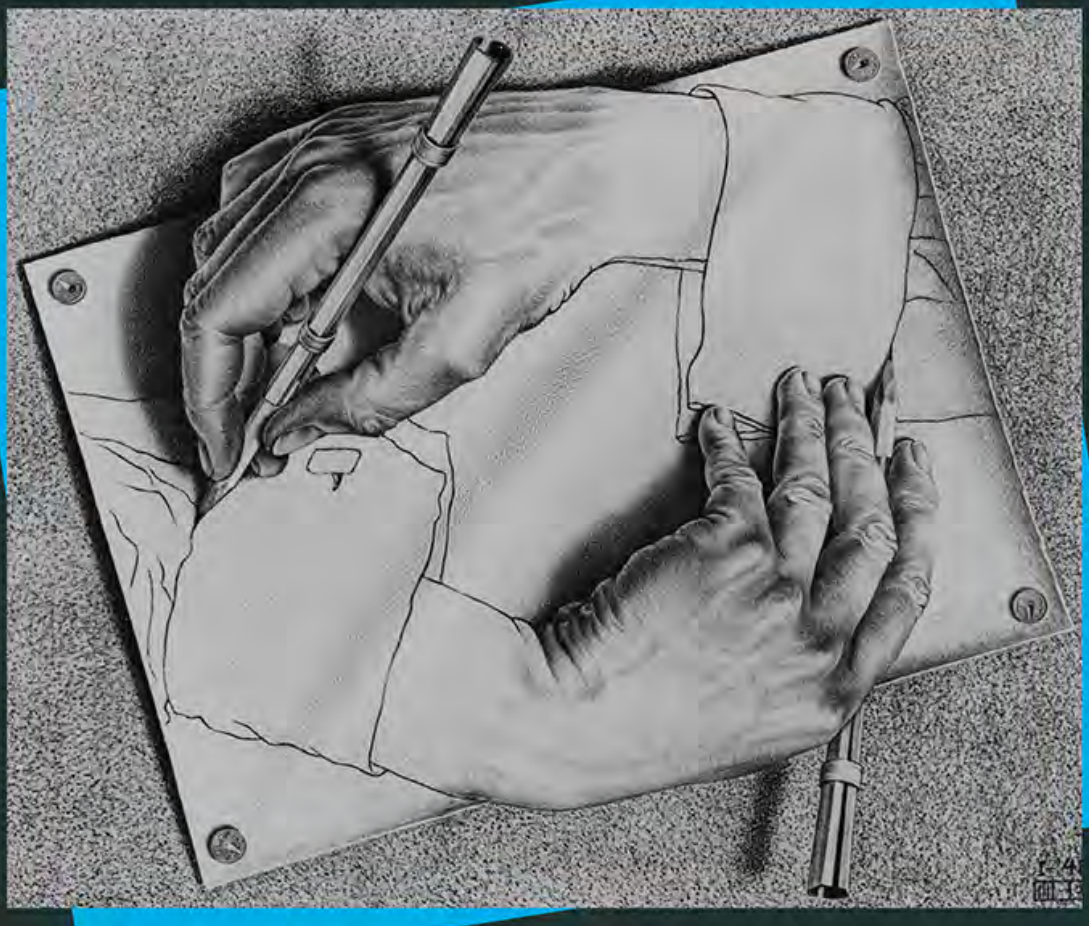
ADVANCING DEVELOPMENTAL SCIENCE

PHILOSOPHY, THEORY, AND METHOD



Edited by ANTHONY STEVEN DICK
and ULRICH MÜLLER

ROUTLEDGE

Advancing Developmental Science

Developmental science is an interdisciplinary scientific field dedicated to describing, understanding, and explaining change in behavior across the lifespan and the psychological, environmental, and biological processes that co-determine this change during the organism's development. Developmental science is thus a broad discipline that lies at the intersection of psychology, biology, sociology, anthropology, and other allied disciplines. *Advancing Developmental Science*: *Philosophy, Theory, and Method* reflects this broad view of developmental science, and reviews the philosophical, theoretical, and methodological issues facing the field. It does so within the Process-Relational paradigm, as described by developmentalist Willis Overton over the course of his career. Within that framework, this book explores development in a number of specific cognitive, neurobiological, and social domains, and provides students and researchers with a comprehensive suite of conceptual and methodological tools to describe, explain, and optimize intraindividual change across the lifespan.

