stages, but such an analysis offers no clue as to why, for instance, it takes almost two years for children to acquire complex onsets. Within this span of time the learner does in fact encounter many input forms with branching onsets and the prediction of the system is that the grammar would be modified accordingly well ahead of the time when correct outputs start to surface in the data.

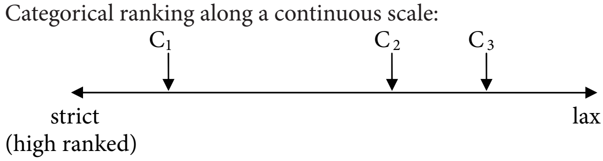
The other problem with the CDA is that since the rankings are categorical the moment a markedness constraint is demoted below the pertinent faithfulness constraint the prediction is that the learner will start using exclusively the new forms allowed by the grammar and all previous errors will stop from surfacing. That is, the moment that Max dominates *Complex all previous errors with complex onsets should disappear and only faithful renderings of the adult complex targets should be attested. As is well known, this is not the case. Learning is gradual.

Finally the fact that the rankings of the grammar are categorical and the change from one state to the next happens at a concrete point in time also precludes the system from accounting for variability. The existence of variable outputs in young children is vastly documented in all sorts of corpora; however it has been often ignored in generative accounts of the data. The corpora under analysis are not the exception. Routinely our five children produce the same target form with different syllable structures. Irene can produce in the same session (at 1;01.25) the target [ʻaγwa] ʻwater' as [ʻaba] and as [ʻaγwa]. Then at 1;04.16 when she attempts a difficult word such as [peli'roχo] ʻread-headed' the outputs [ʻuχo], [uχ'uχo], [ʻpuχo], [ʻtuχo] and [ʻχuχo] appear indiscriminately. At 1;05.01 [po'tito] ʻbaby food jar' is either [ʻito] or [ʻtito] and [panta'lon] either [a'on] or [pa'ton]. These patterns of variation are quite persistent and go well beyond single sessions. For instance [pe'δrin] ʻproper name' is pronounced [pe'δin] at 1;04.16, [ʻpin] at 1;05.01 and also in this session as [e'in] and [pe'δin]. It is not the case that the different forms correspond to different stages of the grammar since often a correct version of a word is later produced with a syllable structure that deviates from the target form. [bi'γote] ʻmustache' can be first pronounce correctly but then it appears as [bi'ote] or [i'γote] next to target-like [bi'γote]. All the other subjects have many similar examples of variation and, as mentioned, this is something that has been extensively reported in all languages.

6. An OT analysis based on the Gradual Learning Algorithm (GLA)

The GLA is in many aspects a development of the CDA. It is also an error-driven algorithm that assumes that a learner extracts information by comparing pairs of winner/loser marks and uses it to adjust the rankings of constraints. One of the main differences is that under the GLA the ranking of constraints is not categorical. Instead it assumes a "continuous ranking scale" in which each constraint is given a numerical value and it is this value (not the constraint itself) that is altered when new input data is in conflict with the possibilities of the current state of the grammar. Boersma and Hayes (2001) depict this continuous scale graphically as in (27):

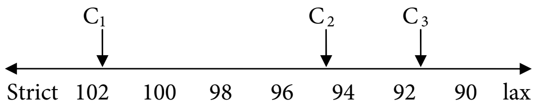
(27) Categorical ranking along a continuous scale:



This figure shows that although the ranking may be categorical (in that C_1 dominates C_2 and C_2 dominates C_3) in fact the distance between different constraints is relevant.

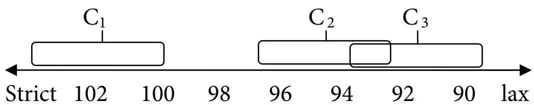
The next important point of divergence with the DCA is that the evaluation of competing candidates includes a random variable (also referred to as "stochastic or noisy evaluation"). This implies that the constraints in the grammar are not static at the moment of evaluation but are rather moving targets within fixed ranges. The range of a constraint is conventionally given a value of 2. These ranges, though, are not to be understood as properties of constraints but rather as noise introduced in the evaluation mechanism. At each single evaluation the actual strength of a constraint can vary two points. The center of the range is called the "selection point." Let's assume that the distance in (27) between C_2 and C_3 is 2.5 and the distance between C_1 and C_2 is 6.6:

(28)



With the range of each constraint represented graphically we have:

(29)



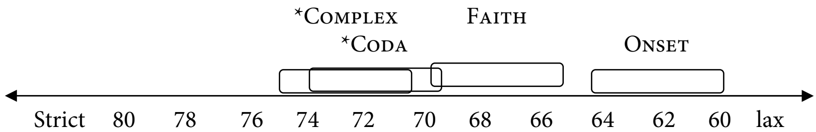
This means that the ranking between C_1 and C_2 will produce categorical results while the ranking between C_2 and C_3 will allow variation. With the current values it is very unlikely that any combination of random values assigned to C_1 and C_2 could result in C_2 dominating C_1 at a specific instance of evaluation. On the other hand for C_2 and C_3 although the most likely scenario will have C_2 on top, it falls within the possibilities of random assignment that for some evaluations C3 will actually dominate C2. This is what allows this model to account for variation. The actual mechanism goes farther than this abstraction and is actually able to predict the specific frequencies of variation based on the selection points of each constraint and it actually conceives the range of each constraint as a *normal* distribution instead of an area, but for the present purposes this suffices to understand how variation is derived (see Boersma 1997 and Boersma and Hayes 2001 for a more detailed description).

The GLA also assumes a comparison of winner/loser marks and mark cancellation as described above. Where it differs from the CDA is in the adjustments applied to the current rankings based on the error-driven information obtained from the pair evaluations. Instead of demoting constraints to the immediately lower stratum the GLA uses a numerical value called "plasticity" to change the ranking of a constraint. This value is arbitrarily set low in order to avoid the grammar converging into the correct ranking too fast. As argued above this is one of the main problems of the CDA when confronted with gradual progress toward adult targets. Another positive outcome of setting a low plasticity value is that the grammar becomes more robust and less likely to be affected by contradictory inputs. Finally another difference between the two algorithms is that GLA assumes that after comparing winner and loser pairs the learner will adjust as many constraints as needed and that this adjustment would constitute a demotion in some cases but a promotion in others.

Let's explore now how these new assumptions can be put at work in accounting for the observed stages of acquisition of the Spanish syllable. For the initial state it will again be assumed that markedness dominates faithfulness but only because it simplifies the account, not because this is a necessary condition of the algorithm. Following

Boersma and Levelt (1999), markedness constraints can arbitrarily be set to 100 and Faith to 50. Arguably, by the time the child produces the first outputs, a considerable amount of reranking may have taken place so it can be assumed that by the end of the first year when our period of analysis starts the constraints have moved from their original values. For stage 1) we assume something along the lines of (30):

(30)



In essence this is comparable to (14) above and, as before, as long as *Coda and *Complex dominate Faith neither codas nor complex syllabic constituents will surface, which is appropriate for this stage. However, the fact that there is some minimal overlap between *Coda and Faith implies that there is a small chance of seeing a coda well in advance of the moment when they become frequent in the data (this is actually what is found in the corpus). Similarly since *Complex and Faith are rather close there is a probability of branching structures to sporadically surface. Onset and Faith are depicted a bit more distant because the V syllable almost never surfaces as CV. But we leave it close enough because there is an example of *araña* pronounced [naˈɾaɲa] by Mag at 1;10.16.

From this moment every time the child processes a CVC input and finds that his/her grammar is not set to produce the correct output, *Coda and Faith will gradually move closer together and in the process a stage of variable outputs will be observed. As even more inputs are processed *Coda will overpass the selection point of Faith and move below it. When *Coda has moved to the position occupied by Onset in (30) we have reached the second stage.

As *Coda was being drawn towards Faith and then below, the child was also processing numerous inputs with complex nucleus and complex onsets (more of the former since their frequency is higher in the ambient language). As a consequence *Complex(Nuc) has been also slowly floating (as if it were an iceberg) toward Faith but at a lower pace than *Coda. Between three to six months after *Coda reached a position that determined positing stage II, *Complex(Nuc) will be lax enough in comparison to Faith to describe stage III.

Finally, when Faith overtakes *Complex(Ons), we obtain stage IV and we can reasonable assume that, when *ComplexCoda is finally below Faith, the grammar will be set to allow all the attested syllabic structures in the target language.

Recall that Table 1 above shows that the progression of the CV syllable, when compared to the adult average frequency for this structure, is basically flat. This is because none of the constraints affects the CV syllable and as a consequence it is predicted to be faithfully parsed regardless of the ranking of the constraints. Next, in Table 2, V syllables were more frequent in children utterances that they were for adults, and it was argued that this was mainly because of the rendering of VC as V. This can account in part for the decreasing path toward normal values. If the grammar is set from the outset of the period under consideration to allow onsetless syllables then the expectation is also a flat line over time. The frequency data for CVC and VC displayed a long gradient slope that converged with adult target towards the end of the period under study. This can now be interpreted as the result of *Coda drifting slowly closer to Faith and then below it by the time normal frequencies are attested. Similarly, the rising slopes found for complex nuclei and complex onset can be interpreted as the byproduct of the relevant constraint moving toward and then beyond Faith. There is only one piece of this account that does not seem right. If the speed of convergence to the target ranking is proportional to the frequency of each structure in the child-directed speech, we would expect *Coda converging faster than *Complex. However, the opposite was found: the acquisition of codas presents a long and gradual upward slope, while the branching constituents have sharp ascent. In accordance with the GLA, Complex(Ons) takes a long time to reach a point when it is close enough to Faith, but, when it does, the frequency of branching onset increments fairly quickly. Similarly, Complex(nuc) reaches the point of having an effect on outputs only slightly behind *Coda, but when it does, it reaches the adult norm faster than *Coda. The slow attainment of the normal frequencies in the coda may be due to the fact that more than one constraint needs to be correctly ranked before the right set of codas can be faithfully parsed. In that sense, constraints such as CodaSon — Codas are sonorant (Zec 1988) and CodaCond — A coda does not license it own place of articulation (Itô and Mester 1994) may be behind the slow path of acquisition of codas.

In closing, this analysis maintains all the advantages noted in the previous account but is able to overcome its main shortcomings providing a more realistic account of the gradual path of acquisition.

7. Conclusion

In establishing the stages of acquisition of Spanish syllable structure we have seen that by combining categorical cuts with a complementary view that reflects the inherent gradual nature of the process, we obtain a better understanding of how syllable types emerge and spread in acquisition. In modeling the attested results in a theoretical framework we found that the GLA is to be preferred because it is able to capture both the categorical and the gradient aspects of learning. In previous studies it had been found that frequency of a structure in the ambient language was one of the more reliable predictors for order of acquisition of syllables, but frequency itself had to be treated as something alien to the grammar. One of the great features of the GLA is that it can account for the fact that the relative speed of acquisition of a given syllable type depends on how many times this syllable is available as input giving the learner an opportunity to move the relevant constraints closer and closer to the target ranking.

References

Bernhardt, B.H. and Stemberger, J.P. 1998. *Handbook of Phonological Development from the Perspective of Constraint-based Nonlinear Phonology*. San Diego CA: Academic Press.

Bonilha, G.F.G. 2000. Aquisição dos ditongos orais decrescentes: uma análise à luz da Teoria da Otimidade. PhD dissertation, UCPel.

Bonilha, G.F.G. 2004. Aquisição fonológica do português brasileiro: uma abordagem conexionista da Teoria da Otimidade. PhD dissertation, PUCRS.

Boersma, P. 1997. The elements of functional phonology. Ms, University of Amsterdam. (Rutgers Optimality Archive 173, http://roa.rutgers.edu/index.php3).

Boersma, Paul and Clara Levelt. 1999. Gradual Constraint-Ranking Learning algorithm predicts acquisition order. In *Proceedings of the 30th Child Language Research Forum*, 229–237. Stanford: CSLI.

Boersma, P. and Hayes, B. 2001. Empirical tests of the gradual learning algorithm. *Linguistic Inquiry* 32: 45–86.

Carreira, M. 1991. The acquisition of Spanish syllable structure. In *New Analyses in Romance Linguistics* [Current Issues in Linguistic Theory 69], D. Wanner and D. Kibbee (eds), 3–18. Amsterdam: John Benjamins.

Costa, J. and Freitas, M.J. 1998. V and CV as unmarked syllables: Evidence from the acquisition of Portuguese. Presented at the Conference 'The syllable Typology and Theory'. Tuebingen.

Demuth, C. 1995. Markedness and the development of prosodic structure. *Proceedings of the North East Linguistic Society* 25: 13–25.

Fee, J. 1995. Segments and syllables in early language acquisition. In *Phonological Acquisition and Phonological Theory*, J. Archibald (ed.), 43–62. Hillsdale NJ: Lawrence Erlbaum Associates.

Fikkert, P. 1994. On the Acquisition of Prosodic Structure. PhD dissertation, University of Leiden. The Hague: HAG.

Freitas, M. J. 1996. Onsets in early productions. In *Proceedings of the UBC International Conference on Phonological Acquisition*, B. Bernhardt, J. Gilbert and D. Ingram (eds), 76–84. Somerville MA: Cascadilla.

Freitas, M.J. 1997. Aquisição da estrutura silábica do português europeu. PhD dissertation, Universidade de Lisboa.

Gnanadesikan, A. 1995. Markedness and faithfulness constraints in child phonology. Ms, University of Massachusetts, Amherst. (Rutgers Optimality Archive 67, http://roa.rutgers.edu/index.php3).

Hualde, J.I. 1999. La silabificación en Español. In *Fonología generativa contemporánea de la lengua española*, R. Nuñez-Cedeño and Morales-Front, A. (eds), 170–189. Washington DC: Georgetown University Press.

Itô, J. and Mester, A. 1994. Reflections on CodaCond and alignment. In *Phonology at Santa Cruz* 3, J. Merchant, J. Padgett and R. Walker (eds), 27–46. Santa Cruz CA: LRC. (Rutgers Optimality Archive 141, http://roa.rutgers.edu/ index.php3).

Kappa, I. 2002. On the acquisition of syllabic structure in Greek. *Journal of Greek Linguistics* 3: 1–52

Kirk, C and Demuth, K. 2003. Onset/coda asymmetries in the acquisition of clusters. In *Proceedings of the 27th Annual Boston University Conference on Language Development*, B. Beachley, A. Brown and F. Conlin (eds), 437–448. Somerville MA: Cascadilla.

Levelt, C. and R. van de Vijver. 1998. Syllable types in cross-linguistic and developmental grammars. (Rutgers Optimality Archive 265, http://roa.rutgers.edu/ index.php3).

Levelt, C.C., Schiller, N.O. and Levelt, W.J. 2000. The acquisition of syllable types. *Language Acquisition* 8: 237–264.

Lleó, C. 2003. Prosodic licensing of codas in the acquisition of Spanish. *Probus* 15: 257–281.

Lleó, C. and Prinz, M. 1996. Consonant clusters in child phonology and the directionality of syllable structure assignment. *Journal of Child Language* 23: 31–56.

López Ornat, S. 1994. *La adquisición de la lengua Española*. Madrid: Siglo XXI.

Macken, M. 1976. Permitted complexity in phonological development: One child's acquisition of Spanish consonants. *Papers and Reports on Child Language Development* 11: 28–60.

McCarthy, J. and Prince, A. 1994. Prosodic morphology. In *A Handbook of Phonological Theory*, J. Goldsmith (ed.), 318–366. Oxford: Blackwell.

MacWhinney, B. 2000. *The CHILDES Project: Tools for analyzing talk* (3rd ed.). Mahwah NJ: Lawrence Erlbaum Associates.

Menn, Lise. 1971. Phonotactic rules in beginning speech: a study in the development of English discourse. *Lingua* 26: 225–251.

Montes, R. 1987. *Secuencias de clarificación en conversaciones con niños* [Morphe 3–4]. Puebla: Universidad Autónoma de Puebla.

Montes, R. 1992. Achieving Understanding: Repair mechanisms in mother–child conversations. PhD dissertation, Georgetown University.

Pan, N. and Snyder, W. 2003. Setting the parameters of syllable structure in early child Dutch. In *Proceedings of the 27th Annual Boston University Conference on Language Development*, B. Beachley, A. Brown and F. Conlin (eds), 615–625. Somerville MA: Cascadilla.

Pinker, S. 1979. Formal models of language learning. *Cognition* 1: 217–283.

Prieto, P. and Bosch-Baliarda, M. 2005. The development of codas in Catalan. *Catalan Journal of Linguistics* 5.

Rose, Y. 2000. Headedness and Prosodic Licensing in the L1 Acquisition of Phonology. PhD dissertation, McGill University.

Roug, L., Landberg, I. and Lundberg, L.-J. 1989. Phonetic development in early infancy: A study of four Swedish children during the first 18 months of life. *Journal of Child Language* 16: 19–40.

Stites, J., Demuth, K. and Kirk, C. 2004. Markedness versus frequency effects in coda acquisition. In *Proceedings of the 28th Annual Boston University Conference on Language Development,* A. Brugos, L. Micciulla and C.E. Smith (eds), 565–576. Somerville MA: Cascadilla.

Tesar, B and Smolensky, P. 1998. Learnability in optimality theory. *Linguistic Inquiry* 29: 229–268.

Velten, H. de Veltheyme. 1943. The growth of phonemic and lexical patterns in infant speech. *Language* 19: 281–292.

Vihman, M.M. 1996. *Phonological Development: The origins of child language*. Oxford: Blackwell.

Zec, D. 1988. Sonority Constraints on Prosodic Structure. PhD dissertation, Stanford University.

Constraint conflict in the acquisition of clusters in Spanish

Jessica A. Barlow
San Diego State University

This study characterizes the cluster production patterns of four Spanish-speaking children, whose data are drawn from original and published research. Each child demonstrates a different pattern of production. The data support previous claims that there is a general preference for "sonority-based onset selection" cross-linguistically; this is explained via an appeal to independently motivated syllable structure markedness constraints. Divergence from the sonority pattern also occurs within and across the children's systems, which also has been observed in previous research. The asymmetries between cluster types are accounted for by appealing to independently motivated segmental markedness and faithfulness constraints. Taken together, the constraint interactions make testable predictions for different typologies of developing and fully-developed grammars.

Keywords: Syllable, cluster, sonority, heterosyllabic, tautosyllabic, child

0. Introduction

There have been numerous studies on children's acquisition of consonant clusters. The available published research shows that systematic reduction patterns are common in the process of acquisition of these structures (McLeod, van Doorn, and Reed 2001; Smit 1993). One reduction trend identified in the literature on cluster acquisition is referred to as "sonority-based onset selection" (hereafter, "the sonority pattern"; Pater and Barlow 2003), in which the least sonorous segment of the target cluster is preserved according to a sonority scale such as that in (1) (e.g., Barlow 1997; Chin 1996; Gnanadesikan 2004; Goad and Rose 2004; Ohala 1996, 1999).

(1) Sonority scale (most to least) (Blevins 1995; Selkirk 1984)
vowels > glides > liquids > nasals > fricatives > stops

Within optimality theory (OT; Prince and Smolensky 1993), cluster reduction usually is accounted for by ranking syllable markedness constraints above segmental faithfulness constraints, a common pattern in acquisition of language generally (e.g., Barlow, 1997; Gnanadesikan 2004; Ohala 1996; Smolensky 1996). For tautosyllabic clusters (i.e., clusters which occur within the same syllable, in the onset), for example, this would require ranking a constraint against complex onsets over a constraint against deletion (as defined in (2)).

(2) *Complex: No branching onsets (Prince and Smolensky 1993)
Max: No deletion (McCarthy and Prince 1995)

To account for the sonority pattern described above, additional syllable markedness constraints based on the sonority hierarchy (shown in (3)) select the least sonorous segment as the optimal onset (Pater and Barlow 2003; adapted from Prince and Smolensky 1993). These sonority constraints, which are ranked in a universal order, show a preference for less sonorous sounds in the onset. Specifically, *G-Onset prohibits a glide in the onset, while *L-Onset prohibits a liquid in the onset, and so on. Because of the universal ranking of these sonority constraints, a glide in the onset will always be considered a worse violation than a liquid in the onset, which is always worse than a nasal or fricative in the onset (all other things being equal). Thus, a stop is the least marked onset segment, and therefore no *S(top)-Onset constraint is posited.

(3) *G-Onset >> *L-Onset >> *N- Onset >> *F- Onset
(where G=glide, L=liquid, N=nasal, F=fricative)

An example of this ranking for cluster reduction is shown in (4) for target *flecha* /fletʃa/ 'arrow,' produced as [fetʃa], rather than [letʃa].[1]

(4) Tableau: *Complex >> MAX >> *L-Ons >> … >> *F-Ons

/fletʃa/ *flecha*	*Complex	Max	*L-Ons	*F-Ons
a. [fletʃa]	*!		*	*
b.☞ [fetʃa]		*		*
c. [letʃa]		*	*!	

The majority of evidence of this sonority pattern in the acquisition of consonant clusters comes from studies of acquisition of tautosyllabic clusters in English. (See also Barlow (1997), Gnanadesikan (2004), and Ohala (1996) for additional examples of the effects of sonority constraints in acquisition, as well as Hammond (1999), Lamontagne and Rice (1995), and Zec (1995) for examples in adult languages.) Few studies consider heterosyllabic clusters (those that occur across a syllable boundary) (e.g., Chervela 1981; Ohala 1998). Similarly, few studies specifically address the acquisition of clusters in other languages, regardless of cluster type (but see Fikkert 1998; Goldstein and

1. The consonant + tap /ɾ/ clusters are reduced following the same pattern, and, as is argued here, this is attributed to the proposed constraint-ranking. However, as an anonymous reviewer notes, one could argue that the reduction of these clusters to the least sonorous segment could be attributed instead to the fact that adult Spanish disallows the tap /ɾ/ in word-initial position. While this is in fact possible, it is unlikely, given that word-internal tautosyllabic clusters (as in [tɾ] in *cuatro* 'four') also show reduction to the least sonorous singleton, and this is a context in which the tap is allowed to occur in the adult grammar.

Cintrón 2001; Jongstra 2003; Lleó and Prinz 1996; Rūķe-Draviņa 1990). These omissions in the literature are the motivation for the current study of the acquisition of tauto- and heterosyllabic clusters by Spanish-speaking children.