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Advancing Developmental Science

Philosophy, Theory, and Method

Edited by
Anthony Steven Dick and Ulrich Müller

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Foreword

I imagine that most professors aspire to have their scholarly careers matter in some way; for example, writing a significant piece that is acknowledged as seminal by their peers, formulating an influential idea, or perhaps, even more, a theoretical model that is primarily associated with their work, making an important and creative contribution to the methods used in their field, or being a recognized leader in an area of research that is regarded as central to one's discipline. On the other hand, I guess as well that few professors, even ones with lofty views of their intellectual abilities, would set as their goal the thorough transformation of their field, of being the icon for defining the philosophical, theoretical, and methodological foundations of it and, at the same time, being the key scholar in several domains of research in one's discipline, a leader of one's profession, and a generous and wise colleague, teacher, mentor, and friend who is celebrated by his colleagues and past and current students. Moreover, even if a professor had such ambitions, it would be unlikely that he or she would expect to remain in these roles for five decades.

Yet, with humility, good humor, magnanimity, and extraordinary generativity, Professor Willis F. (Bill) Overton has made all of these contributions. He is, by anyone's reckoning, a historically singular scholar, colleague, and person. More so than any other developmental scientist in the past 50 years, his scholarly contributions have framed the fundamental dimensions of the field.

At least from the 1960s and through this writing, Bill Overton has enhanced developmental science in multiple ways. His scholarship has revised the split metatheoretical traditions of the field, from mechanistic and reductionist conceptions to, today, a relational developmental systems (RDS) metatheory that is derived from what he explains is a new paradigm for the field, a process-relational one. He has resolved the classic antimonies of developmental science—nature–nurture, continuity–discontinuity, and basic–applied—and provided the intellectual grounding for new, relational methods. He has enhanced the work of other scholars who have sought to use RDS-based concepts and methods in the diverse areas of scholarship present in contemporary developmental science—a contribution that will be made strikingly evident by the chapters in the present book. And he has been the leading scholarly voice in several areas of research in developmental science, using RDS-based models and methods to understand the embodied nature of cognitive development within the autopoietic human development system; for example, in regard to his and his colleague Bob Ricco's dual systems competence ⇔ procedural processing theory of reasoning, which provides new and productive frameworks for studying the development of such foundational cognitive processes as mental operations, representations thinking, reasoning, and memory. As a result of this scholarship, Bill Overton's research has transformed the study of cognitive development from a primarily reductionist and mechanistic field to one integrating multiple individual and contextual processes in a coactional, agentic, and adaptive system.

Because of the scientific contributions of Bill Overton, then, the sun has set on split, reductionist accounts of development, especially ones dividing nature from nurture. From the late 1960s, through this writing, Bill Overton's intellectual vision and voice have enabled developmental science to evolve from a field dominated by psychogenic or biogenic split and reductionist accounts of the life span to a multidisciplinary scholarly domain that integrates variables from biological through cultural and historical levels of organization into a synthetic, coactional system. In other words, his work has been the most important basis for the rejection in contemporary developmental science of reductionist accounts of development that pull apart (split) facets of the integrated developmental system. In turn, his work advocates for the adoption of RDS-based theoretical models of development that focus on process (systematic changes in the developmental system), becoming (moving from potential to actuality; a developmental process as having a past, present, and future), holism (the meanings of entities and events derive from the context in which they are embedded), relational analysis (assessment of the mutually influential relations within the developmental system), and the use of multiple perspectives and explanatory forms (employment of ideas from multiple theory-based models of change within and of the developmental system).

It is also his scholarship that has resulted in developmental scientists today embracing a view of the developing organism as an inherently active, self-creating (autopoietic), self-organizing, self-regulating (agentic), nonlinear/complex, and adaptive system. It is the work of Bill Overton that has brought to the fore of developmental science the bidirectional arrow between individual and context—⇔—a symbol used to represent the idea that the fundamental process of human development involves mutually influential relations between an individual and his or her multilevel and changing context, a process signified as "individual ⇔ context relations."