In this paper, asymmetries in cluster reduction strategies within and across children's grammars will be considered as they compare to findings cross-linguistically. The competing patterns of reduction will be accounted for within a framework of optimality theory, and will illustrate how rankings of independently-motivated constraints naturally allow for the observed asymmetries to occur.

1. Data Sources

This study will consider data from four different children, from different populations. The first two children, SD1 (female; aged 3;4) and SD2 (female, aged 3;9), were from the Southern California area, and were monolingual in Spanish at the time of testing. These two children were diagnosed with phonological delay but were typically developing in all other respects as based on formal oral-motor, linguistic, cognitive, and hearing assessments. (For more information about these two children and their sound systems, see Barlow (2003a, b, 2005).) Speech samples from SD1 and SD2 consist of 214 single-word utterances (elicited spontaneously or in imitation), with interjudge transcription reliability calculated at 89% and 88% for the two children, respectively.

The analyses of cluster production presented for SD1 and SD2 are drawn from an earlier study (Barlow 2003a) for comparison with two additional children (described below) who show different cluster production patterns. The main aspects of the original analyses from Barlow (2003a) are repeated here for clarity and continuity across all four children.

The data from the other two children are drawn from published studies of typically-developing children. Fabiola (female, aged 3;4; Eblen 1982) was a monolingual speaker of Mexican Spanish. Her speech sample consisted of 63 single-word, phrase, and sentence utterances (elicited spontaneously or in imitation). Intrajudge and interjudge transcription reliability for her productions was 83% and 80%, respectively. While the utterances are relatively few in number, as compared to the other three children, they are considered here in order to illustrate the typological variation that can occur in acquisition of consonant clusters in Spanish.

Joaquín (male, aged 2;1–2;10; Montes Giraldo 1971) was a monolingual speaker of Colombian Spanish. His data consisted of 156 words (also elicited spontaneously or in imitation) that were monitored longitudinally. Though no transcription reliability was reported, the data are appealed to here, once again, in order to illustrate variations in cluster production. For the purposes of the present study, data analysis focused on the period of time during which Joaquín's cluster production patterns were stable and relatively consistent. Thus, it is assumed that his grammar as it related to clusters remained relatively unchanged during this period.

The population of children that are considered here are heterogeneous in a number of ways. First, SD1 and SD2 were phonologically delayed, while Fabiola and Joaquín were typically developing. It should be noted that, generally, the grammars of these two populations are similar to one another (see, e.g., Ingram 1989a, b), even in terms of cluster reduction patterns (e.g., Pater and Barlow 2003). The children also differ in terms of dialect differences: SD1 and SD2 both were learning a Southern California variety of Spanish, while Fabiola was learning Mexican Spanish and Joaquín was learning Colombian Spanish. Dialect differences can be attributed to differences in acquisition patterns (e.g., Craig, Thompson, Washington, and Potter 2003; Goldstein and Iglesias 2001). Nevertheless, these three dialects do not differ from one another in terms of the consonant cluster production patterns examined in the current study (Hammond 2001); therefore, any observed differences between the children's productions of clusters are not likely due to dialect differences.

The data from each child were analyzed for cluster production patterns. In each case, a determination of whether clusters were produced correctly or in error was made. Those produced in error were evaluated for syllabic and segmental patterns of production. As will be shown, each child showed a unique pattern of production for tautosyllabic and heterosyllabic clusters.

2. SD1

Data from SD1 are considered first. Her sound system allows tautosyllabic clusters to be produced, without reduction, as shown in (5), while heterosyllabic clusters are reduced to the least sonorous singleton, as shown in (6). (Note that *blanca*, *brinca*, *grande*, and *frente* are cross-listed in (5) and (6) to illustrate tautosyllabic initial clusters and heterosyllabic medial clusters. Similarly, *estrella* is cross-listed in (5) and (6) to illustrate the tauto- and heterosyllabic cluster [s.tɾ].)

(5) SD1: Tautosyllabic clusters preserved (Barlow 2003a)

Target	Production	Gloss	Target	Production	Gloss
plátanos	[plata]	'bananas'	*plato*	[plato]	'plate'
bloque	[bloke]	'block'	*blanca*	[blaka]	'camera'
brinca	[bɾika]	'jumps'	*bisikleta*	[kleta]	'bicycle'
fresa	[fɾeda]	'strawberry'	*estrella*	[etɾeja]	'star'

(6) SD1: Heterosyllabic clusters reduced (Barlow 2003a)

Target	Production	Gloss	Target	Production	Gloss
delfín	[ofi]	'dolphin'	*fuente*	[fuete]	'fountain'
pintura	[putuɾa]	'painting'	*llanta*	[jato]	'tire'
lengua	[legua]	'tongue'	*gancho*	[gatʃo]	'hook'
castillo	[katijo]	'castle'	*estrella*	[etɾeja]	'star'

To account for the preservation of clusters in onset position, it is assumed that SD2's grammar ranks Max over *Complex, allowing for the more faithful form, in the present case [plato] for *plato* 'plate,' to surface, as shown in (7).

(7) Max >> *Complex

/plato/ *plato*	Max	*Complex
a. ☞ [plato]		*
b. [pato]	*!	

Regarding the heterosyllabic clusters, this pattern would be accounted for by appealing to Max and the sonority constraints, as well as *Coda, defined in (8), which prohibits the occurrence of coda consonants. Ranking *Coda above Max and the sonority constraints would account for the pattern nicely, as shown in (9), where the least sonorous onset segment is chosen as optimal for the word *llanta* 'tire,' realized as [ja.to].

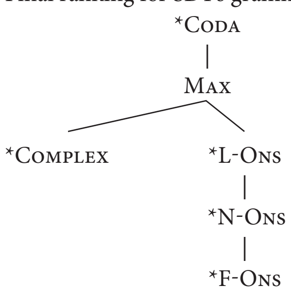
(8) *Coda: No coda consonants (Prince and Smolensky 1993)

(9) *Coda >> Max >> … >> *N-Ons

/janta/ *llanta*	*Coda	Max	*N-Ons
a. [jan.to]	*!		
b. ☞ [ja.to]		*	
c. [ja.no]		*	*!
d. [jat.o]	*!	*	

The final ranking shown in (10) accounts for SD1's production of tauto- and heterosyllabic clusters. This ranking is further illustrated in the tableau in (11).[2]

(10) Final ranking for SD1's grammar



2. It should be noted that SD1 (and also SD2, discussed later) did produce word-final consonants, despite the absence of word-internal coda consonants. This asymmetry is accounted for in Barlow (2003a) in detail, by assuming that final consonants are onsets to empty-headed syllables (see also Goad and Brannen 2003). That aspect of the accounts of SD1's and SD2's grammars will not be addressed further here, as it is beyond the scope of this paper.

(11) Illustrative tableau for SD1's grammar

/bɾiŋka/ *brinca*	*Coda	Max	*Comp	*L-ONS	*N-Ons	*F-Ons
a. [bɾiŋ.ka]	*!		*	*		
b. ☞ [bɾi.ka]		*	*	*		
c. [bɾi.ŋa]		*	*	*	*!	
d. [biŋ.ka]	*!	*				
e. [ɾiŋ.ka]	*!	*		*		
f. [bi.ka]		**!				
g. [ɾi.ka]		**!		*		

There is additional evidence for the sonority pattern with SD1's heterosyllabic obstruent + obstruent /s/C sequences, which reduce to the least sonorous segment, as shown for the word *castillo* 'castle,' produced as [katijo] in (12) (where only relevant constraints are included). In this case, both sounds in the input have relatively low sonority; yet, an emergent sonority pattern is revealed, whereby the less sonorous stop is chosen over the more sonorous fricative.

(12) Sonority pattern in obstruent + obstruent clusters

/kastijo/ *castillo*	*Coda	Max	*F-Ons
a. [kas.tijo]	*!		
b. ☞ [ka.tijo]		*	
c. [ka.sijo]		*	*!

This ranking likewise accounts for SD1's production of three-element clusters, as with [s.tɾ] in *estrella* 'star' (from (5) and (6) above), where the heterosyllabic cluster [s.t] is reduced, but the tautosyllabic [tɾ] cluster is preserved. See (13) below:

(13) Reduction of three-element clusters

/estɾeja/ *estrella*	*Coda	Max	*Comp	*L-Ons	*F-Ons
a. [es.tɾeja]	*!		*	*	
b. ☞ [e.tɾeja]		*	*	*	
c. [es.teja]	*!	*			
d. [e.teja]		**!			
e. [e.seja]		**!			*

Thus, while tautosyllabic clusters are preserved in SD1's productions, heterosyllabic clusters are reduced, following the sonority pattern. We now consider SD2, who shows a different pattern of production for the two types of clusters.

3. SD2

SD2 reduces *both* tauto- and heterosyllabic clusters, as shown in (14) and (15). While the sonority pattern generally accounts for the child's productions, in specific contexts this pattern is disrupted. (Note that *princesa*, *blanco*, *brinca*, *grande*, and *frente* are cross-listed in (14) and (15) to illustrate tautosyllabic initial clusters and the heterosyllabic medial clusters.)

(14) SD2: Tautosyllabic clusters reduced (Barlow 2003a)

Target	**Production**	**Gloss**	**Target**	**Production**	**Gloss**
plato	[pato]	'plate'	*princesa*	[pisesa]	'princess'
bloque	[boke]	'block'	*blanco*	[bako]	'white'
brinca	[bika]	'jumps'	*clavo*	[kaβo]	'nail'
crema	[kema]	'cream'	*grande*	[gane]	'large'
flecha	[fetʃa]	'arrow'	*frente*	[fete]	'forehead'

(15) SD2: Heterosyllabic clusters reduce to least sonorous segment (Barlow 2003a)

Target	**Production**	**Gloss**	**Target**	**Production**	**Gloss**
frente	[fete]	'forehead'	*campana*	[kapana]	'bell'
gente	[xete]	'people'	*llanta*	[tʃata]	'tire'
princesa	[pisesa]	'princess'	*brinca*	[bika]	'jumps'
blanco	[bako]	'white'	*dormida*	[nomija]	'slept'

To account for the reduction of tautosyllabic clusters, it is assumed that *Complex outranks MAX and the sonority constraints, contrary to SD1's grammar. A sample tableau is shown in (16).

(16) *Complex >> Max >> *L-Ons >> … >> *F-Ons

/fletʃa/ *flecha*	*Complex	Max	*L-Ons	*F-Ons
a. [fletʃa]	*!		*	*
b. ☞ [fetʃa]		*		*
c. [letʃa]		*	*!	

Since heterosyllabic clusters are reduced according to the sonority pattern, the same ranking that accounts for SD1's reduction of heterosyllabic clusters also accounts for the reduction of *most* of the heterosyllabic clusters in SD2's grammar. This is illustrated in the tableau in (17).

(17) *Coda >> Max >> *N-Ons >> …

/xente/ *gente*	*Coda	Max	*N-Ons
a. [xen.te]	*!		
b. ☞ [xe.te]		*	
c. [xe.ne]		*	*!

While this accounts for *most* heterosyllabic clusters, certain clusters do diverge from the sonority pattern. The data in (18) show how nasal + voiced stop clusters instead reduce to the most sonorous segment. Incidentally, a similar asymmetry has been observed in acquisition studies of Spanish and English (Hernández-Chávez, Vogel, and Clumeck 1975; Ingram 1989; Macken 1979; Smith 1973).

(18) SD2: Nasal + voiced stop clusters reduce to most sonorous segment (Barlow 2003a)

Target	**Production**	**Gloss**	**Target**	**Production**	**Gloss**
grande	[gane]	'big'	*bandera*	[βaneja]	'flag'
llorando	[dʒolano]	'crying'	*lengua*	[lenua]	'tongue'
prende	[pene]	'turn on'	*tamborito*	[tamolito]	'drum'

The current ranking incorrectly predicts that the obstruent [d], rather than the sonorant [n] would be chosen by the grammar for the [n.d] cluster in a word such as *grande* 'big,' as illustrated in the tableau in (19).

(19) SD2's nasal + voiced obstruent clusters

/gɾande/ *grande*	*Coda	Max	*N-Ons
a. [gan.de]	*!		
b. 👎 [ga.de]		*	
c. (☞) [ga.ne]		*	*!

To account for this asymmetry in reduction for the two different types of clusters, we must assume that some constraint interaction is at work, which is disrupting the general sonority pattern. Since the nature of the asymmetry between the two cluster types pertains to the voicing of obstruents, it is assumed that this asymmetry is the result of the interaction between the sonority constraints and segmental voicing constraints. Specifically, two additional constraints, defined in (20), are appealed to in order to account for these differential patterns of reduction (e.g., Lombardi 1991, 1999). *Voice, which is a markedness constraint against voiced obstruents, is in conflict with Ident-Voice, a faithfulness constraint requiring faithfulness to voice feature specifications.

(20) *Voice: No voiced obstruents
Ident-Voice: Segments in correspondence should agree in voicing

The motivation for *Voice and Ident-Voice can be found in cross-linguistic patterns related to laryngeal neutralization. For example, voicing plays a role in the patterning of heterosyllabic clusters, including nasal + obstruent clusters, as it does in the case of SD2. Specifically, many languages show asymmetries with respect to the patterning of nasal + voiced obstruent clusters versus nasal + voiceless obstruent clusters (e.g., Archangeli, Moll, and Ohno 1998; Hyman 2001; Pater 1999).

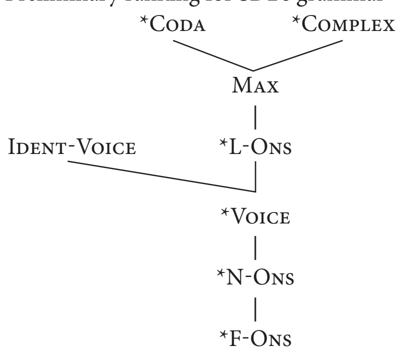
Since violation of Ident-VOICE is not generally observed in SD2's productions, the constraint must rank above *Voice. This illustrates how, in some cases, violation of *Voice in SD2's grammar can result in emergent unmarkedness (McCarthy and Prince 1995, 1999). Thus, while voiced obstruents are allowed to occur, they are disallowed in specific contexts. That is, where nasal + *voiced* stop clusters are concerned, SD2's grammar shows a preference for sonorants rather than voiced obstruents in the onset. This warrants a ranking of *Voice over the sonority constraint *N-Ons, allowing for *lengua* 'tongue' to surface as [lenua], as shown in (21).

(21) *VOICE >> *N-ONS

/leŋgua/ *lengua*	*VOICE	*N-ONS
a. [le.gua]	*!	
b. ☞ [le.nua]		*

The independent rankings converge on the tentative ranking for SD2 shown in (22), and two sample tableaux are shown in (23) to illustrate this ranking (for *gente*, only relevant constraints are shown).

(22) Preliminary ranking for SD2's grammar



(23) Illustrative tableaux

/gɾande/ *grande*	*COMP	*CODA	MAX	ID-VOI	*L-ONS	*VOI	*N-ONS
a. [gɾan.de]	*!	*			*	**	
b. [ga.de]			**			**!	
c. ☞ [ga.ne]			**			*	*
d. [ɾa.de]			**		*!	*	
e. [ɾa.ne]			**		*!		*
f. [ga.te]			**	*!		*	

/xente/ *gente*	*CODA	MAX	ID-VOI	*VOI	*N-ONS
a. [xen.te]	*!				
b. ☞ [xe.te]		*			
c. [xe.ne]		*			*!
d. [xe.de]		*	*!	*	

This ranking also predicts the emergent sonority pattern for sonorant + sonorant (liquid + nasal) clusters, as in the case of *dormida* 'slept,' shown in (24) (where only relevant segments are shown, given additional changes that occur). In this case, both sounds in the input have relatively high sonority; yet, an emergent sonority pattern is revealed, whereby the less sonorous nasal is chosen over the more sonorous liquid.

(24) Emergent sonority

/doɾmiða/ *dormida*	*Coda	Max	*L-Ons	*N-Ons
a. [...oɾ.mi...]	*!			*
b. [...o.ɾi...]		*	*!	
c. ☞ [...o.mi...]		*		*

While sonorant + sonorant sequences show the emergent sonority pattern, the /s/ + obstruent clusters present a problem. For this child, /-st-/ and /-sk-/ surface correctly, as shown in (25), which is in violation of *Coda, and, given the rankings, that should be a fatal violation (as illustrated in (26)).

(25) /s/ clusters surface correctly

Target	**Production**	**Gloss**
castillo	[kastijo]	'castle'
una estrella	[unasteja]	'a star'
escoba	[eskoba]	'broom'

(26) Heterosyllabic /s/ clusters do not reduce

/kastijo/ *castillo*	*Coda	Max	*F-Ons
a. (☞) [kas.tijo]	*!		
b. ☟ [ka.tijo]		*	
c. [ka.sijo]		*	*!

In fact, /s/ clusters in Spanish are peculiar. The research on /s/ clusters in Indo-European languages provides much evidence that they pattern differently in historical sound change, reduplication patterns, and even in phonological acquisition (see Barlow 2001 for a review of literature regarding the special status of /s/ clusters in developing and fully-developed systems). Some have assumed that the /s/ is extrasyllabic to the syllable. Whether /s/ clusters are structurally different in Spanish, or just specifically in this child's system, it is not clear. However, without making such assumptions about differing structural representations, one way to account for this difference in cluster production would be to explode the *Coda constraint into *Coda-Sonorant and *Coda-Obstruent (similar to the sonority constraints), with the former ranked above Max, and the latter ranked below it and the sonority constraints. This would in fact account for the differential patterning of the obstruent +obstruent (/s/) clusters versus other sonorant + obstruent clusters, as illustrated in (27) (where only relevant constraints are shown):[3]

3. This would predict that all obstruent + sonorant and obstruent + obstruent clusters would be allowed to occur in SD2's productions. Only /s/ clusters were targeted in the speech sample, so it is unclear if these other cluster types would pattern in the same way. Further evaluation of how /s/ clusters pattern in comparison to other obstruent-initial heterosyllabic clusters in acquisition is necessary.

(27) Comparison of differential reduction of heterosyllabic clusters

/kastijo/ *castillo*	*Coda-Son	Max	*Coda-Obs
a.☞ [kas.tijo]			*
b. [ka.tijo]		*!	
c. [ka.sijo]		*!	

/xente/ *gente*	*Coda-Son	Max	*N-Ons	*Coda-Obs
a. [xen.te]	*!			
b. ☞ [xe.te]		*		*
c. [xe.ne]		*	*!	

With this modification in mind, we converge upon the final ranking for SD2, as shown in (28).

(28) Final ranking for SD2's grammar

*Coda-sonorant   *Complex

Max

|

Ident-Voice   *L-Ons

*Voice

|

*N-Ons

|

*F-Ons

|

*Coda-Obstruent

We now turn to the third child, Fabiola, to consider how her grammar differs from that of the previous two children.

4. Fabiola.

Fabiola presents with yet another interesting grammar. First we consider the tautosyllabic clusters, which reduce according to the sonority pattern, as shown in (29). This motivates the ranking in (30) which also was the ranking that accounted for SD2's reduction of tautosyllabic clusters.

(29) Fabiola's production of tautosyllabic clusters

Target	Production	Gloss
frijoles	[fihole]	'beans'
flor	[fol]	'flower'
sombrero	[somelo]	'hat'

(30) *Complex >> Max >> *L-Ons >> … >> *F-Ons

/floɾ/ *flor*	*Comp	Max	*L-Ons	*F-Ons
a. [flo…]	*!		*	*
b. ☞ [fo…]		*		*
c. [lo…]		*	*!	

Regarding heterosyllabic clusters, however, Fabiola's reductions show another example of a deviation from the sonority pattern. Moreover, her grammar does allow some heterosyllabic clusters to occur. Starting with the data in (31) we see that the sonorant + voiced obstruent clusters are reduced to a singleton, and in this case it is the most sonorous segment that is preserved, just as we observed with SD2. One might posit the same ranking as for SD2 to account for the pattern, as shown in (32).

(31) Fabiola's production of sonorant + voiced obstruent clusters

Target	**Production**	**Gloss**
sombrero	[somelo]	'hat'
jugando	[hugano]	'playing'
falda	[fala]	'skirt'
sandía	[sænijə]	'watermelon'

(32) *Coda >> Max >> *Voice >> *N-Ons?

/sandia/ *sandía*	*Coda	Max	*Voice	*N-Ons
a. [sæn.dijə]	*!		*	
b. [sæ.dijə]		*	*!	
c. ☞ [sæ.nijə]		*		*

However, this does not account for all the data, because she actually produces sonorant + *voiceless* obstruent clusters intact, as shown in (33). Once again, we see effects of voicing playing a role, but the outcome is a little different in this case, as compared to SD2.

(33) Fabiola's sonorant + voiceless obstruent heterosyllabic clusters

Target	**Production**	**Gloss**
campanas	[kampana]	'bells'
cincho	[tʃintʃo]	'belt'
bolsa	[bolsa]	'purse'

In other words, to account for the data in (31), it was necessary to assume that *Coda outranked Max. Yet, to account for the data in (33), the reverse ranking would seem necessary. This appears to be a ranking paradox with respect to *Coda and Max, given the asymmetries in reduction, as shown in the tableau in (34).

(34) A ranking paradox for *Coda and Max?

/bolsa/ *bolsa*	Max	*Coda	*L-Ons
a. ☞ [bol.sa]		*	
b. [bo.sa]	*!		
c. [bo.la]	*!		*

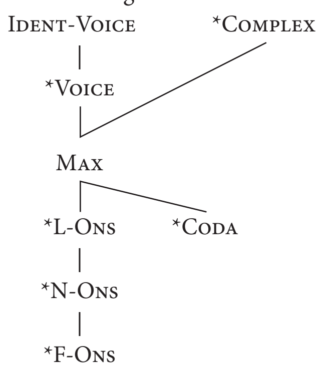
In fact, an appeal to the same segmental constraints related to voicing is appropriate here as well. This time, we rank *Voice above Max (again assuming Ident-Voice is ranked higher), as shown in the tableau in (35). This ranking allows for reduction of the sonorant + *voiced* obstruent clusters, but not the sonorant + *voiceless* obstruent clusters.

(35) *Voice >> Max >> *Coda

/sandia/ *sandía*	*Voice	Max	*Coda
a. [sæn.dijə]	*!		*
b. ☞ [sæ.nijə]		*	

The independent rankings converge on the final ranking in (36) for Fabiola's grammar, with tableaux shown for the words *sombrero* 'hat' and *campanas* 'bells' in (37) (only relevant constraints are shown for *campanas*; the omission of the final consonant is ignored for clarity).

(36) Final ranking for Fabiola



(37) Illustrative tableaux for Fabiola's grammar

/sombɾeɾo/ *sombrero*	Id-Voi	*Comp	*Voi	Max	*Coda	*L-Ons	*N-Ons
a. […m.bɾ…]		*!	*		*	*	
b. […bɾ…]		*!	*	*		*	
c. […m.b…]			*!	*	*		
d. […b…]			*!	**			
e. ☞ […m…]				**			*
f. […ɾ…]				**		*!	
g. […p…]	*!			**			

/kampanas/ *campanas*	Max	*Coda	*N-Ons
a. ☞ [kam.pana]		*	
b. [ka.pana]	*!		
c. [ka.mana]	*!		*

This also accounts for Fabiola's obstruent + obstruent /s/C clusters, of which both segments are generally preserved, as shown in the data in (38). (The same is assumed for sonorant + sonorant sequences, but data are lacking.) The tableau that follows in (39) illustrates the ranking.[4]

(38) Fabiola's production of obstruent + obstruent clusters

Target	**Production**	**Gloss**
vestido	[bɛstiðo]	'dress'
pastel	[pastɛl]	'cake'
viste	[biste]	'[he] dresses'
está	[ɛsta]	'[he] is'
pescado	[pɛskaðo]	'fish'

(39) Preservation of obstruent + obstruent clusters

/esta/ *está*	Max	*Coda	*F-Ons
a. ☞ [ɛs.ta]		*	
b. [ɛ.ta]	*!		
c. [ɛ.sa]	*!		*

Fabiola's grammar allows for heterosyllabic clusters; thus, Max outranks *Coda. However, conflicting segmental markedness and faithfulness constraints select simplified forms in some specific cases. The sonority pattern that was so prevalent in SD1's and SD2's productions is not evident in Fabiola's heterosyllabic cluster reduction patterns, but recall it is evident in her tautosyllabic cluster reduction patterns. Additionally, both Fabiola and SD2 produced /s/ clusters, and the constraint ranking posited to account for other heterosyllabic clusters in Fabiola's grammar also accounted for the /s/ clusters. Recall that this was not the case for SD2; accounting for his production of /s/ clusters necessitated the explosion of the *Coda constraint.

Next we consider the fourth child who shows yet another interesting cluster pattern.

4. In order to preserve singleton onsets, it is assumed that Ident-Manner and Onset rank high in Fabiola's grammar. In addition, to preserve onsetless syllables (where appropriate), it is assumed that Dep is ranked high above Onset.

5. Joaquín

Turning now to Joaquín's data, once again an asymmetry in cluster production is apparent. Similar to the case of Fabiola, reduction of both tauto- and heterosyllabic clusters occurs, while certain heterosyllabic clusters are also preserved.

As with SD2 and Fabiola, tautosyllabic clusters are reduced to the least sonorous segment, shown in (40). The same ranking accounts for that pattern, as shown in (41).

(40) Joaquín's production of tautosyllabic clusters

Target	**Production**	**Gloss**	**Target**	**Production**	**Gloss**
brillar	[bija]	'to shine'	*trapo*	[papo]	'rag'
tren	[tan]	'train'	*crema*	[kəma]	'cream'
cuatro	[kato]	'four'	*frío*	[pijo]	'cold'

(41) *Complex >> Max >> *L-Ons >> *F-Ons

/bɾijaɾ/ *brillar*	*Complex	Max	*L-Ons
a. [bɾija]	*!		*
b. ☞ [bija]		*	
c. [ɾija]		*	*!

In (42), the data show that most heterosyllabic clusters reduced to singletons. This looks like another example of the ranking of *Coda above Max, as in (43).

(42) Joaquín's production of most heterosyllabic clusters

Target	**Production**	**Gloss**	**Target**	**Production**	**Gloss**
puerta	[bota]	'door'	*harto*	[ato]	'enough'
Arturito	[atulito]	(Name)	*dulce*	[lute]	'candy'
volqueta	[boketa]	'dump truck'	*soltó*	[toto]	'let go'

(43) *Coda >> Max >> *L-Ons?

/solto/ *soltó*	*Coda	Max	*L-Ons
a. [tol.to]	*!		
b. ☞ [to.to]		*	
c. [to.lo]		*	*!

However, other heterosyllabic clusters are allowed, as shown in the data in (44): Nasal + obstruent clusters surface, regardless of voicing on the obstruent.

(44) Joaquín's productions of nasal + obstruent clusters

Target	**Production**	**Gloss**	**Target**	**Production**	**Gloss**
campana	[kampano]	'bell'	*lámpara*	[pampala]	'lamp'
limpio	[limpo]	'[he] cleans'	*ventana*	[pantana]	'window'
timbra	[pimba]	'stamp, ring'	*lavando*	[labando]	'washing'
tengo	[kaŋgo]	'[I] have'	*gancho*	[kanta]	'hanger'

Thus, to account for the forms in (42), it appears that a ranking of *Coda over Max is necessary; however, to account for the clusters in (44), it appears that Max must outrank *Coda. This suggests, once again, a ranking paradox, as the tableau in (45) illustrates. (Compare with (43).).

(45) A ranking paradox for *Coda and Max?

/kampana/ *campana*	*Coda	Max
a. (☞) [kam.pano]	*!	
b. 👎 [ka.pano]		*

Actually, the asymmetry seems to relate specifically to whether a nasal segment is in the cluster or not, and so it requires an appeal to a faithfulness constraint requiring the preservation of nasal segments, defined as a Max-[Feature] constraint in (46). This constraint functions differently from Ident constraints in that it requires the *segment* that corresponds to the feature to surface in output forms, not just the feature. (An Ident constraint requires that segments in correspondence share the same feature specification; if a segment is deleted, no Ident violation is incurred.)

(46) Max-Nasal: An input nasal feature must have an output correspondent (Archangeli et al. 1998)

This constraint in particular has been motivated for accounts of nasal clusters in fully-developed languages, and is clearly relevant here. In fact, the nasals appear to be important in Joaquín's grammar in other domains, given that nasal assimilation occurs in many of his productions (such as *lima* 'lime' produced as [mima], or *gallina* 'hen' produced as [ənina]).

By ranking Max-Nasal above *Coda, and then ranking *Coda above Max, the asymmetry in the child's productions is accounted for, as shown in the partial ranking in (47).

(47) Max-Nasal >> *Coda >> Max

/kampana/ *campana*	Max-Nas	*Coda	Max
a. ☞ [kam.pano]		*	
b. [ka.pano]	*!		*
/solto/ *soltó*	Max-Nas	*Coda	Max
a. [sol.to]		*!	
b. ☞ [so.to]			*

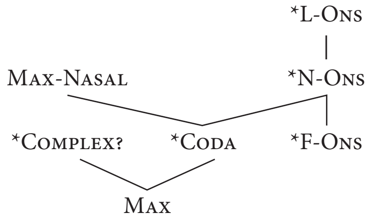
Further considering the ranking, it is clear that *N-Ons also must outrank *Coda, in order to correctly allow for the preservation of nasal clusters, as shown in (48).

(48) Ranking of sonority constraints and *Coda

/kampana/ *campana*	*N-Ons	*Coda
a. ☞ [kam.pano]		*
b. [ka.mano]	*!	

Ranking *N-Ons above *Coda means that *L-Ons must also rank above *Coda, given the universal ranking of the sonority constraints. The full constraint ranking is shown in (49), with representative tableaux shown for the words *timbra* 'stamp, ring', *campana* 'bell', and *harto* 'enough' in (50). (For *campana* and *harto*, only relevant constraints are shown.)[5]

(49) Final ranking for Joaquín's grammar



(50) Illustrative tableaux for Joaquín's grammar

/timbɾa/ *timbra*	*L-Ons	*N-Ons	Max-Nas	*Coda	*Comp	Max
a. [tim.bɾa]	*!			*	*	
b. [ti.bɾa]	*!		*		*	*
c. ☞ [tim.ba]				*		*
d. [ti.ba]			*!			**
e. [ti.ma]		*!				**

/kampana/ *campana*	*N-Ons	Max-Nas	*Coda	Max
a. ☞ [kam.pano]			*	
b. [ka.mano]	*!			*
c. [ka.pano]		*!		*

/aɾto/ *harto*	*L-Ons	*Coda	Max
a. [aɾ.to]		*!	
b. ☞ [a.to]			*
c. [a.ɾo]	*!		*

This ranking also accounts for sonorant + sonorant and obstruent + obstruent sequences, which show the emergent sonority pattern, as illustrated in (51). In the case of *carne* 'meat,' both cluster segments have relatively high sonority. The grammar chooses the less sonorous nasal over the more sonorous liquid, yielding [kane]. Similarly, in the case of *cáscara* 'shell,' the less sonorous of the two obstruents, the stop, is chosen, yielding [kakala].

5. As with Fabiola's case, in order to preserve singleton onsets, it is assumed that Ident-Manner and Onset rank high in Joaquín's grammar. Similarly, to preserve onsetless syllables (where appropriate), it is assumed that Dep outranks Onset.

(51) Emergent sonority pattern

/kaɾne/ *carne*	*L-Ons	*N-Ons	Max-Nas	*Coda	Max
a. [kaɾ.ne]		*		*!	
b.☞ [ka.ne]		*			*
c. [ka.ɾe]	*!		*		*

/kaskaɾa/ *cáscara*	*F-Ons	*Coda	Max
a. [kas.kala]		*!	
b. ☞ [ka.kala]			*
c. [ka.sala]	*!		*

It should be noted that, with the sonority constraints (or at least *L-Ons) ranked higher than Max, this account actually predicts that tautosyllabic clusters will be reduced regardless of the ranking of *Complex, and this is evident in the tableau in (52). Thus, it is not clear how *Complex fits in the ranking, as higher ranked constraints do its job.

(52) Reduction of tautosyllabic clusters

/kɾema/ *crema*	*L-Ons	Max
a. [kɾəma]	*!	
b. ☞ [kəma]		*

This is a scenario that is in some sense opposite to that of Fabiola. Joaquín's grammar shows a general dispreference for heterosyllabic clusters, by ranking *Coda above Max and the sonority constraints, which gives us the sonority pattern; however, because of conflicting segmental constraints, clusters are sometimes preserved. Recall Fabiola also had some clusters occurring in her grammar, but it was assumed that this occurred because of the ranking of Max over *Coda.

Before summarizing the findings of the four children, there are two additional patterns worth noting regarding Joaquín's production patterns. First, it is apparent from the data in (53) that a pattern of stopping is affecting his productions of fricatives, and this likewise affected cluster production patterns, yielding stop onsets for target fricative + liquid clusters.

(53) Stopping in Joaquín's grammar

Target	**Production**	**Gloss**	**Target**	**Production**	**Gloss**
pesado	[patao]	'heavy'	*sala*	[tala]	'room'
dulce	[lute]	'candy'	*fósforo*	[populo]	'match'
florecita	[pulatita]	'flower (dim.)'	*frío*	[pijo]	'cold'

It is therefore assumed that a constraint against fricatives, *Fricative (Barlow 1997), is outranking an Ident-Manner constraint, thus yielding the stopped forms, even in cluster contexts (e.g., *florecita*, *dulce*). Similar such *Fricative effects are observed in English-speaking children's productions, as reported in Pater and Barlow (2003).

There is also some evidence of labial faithfulness in Joaquín's sound system. Consider that target *fósforo* 'match' in (53) has a sequence of two fricatives, with presumably equal sonority. This form reduces to the labial, rather than the coronal. While this is the only observed form that includes two segments of equal sonority, it may be that the Max-[Feature] constraint Max-Labial (Barlow 1997; Pater and Barlow 2003) is showing an effect in Joaquín's grammar, much like Max-Nasal. The two constraints together, *Fricative and Max-Labial, select a labial stop [p] as optimal for *fósforo*, as illustrated in (54).

(54) Effects of Max-Labial?

/fosfoɾo/ *fósforo*	*Fricative	Max-Labial
a. […f…]	*!	
b. […s…]	*!	*
c. ☞ […p…]		
d. […t…]		*!

In fact, there is independent evidence of labial faithfulness in Joaquín's grammar, given that regressive labial assimilation occurs on many forms, as shown in (55). Nevertheless, the claims about the effects of Max-Labial in Joaquín's cluster reduction patterns are tentative, given that we have only one form to work with.

(55) Labial faithfulness in Joaquín's grammar

Target	**Production**	**Gloss**
lástima	[lapima]	'pity'
tapa	[papa]	'lid'
trapo	[papo]	'rag'
lámpara	[pampala]	'lamp'

6. Discussion

To summarize the four accounts, each child's grammar showed a unique production pattern for tauto- and heterosyllabic clusters. Despite these differences, they also showed a general preference for unmarkedness by simplifying the syllable structure and preserving least marked onsets. The differences in production patterns within children's grammars were attributed to the ranking of the syllable markedness constraints over faithfulness constraints (e.g., Barlow 1997; Gnanadesikan 2004; Ohala 1996; Smolensky 1996) and also to conflicting segmental constraints.

Differences within and across grammars were also accounted for, and resulted in typological variation with respect to constraint rankings. One type of variation we saw pertained to *Coda and *Complex with respect to Max. Ranking *Coda and *Complex over Max generally prevented clusters from occurring, while the opposite ranking generally allowed them to occur. But even with *Coda over Max, heterosyllabic clusters could emerge due to conflicting segmental faithfulness constraints, as with the case of Joaquín. Similarly, even when Max outranked *Coda, that still did not prevent certain clusters from being reduced, as with Fabiola's grammar.

The *Voice constraint played a part in this typological variation. The grammars of two of the children, SD2 and Fabiola, showed asymmetries with respect to clusters with voiced versus voiceless obstruents, but the asymmetries presented themselves in different ways. Ranking *Coda above *Voice for SD2 accounted for the asymmetry in the *type of reduction* that occurred for heterosyllabic clusters (i.e., reduction to the least or most sonorous segment). However, for Fabiola, ranking *Voice above Max, in combination with effects of the sonority constraints, resulted in an asymmetry in the *type of cluster that was allowed* to occur (i.e., whether or not sonorant + obstruent clusters were reduced). Of course, SD1 and Joaquín showed no such asymmetry in their cluster productions, which suggests that *Voice was lower ranked in their grammars. Thus, we have observed a typology with respect to *Voice and the sonority constraints, shown in Table 1 (Barlow 2003a).

Table 1. Factorial typology of *Voice and sonority constraints

	/lt/	/ld/	/nt/	/nd/	
a. *Voi >> *L-Ons >> *N-Ons	t	l	t	n	Fabiola
b. *L-Ons >> *Voi >> *N-Ons	t	d	t	n	SD2
c. *L-Ons >> *N-Ons >> *Voi	t	d	t	d	SD1, Joaquín

There is additional evidence for ranking (a) in the productions of Amahl, an English-speaking child discussed by Smith (1973). Further, there is support for ranking (b) as reported for Si, a Spanish-speaking child discussed in Macken (1979). Finally, ranking (c) is the more widely observed sonority pattern, observed for many English-speaking children (Ohala 1998).

Typological variation is also predicted to occur with respect to Max-Nasal and the sonority constraints, and this is shown in Table 2. Joaquín's grammar represents ranking (c). It is assumed that Max-Nasal is lower-ranked in the other three children's grammars, which corresponds to ranking (d). The other two grammars are yet to be attested, but may be identified with further study of phonological acquisition of clusters in Spanish.[6]

Table 2. Factorial typology of Max-Nasal and sonority constraints

	/nt/	/nd/	/ns/	/ɾn/	
a. Max-Nas >> *L-Ons >> *N-Ons >> *F-Ons	n	n	n	n	unattested
b. *L-Ons >> Max-Nas >> *N-Ons >> *F-Ons	n	n	n	n	unattested
c. *L-Ons >> *N-Ons >> Max-Nas>> *F-Ons	t	d	n	n	Joaquín
d. *L-Ons >> *N-Ons >> *F-Ons >> Max-Nas	t	d	s	n	SD1, SD2, Fabiola

Let us consider the nasal clusters in more detail, as they seem to pattern differently in some grammars. There seems to be a great deal of evidence to suggest that nasal clus-

6. Other typological predictions may also be made with respect to the constraints *Fricative and Max-Labial, as well as other markedness constraints, such as *Dorsal, as discussed in Pater and Barlow (2003).

ters hold special status in fully-developed systems. When we first looked at Joaquín's grammar, it seemed as though they held special status in his grammar as well. Those were the only types of clusters that were allowed to occur by his grammar. However, in accounting for this asymmetry, there was no need to refer to any special constraint related to nasal clusters per se, but rather an independently-motivated constraint related to nasal segments was appealed to.

There seems to be some evidence of a cross-linguistic avoidance of nasal + voiceless obstruent clusters, as compared to their voiced counterparts, and this has motivated an appeal to a specific constraint against them (e.g., *NC̥; Pater 1999). SD2 showed differential patterning of voiced versus voiceless obstruent sequences, but these differences were borne out naturally from a set of voice-related segmental constraints that are motivated for a variety of phenomena cross-linguistically.

Furthermore, Fabiola's productions contradicted this cross-linguistic tendency, since nasal + voiceless obstruent clusters occurred (along with other sonorant + voiceless obstruent clusters) to the exclusion of their voiced counterparts. Again, the same set of constraints that accounted for SD2's cluster patterns were also able to account for Fabiola's, despite the differing patterns. Thus, as far as the children here are concerned, there appears to be no need to refer to NC clusters generally (or the voiceless ones in particular) to account for asymmetrical patterning of these types of clusters. Of course, further study of these cluster types versus others, based on evidence from developing and fully-developed sound systems, is needed to further establish this claim.

It is important to briefly consider the status of /s/ clusters in future research, as they posed a challenge in accounting for one of the grammars here. The accounts of medial clusters could correctly account for the patterning of the /s/C clusters for three of the four children, without modification to the core markedness and faithfulness constraints. For SD2, who showed reduction of all clusters except /s/ clusters, it was necessary to adopt an exploded version of *Coda, ranking *Coda-Sonorant *above* Max and *Coda-Obstruent *below* Max and the sonority constraints. Alternatively, it may be the case that /s/C clusters in Spanish (or at least SD2's grammar) are structurally different from other medial clusters, perhaps as extrasyllabic (see Barlow 2001). They are exceptional in many ways for many languages, including Spanish, and there is much evidence in the acquisition literature for variation in the way that these clusters develop over time as compared to other clusters.

Future research that evaluates acquisition patterns of children who are better matched, in terms of speech sample size and dialect background in particular, is necessary in order to further evaluate and expand upon the cluster production typology as it is presented here. And, as always, there are additional issues which are left to future research, such as alternative accounts to cluster reduction patterns (e.g., Goad and Rose 2004),[7] as well as the status of final consonants and consonant clusters (but see,

7. As an anonymous reviewer notes, a head pattern account (Goad and Rose 2004) could account for some of the patterns in the children's productions. Since the head pattern account is problematic for some of the children's productions, and has also been shown to be problematic for patterns in acquisition of English (Pater and Barlow 2003), it was not entertained in the present study.

e.g., Goad and Brannon 2003; Ingram 1989; Kirk and Demuth 2003; Lleó and Prinz 1996; Ohala 1996, 1999).

Acknowledgments

Different versions of this paper were presented at SWOT 8 and BUCLD 28. Related work, which includes more detailed analysis of SD1 and SD2, may be found in Barlow (2003a, b; 2005). This research was supported in part by a grant from the NIH to San Diego State University (NIDCD 05754) and a grant-in-aid from San Diego State University. Carolina García, Tim Tipton, Laura Sendek, and Claudia Horita helped with data collection, transcription, and analysis. Thanks also to Eric Baković, Heather Goad, Irene Moyna, David Perlmutter, Sharon Rose, Yvan Rose, and two anonymous reviewers for helpful comments on aspects of this and/or related work.

References

Archangeli, D., Moll, L. and Ohno, K. 1998. Why not *NC̥. *Chicago Linguistic Society* 34: 1–26.

Barlow, J.A. 1997. A Constraint-Based Account of Syllable Onsets: Evidence from Developing Systems. PhD dissertation, Indiana University, Bloomington.

Barlow, J.A. 2001. The structure of /s/-sequences: Evidence from a disordered system. *Journal of Child Language* 28: 291–324.

Barlow, J.A. 2003a. Asymmetries in the acquisition of consonant clusters in Spanish. *Canadian Journal of Linguistics* 48: 179–210.

Barlow, J.A. 2003b. The stop-spirant alternation in Spanish: Converging evidence for a fortition account. *Southwest Journal of Linguistics* 22: 51–86.

Barlow, J.A. 2005. Phonological change and the representation of consonant clusters in Spanish: A case study. *Clinical Linguistics and Phonetics* 19: 659–679.

Blevins, J. 1995. The syllable in phonological theory. In *The Handbook of Phonological Theory*, J.A. Goldsmith (ed.), 206–244. Oxford: Blackwell.

Chervela, N. 1981. Medial consonant cluster acquisition by Telugu children. *Journal of Child Language* 8: 63–73.

Chin, S. B. 1996. The role of the sonority hierarchy in delayed phonological systems. In *Pathologies of Speech and Language: Contributions of Clinical Phonetics and Linguistics*, T.W. Powell (ed.), 109–117. New Orleans LA: International Clinical Phonetics and Linguistics Association.

Craig, H.K., Thompson, C.A., Washington, J.A. and Potter, S.L. 2003. Phonological features of child African American English. *Journal of Speech, Language, and Hearing Research* 46: 623–635.

Eblen, R. 1982. A study of the acquisition of fricatives by three-year-old children learning Mexican Spanish. *Language and Speech* 25: 201–220.

Fikkert, P. 1998. The acquisition of Dutch phonology. In *The Acquisition of Dutch*, S. Gillis and A. De Houwer (eds), 163–222. Amsterdam: John Benjamins.

Gnanadesikan, A.E. 2004. Markedness and faithfulness constraints in child phonology. In *Constraints in Phonological Acquisition*, R. Kager, J. Pater and W. Zonneveld (eds), 73–108. Cambridge: CUP.

Goad, H. and Brannen, K. 2003. Phonetic evidence for phonological structure in syllabification. In *The Phonological Spectrum*, Vol. II: *Suprasegmental Structure*, J. van de Weijer, V. van Heuven and H. van der Hulst (eds), 3–30. Amsterdam: John Benjamins.

Goad, H. and Rose, Y. 2004. Input elaboration, head faithfulness, and evidence for representation in the acquisition of left-edge clusters in West Germanic. In *Constraints in Phonological Acquisition*, R. Kager, J. Pater and W. Zonneveld (eds), 109–157. Cambridge: CUP.

Goldstein, B.A., and Cintrón, P. 2001. An investigation of phonological skills in Puerto Rican Spanish-speaking 2-year-olds. *Clinical Linguistics and Phonetics* 15: 343–361.

Goldstein, B.A. and Iglesias, A. 2001. The effect of dialect on phonological analysis: Evidence from Spanish-speaking children. *American Journal of Speech-Language Pathology* 10: 394–406.

Hernández-Chávez, E., Vogel, I. and Clumeck, H. 1975. Rules, constraints and the simplicity criterion: An analysis based on the acquisition of nasals in Chicano Spanish. In *Nasálfest: Papers from a Symposium on Nasals and Nasalization*, C. A. Ferguson, L.M. Hyman and J.J. Ohala (eds), 231–248. Stanford CA: Language Universals Project, Department of Linguistics, Stanford University.

Hammond, M. 1999. *English Phonology*, Oxford: OUP.

Hammond, R.M. 2001. *The Sounds of Spanish: Analysis and Application*. Somerville MA: Cascadilla.

Hyman, L.M. 2001. On the limits of phonetic determinism in phonology: *NC revisited. In *The Role of Speech Perception Phenomena in Phonology*, E. Hume and K. Johnson (eds), 141–185. New York NY: Academic Press.

Ingram, D. 1989a. *First Language Acquisition*. Cambridge: CUP.

Ingram, D. 1989b. *Phonological Disability in Children* (2nd ed.). London: Cole and Whurr.

Jongstra, W. 2003. Variation in Reduction Strategies of Dutch Word-Initial Consonant Clusters. PhD dissertation, University of Toronto.

Kirk, C. and Demuth, K. 2003. Coda/onset asymmetries in the acquisition of clusters. *Boston University Conference on Language Development* 27: 437–448.

Lamontagne, G. and Rice, K. 1995. A correspondence account of coalescence. In *Papers in Optimality Theory* [University of Massachusetts Occasional Papers 18], J.N. Beckman, L.W. Dickey and S. Urbanczyk (eds), 211–224. Amherst MA: Graduate Linguistic Student Association, University of Massachusetts.

Lleó, C. and Prinz, M. 1996. Consonant clusters in child phonology and the directionality of syllable structure assignment. *Journal of Child Language* 23: 31–56.

Lombardi, L. 1991. Laryngeal Features and Laryngeal Neutralization. PhD dissertation, University of Massachusetts, Amherst.

Lombardi, L. 1999. Positional faithfulness and voicing assimilation in optimality theory. *Natural Language and Linguistic Theory* 17: 267–302.

Macken, M.A. 1979. Developmental reorganization of phonology: A hierarchy of basic units of acquisition. *Lingua* 49: 11–49.

McCarthy, J.J. and Prince, A.S. 1995. Faithfulness and reduplicative identity. In *Papers in Optimality Theory* [University of Massachusetts Occasional Papers 18], J.N. Beckman, L.W. Dickey and S. Urbanczyk (eds), 249–384. Amherst MA: Graduate Linguistic Student Association, University of Massachusetts.

McCarthy, J.J. and Prince, A.S. 1999. Faithfulness and identity in prosodic morphology. In *The Prosody-Morphology Interface*, R. Kager, H. van der Hulst and W. Zonneveld (eds), 218–309. Cambridge: CUP.

McLeod, S., van Doorn, J. and Reed, V. A. 2001. Consonant cluster development in two-year-olds: General trends and individual differences. *Journal of Speech, Language, and Hearing Research* 44: 1144–1171.

Montes Giraldo, J.J. 1971. Apropiación por el niño del sistema fonológico español. *Thesaurus* 26: 322–346.

Ohala, D. K. 1996. Cluster Reduction and Constraints in Acquisition. PhD dissertation, University of Arizona.

Ohala, D. K. 1998. Medial cluster reduction in early child speech. In *Proceedings from the Annual Child Language Research Forum*, E.V. Clark (ed.), 111–120. Stanford CA: Center Study for the Language and Information.

Ohala, D.K. 1999. The influence of sonority on children's cluster reductions. *Journal of Communication Disorders* 32: 397–422.

Pater, J. 1999. Austronesian nasal substitution and other NC̥ effects. In *The Prosody Morphology Interface*, H. van der Hulst, R. Kager and W. Zonneveld (eds), 310–343. Cambridge: CUP.

Pater, J. and Barlow, J. A. 2003. Constraint conflict in cluster reduction. *Journal of Child Language* 30: 487–526.

Prince, A. and Smolensky, P. 1993. *Optimality Theory: Constraint Interaction in Generative Grammar*. New Brunswick NJ: Rutgers Center for Cognitive Science, Rutgers University. (2002 version available: http://roa.rutgers.edu/view.php3?id=698).

Rūķe-Draviņa, V. 1990. The acquisition process of consonantal clusters in the child: Some universal rules? *Nordic Journal of Linguistics* 13: 153–163.

Selkirk, E. 1984. On the major class features and syllable theory. In *Language Sound Structure: Studies in Phonology Presented to Morris Halle by his Teacher and Students*, M. Aronoff and R.T. Oehrle (eds), 107–136. Cambridge MA: The MIT Press.

Smit, A.B. 1993. Phonologic error distributions in the Iowa-Nebraska Articulation Norms Project: Word-initial consonant clusters. *Journal of Speech and Hearing Research* 36: 931–947.

Smith, N.V. 1973. *The Acquisition of Phonology: A Case Study*. Cambridge: CUP.

Smolensky, P. 1996. On the comprehension/production dilemma in child language. *Linguistic Inquiry* 27: 720–731.

Zec, D. 1995. Sonority constraints on syllable structure. *Phonology* 12: 85–129.

Subject index

Index of constraints

Linguistik Aktuell/Linguistics Today

A complete list of titles in this series can be found on the publishers' website, *www.benjamins.com*

107 **CORVER, Norbert and Jairo NUNES (eds.):** The Copy Theory of Movement. *Expected August 2007*

106 **DEHÉ, Nicole and Yordanka KAVALOVA (eds.):** Parentheticals. *Expected August 2007*

105 **HAUMANN, Dagmar:** Adverb Licensing and Clause Structure in English. 2007. ix, 435 pp.

104 **JEONG, Youngmi:** Applicatives. Structure and interpretation from a minimalist perspective. 2007. viii, 140 pp.

103 **WURFF, Wim van der (ed.):** Imperative Clauses in Generative Grammar. Studies in honour of Frits Beukema. viii, 339 pp. + index. *Expected May 2007*

102 **BAYER, Josef, Tanmoy BHATTACHARYA and M.T. Hany BABU (eds.):** Linguistic Theory and South Asian Languages. Essays in honour of K. A. Jayaseelan. x, 282 pp. + index. *Expected May 2007*

101 **KARIMI, Simin, Vida SAMIIAN and Wendy K. WILKINS (eds.):** Phrasal and Clausal Architecture. Syntactic derivation and interpretation. In honor of Joseph E. Emonds. 2007. vi, 424 pp.

100 **SCHWABE, Kerstin and Susanne WINKLER (eds.):** On Information Structure, Meaning and Form. Generalizations across languages. ix, 566 pp. *Expected March 2007*

99 **MARTÍNEZ-GIL, Fernando and Sonia COLINA (eds.):** Optimality-Theoretic Studies in Spanish Phonology. 2007. viii, 560 pp.

98 **PIRES, Acrisio:** The Minimalist Syntax of Defective Domains. Gerunds and infinitives. 2006. xiv, 188 pp.

97 **HARTMANN, Jutta M. and László MOLNÁRFI (eds.):** Comparative Studies in Germanic Syntax. From Afrikaans to Zurich German. 2006. vi, 332 pp.

96 **LYNGFELT, Benjamin and Torgrim SOLSTAD (eds.):** Demoting the Agent. Passive, middle and other voice phenomena. 2006. x, 333 pp.

95 **VOGELEER, Svetlana and Liliane TASMOWSKI (eds.):** Non-definiteness and Plurality. 2006. vi, 358 pp.

94 **ARCHE, María J.:** Individuals in Time. Tense, aspect and the individual/stage distinction. 2006. xiv, 281 pp.

93 **PROGOVAC, Ljiljana, Kate PAESANI, Eugenia CASIELLES and Ellen BARTON (eds.):** The Syntax of Nonsententials. Multidisciplinary perspectives. 2006. x, 372 pp.

92 **BOECKX, Cedric (ed.):** Agreement Systems. 2006. ix, 346 pp.

91 **BOECKX, Cedric (ed.):** Minimalist Essays. 2006. xvi, 399 pp.

90 **DALMI, Gréte:** The Role of Agreement in Non-Finite Predication. 2005. xvi, 222 pp.

89 **VELDE, John R. te:** Deriving Coordinate Symmetries. A phase-based approach integrating Select, Merge, Copy and Match. 2006. x, 385 pp.

88 **MOHR, Sabine:** Clausal Architecture and Subject Positions. Impersonal constructions in the Germanic languages. 2005. viii, 207 pp.

87 **JULIEN, Marit:** Nominal Phrases from a Scandinavian Perspective. 2005. xvi, 348 pp.

86 **COSTA, João and Maria Cristina FIGUEIREDO SILVA (eds.):** Studies on Agreement. 2006. vi, 285 pp.

85 **MIKKELSEN, Line:** Copular Clauses. Specification, predication and equation. 2005. viii, 210 pp.

84 **PAFEL, Jürgen:** Quantifier Scope in German. 2006. xvi, 312 pp.

83 **SCHWEIKERT, Walter:** The Order of Prepositional Phrases in the Structure of the Clause. 2005. xii, 338 pp.

82 **QUINN, Heidi:** The Distribution of Pronoun Case Forms in English. 2005. xii, 409 pp.

81 **FUSS, Eric:** The Rise of Agreement. A formal approach to the syntax and grammaticalization of verbal inflection. 2005. xii, 336 pp.

80 **BURKHARDT, Petra:** The Syntax–Discourse Interface. Representing and interpreting dependency. 2005. xii, 259 pp.

79 **SCHMID, Tanja:** Infinitival Syntax. Infinitivus Pro Participio as a repair strategy. 2005. xiv, 251 pp.

78 **DIKKEN, Marcel den and Christina M. TORTORA (eds.):** The Function of Function Words and Functional Categories. 2005. vii, 292 pp.

77 **ÖZTÜRK, Balkız:** Case, Referentiality and Phrase Structure. 2005. x, 268 pp.

76 **STAVROU, Melita and Arhonto TERZI (eds.):** Advances in Greek Generative Syntax. In honor of Dimitra Theophanopoulou-Kontou. 2005. viii, 366 pp.

75 **DI SCIULLO, Anna Maria (ed.):** UG and External Systems. Language, brain and computation. 2005. xviii, 398 pp.

74 **HEGGIE, Lorie and Francisco ORDÓÑEZ (eds.):** Clitic and Affix Combinations. Theoretical perspectives. 2005. viii, 390 pp.

73 **CARNIE, Andrew, Heidi HARLEY and Sheila Ann DOOLEY (eds.):** Verb First. On the syntax of verb-initial languages. 2005. xiv, 434 pp.

72 **FUSS, Eric and Carola TRIPS (eds.):** Diachronic Clues to Synchronic Grammar. 2004. viii, 228 pp.

71 **GELDEREN, Elly van:** Grammaticalization as Economy. 2004. xvi, 320 pp.

70 **AUSTIN, Jennifer R., Stefan ENGELBERG and Gisa RAUH (eds.):** Adverbials. The interplay between meaning, context, and syntactic structure. 2004. x, 346 pp.

69 **KISS, Katalin É. and Henk van RIEMSDIJK (eds.):** Verb Clusters. A study of Hungarian, German and Dutch. 2004. vi, 514 pp.

68 **BREUL, Carsten:** Focus Structure in Generative Grammar. An integrated syntactic, semantic and intonational approach. 2004. x, 432 pp.

67 **MIŠESKA TOMIĆ, Olga (ed.):** Balkan Syntax and Semantics. 2004. xvi, 499 pp.

66 **GROHMANN, Kleanthes K.:** Prolific Domains. On the Anti-Locality of movement dependencies. 2003. xvi, 372 pp.

65 **MANNINEN, Satu Helena:** Small Phrase Layers. A study of Finnish Manner Adverbials. 2003. xii, 275 pp.

64 **BOECKX, Cedric and Kleanthes K. GROHMANN (eds.):** Multiple *Wh*-Fronting. 2003. x, 292 pp.

63 **BOECKX, Cedric:** Islands and Chains. Resumption as stranding. 2003. xii, 224 pp.

62 **CARNIE, Andrew, Heidi HARLEY and MaryAnn WILLIE (eds.):** Formal Approaches to Function in Grammar. In honor of Eloise Jelinek. 2003. xii, 378 pp.

61 **SCHWABE, Kerstin and Susanne WINKLER (eds.):** The Interfaces. Deriving and interpreting omitted structures. 2003. vi, 403 pp.

60 **TRIPS, Carola:** From OV to VO in Early Middle English. 2002. xiv, 359 pp.

59 **DEHÉ, Nicole:** Particle Verbs in English. Syntax, information structure and intonation. 2002. xii, 305 pp.

58 **DI SCIULLO, Anna Maria (ed.):** Asymmetry in Grammar. Volume 2: Morphology, phonology, acquisition. 2003. vi, 309 pp.

57 **DI SCIULLO, Anna Maria (ed.):** Asymmetry in Grammar. Volume 1: Syntax and semantics. 2003. vi, 405 pp.

56 **COENE, Martine and Yves D'HULST (eds.):** From NP to DP. Volume 2: The expression of possession in noun phrases. 2003. x, 295 pp.

55 **COENE, Martine and Yves D'HULST (eds.):** From NP to DP. Volume 1: The syntax and semantics of noun phrases. 2003. vi, 362 pp.

54 **BAPTISTA, Marlyse:** The Syntax of Cape Verdean Creole. The Sotavento varieties. 2003. xxii, 294 pp. (incl. CD-rom).

53 **ZWART, C. Jan-Wouter and Werner ABRAHAM (eds.):** Studies in Comparative Germanic Syntax. Proceedings from the 15th Workshop on Comparative Germanic Syntax (Groningen, May 26–27, 2000). 2002. xiv, 407 pp.

52 **SIMON, Horst J. and Heike WIESE (eds.):** Pronouns – Grammar and Representation. 2002. xii, 294 pp.

51 **GERLACH, Birgit:** Clitics between Syntax and Lexicon. 2002. xii, 282 pp.

50 **STEINBACH, Markus:** Middle Voice. A comparative study in the syntax-semantics interface of German. 2002. xii, 340 pp.

49 **ALEXIADOU, Artemis (ed.):** Theoretical Approaches to Universals. 2002. viii, 319 pp.

48 **ALEXIADOU, Artemis, Elena ANAGNOSTOPOULOU, Sjef BARBIERS and Hans-Martin GÄRTNER (eds.):** Dimensions of Movement. From features to remnants. 2002. vi, 345 pp.

47 **BARBIERS, Sjef, Frits BEUKEMA and Wim van der WURFF (eds.):** Modality and its Interaction with the Verbal System. 2002. x, 290 pp.

46 **PANAGIOTIDIS, Phoevos:** Pronouns, Clitics and Empty Nouns. 'Pronominality' and licensing in syntax. 2002. x, 214 pp.

45 **ABRAHAM, Werner and C. Jan-Wouter ZWART (eds.):** Issues in Formal German(ic) Typology. 2002. xviii, 336 pp.

44 **TAYLAN, Eser Erguvanlı (ed.):** The Verb in Turkish. 2002. xviii, 267 pp.

43 **FEATHERSTON, Sam:** Empty Categories in Sentence Processing. 2001. xvi, 279 pp.

42 **ALEXIADOU, Artemis:** Functional Structure in Nominals. Nominalization and ergativity. 2001. x, 233 pp.

41 **ZELLER, Jochen:** Particle Verbs and Local Domains. 2001. xii, 325 pp.

40 **HOEKSEMA, Jack, Hotze RULLMANN, Víctor SÁNCHEZ-VALENCIA and Ton van der WOUDEN (eds.):** Perspectives on Negation and Polarity Items. 2001. xii, 368 pp.

39 **GELDEREN, Elly van:** A History of English Reflexive Pronouns. Person, *Self*, and Interpretability. 2000. xiv, 279 pp.

38 **MEINUNGER, André:** Syntactic Aspects of Topic and Comment. 2000. xii, 247 pp.

37 **LUTZ, Uli, Gereon MÜLLER and Arnim von STECHOW (eds.):** Wh-Scope Marking. 2000. vi, 483 pp.

36 **GERLACH, Birgit and Janet GRIJZENHOUT (eds.):** Clitics in Phonology, Morphology and Syntax. 2001. xii, 441 pp.

35 **HRÓARSDÓTTIR, Thorbjörg:** Word Order Change in Icelandic. From OV to VO. 2001. xiv, 385 pp.

34 **REULAND, Eric (ed.):** Arguments and Case. Explaining Burzio's Generalization. 2000. xii, 255 pp.

33 **PUSKÁS, Genoveva:** Word Order in Hungarian. The syntax of Ā-positions. 2000. xvi, 398 pp.

32 **ALEXIADOU, Artemis, Paul LAW, André MEINUNGER and Chris WILDER (eds.):** The Syntax of Relative Clauses. 2000. vi, 397 pp.

31 **SVENONIUS, Peter (ed.):** The Derivation of VO and OV. 2000. vi, 372 pp.

30 **BEUKEMA, Frits and Marcel den DIKKEN (eds.):** Clitic Phenomena in European Languages. 2000. x, 324 pp.

29 **MIYAMOTO, Tadao:** The Light Verb Construction in Japanese. The role of the verbal noun. 2000. xiv, 232 pp.

28 **HERMANS, Ben and Marc van OOSTENDORP (eds.):** The Derivational Residue in Phonological Optimality Theory. 2000. viii, 322 pp.

27 **RŮŽIČKA, Rudolf:** Control in Grammar and Pragmatics. A cross-linguistic study. 1999. x, 206 pp.

26 **ACKEMA, Peter:** Issues in Morphosyntax. 1999. viii, 310 pp.

25 **FELSER, Claudia:** Verbal Complement Clauses. A minimalist study of direct perception constructions. 1999. xiv, 278 pp.

24 **REBUSCHI, Georges and Laurice TULLER (eds.):** The Grammar of Focus. 1999. vi, 366 pp.

23 **GIANNAKIDOU, Anastasia:** Polarity Sensitivity as (Non)Veridical Dependency. 1998. xvi, 282 pp.

22 **ALEXIADOU, Artemis and Chris WILDER (eds.):** Possessors, Predicates and Movement in the Determiner Phrase. 1998. vi, 388 pp.

21 **KLEIN, Henny:** Adverbs of Degree in Dutch and Related Languages. 1998. x, 232 pp.

20 **LAENZLINGER, Christopher:** Comparative Studies in Word Order Variation. Adverbs, pronouns, and clause structure in Romance and Germanic. 1998. x, 371 pp.

19 **JOSEFSSON, Gunlög:** Minimal Words in a Minimal Syntax. Word formation in Swedish. 1998. ix, 199 pp.

18 **ALEXIADOU, Artemis:** Adverb Placement. A case study in antisymmetric syntax. 1997. x, 256 pp.

17 **BEERMANN, Dorothee A., David LEBLANC and Henk van RIEMSDIJK (eds.):** Rightward Movement. 1997. vi, 410 pp.

16 **LIU, Feng-Hsi:** Scope and Specificity. 1997. viii, 187 pp.

15 **ROHRBACHER, Bernhard Wolfgang:** Morphology-Driven Syntax. A theory of V to I raising and pro-drop. 1999. viii, 296 pp.

14 **ANAGNOSTOPOULOU, Elena, Henk van RIEMSDIJK and Frans ZWARTS (eds.):** Materials on Left Dislocation. 1997. viii, 349 pp.

13 **ALEXIADOU, Artemis and T. Alan HALL (eds.):** Studies on Universal Grammar and Typological Variation. 1997. viii, 252 pp.

12 **ABRAHAM, Werner, Samuel David EPSTEIN, Höskuldur THRÁINSSON and C. Jan-Wouter ZWART (eds.):** Minimal Ideas. Syntactic studies in the minimalist framework. 1996. xii, 364 pp.

11 **LUTZ, Uli and Jürgen PAFEL (eds.):** On Extraction and Extraposition in German. 1996. xii, 315 pp.

10 **CINQUE, Guglielmo and Giuliana GIUSTI (eds.):** Advances in Roumanian Linguistics. 1995. xi, 172 pp.

9 **GELDEREN, Elly van:** The Rise of Functional Categories. 1993. x, 224 pp.

8 **FANSELOW, Gisbert (ed.):** The Parametrization of Universal Grammar. 1993. xvii, 232 pp.

7 **ÅFARLÍ, Tor A.:** The Syntax of Norwegian Passive Constructions. 1992. xii, 177 pp.

6 **BHATT, Christa, Elisabeth LÖBEL and Claudia Maria SCHMIDT (eds.):** Syntactic Phrase Structure Phenomena in Noun Phrases and Sentences. 1989. ix, 187 pp.

5 **GREWENDORF, Günther and Wolfgang STERNEFELD (eds.):** Scrambling and Barriers. 1990. vi, 442 pp.

4 **ABRAHAM, Werner and Sjaak De MEIJ (eds.):** Topic, Focus and Configurationality. Papers from the 6th Groningen Grammar Talks, Groningen, 1984. 1986. v, 349 pp.

3 **ABRAHAM, Werner (ed.):** On the Formal Syntax of the Westgermania. Papers from the 3rd Groningen Grammar Talks (3e Groninger Grammatikgespräche), Groningen, January 1981. 1983. vi, 242 pp.

2 **EHLICH, Konrad and Jürgen REHBEIN:** Augenkommunikation. Methodenreflexion und Beispielanalyse. 1982. viii, 150 pp. With many photographic ills.

1 **KLAPPENBACH, Ruth (1911–1977):** Studien zur Modernen Deutschen Lexikographie. Auswahl aus den Lexikographischen Arbeiten von Ruth Klappenbach, erweitert um drei Beiträge von Helene Malige-Klappenbach. (Written in German). 1980. xxiii, 313 pp.