The scholarship of Bill Overton has provided, then, nothing sort of a Kuhnian scientific revolution in developmental science. His vision and voice will provide the pathway forward for the field for at least the next 50 years. It is not surprising, then, that his colleagues, past and present, have honored Bill in numerous ways. Some examples are his election to Fellow status in three American Psychological Association divisions (7, 12, and 20), his being given a Lifetime Achievement Award by the Jean Piaget Society (in 2011), his appointment as the Editor of the prestigious *Monographs of the Society for Research in Child Development* (from 1999 to 2006), his election as President of the Jean Piaget Society and President of the Society for the Study of Human Development, the publication in 2013 of two volumes of the *Advances in Child Development and Behavior* series that were dedicated to him and that were framed by his scholarship, and now the publication of this *festschrift*.

In short, Bill Overton's contributions to developmental science are profound. He is and will continue to be a model of extraordinary scientific eminence and accomplishment. He is a colleague respected around the world for his generosity and sage counsel. His thinking, quality, and influence as a scientist are unrivaled, and his passion for understanding and enhancing the lives of diverse individuals through the application of theory-predicated and methodologically rigorous research is unequaled. It is a privilege to have him as a close colleague, a cherished friend, and a mentor and model for more than 40 years. It is an honor to write a foreword to a book that celebrates his unparalleled contributions to developmental science and to developmental scientists.

Richard M. Lerner
Medford, MA
September 15, 2016

1 Integrating Philosophy, Theory, and Method in Contemporary Developmental Science

An Overview of the Issues

Anthony Steven Dick and Ulrich Müller

The motivation for this volume grew out of discussions to honor the life's work of Professor Willis "Bill" Overton, whose writings on the conceptual foundation of developmental science have shaped the field for decades and encouraged developmental researchers to think about the broad assumptions that guide their own empirical and theoretical work. As such, this volume is simultaneously an introduction to and overview of the field of developmental science for students and scientists, a detailed review of a number of topics in developmental science framed in the context of Overton's theoretical and metatheoretical writings, and a *festschrift* honoring Overton's immense contributions to developmental science over the course of his career.

To appeal to these objectives we invited senior investigators, leaders in their respective disciplines and in the larger domain of the developmental sciences, whose work has been significantly influenced by Overton's theoretical and empirical contributions. We also invited a number of Overton's former students to contribute. As a whole, the chapters are framed with reference to Overton's Process-Relational paradigm and Relational-Developmental-Systems metamodel (hereafter referred to as PR-RDS). In this respect this volume reflects a particular viewpoint of these topic areas in developmental science. At the same time, the chapters are remarkably diverse—each contribution provides an integrated analysis of research domains prominent in developmental science, delivering a comprehensive overview of the scope and complexity of the field. In this Introduction, we first present a brief biography summarizing Professor Overton's career. Next, we provide an overview of the PR-RDS metamodel. Finally, we discuss how each chapter in the volume is framed by that model, and how each chapter contributes to modern developmental science.

Willis "Bill" F. Overton: A Brief Biography

Figure 1.1 Willis (Bill) F. Overton, Thaddeus L. Bolton Professor of Psychology, Emeritus Temple University, Philadelphia, PA

Professor Overton is currently Thaddeus L. Bolton Professor Emeritus of Developmental and Clinical Psychology at Temple University. He has, at the time of this writing, accomplished a 57-year academic career in the study of psychology and of human development more generally. Moreover, despite having retired from Temple University, in his emeritus capacity Professor Overton remains active in the field. For example, he served as editor of Volume 1 of the new *Handbook of Child Psychology and Developmental Science*, and recently served as President of the Society for the Study of Human Development (SSHD). His expansive career illustrates his commitment to both the field and to the science.

Professor Overton's academic career began in 1960 after several years of service in the United States Marine Corps. After graduating from Boston University, where he received both a Baccalaureate and Master's in psychology and a minor in philosophy, Professor Overton matriculated in the clinical science program at Clark University, where he also received extensive training in developmental psychology. At that time, Clark University had one of the top programs in clinical and developmental psychology, and at Clark and other institutions Professor Overton studied with several of the most influential theoreticians in the field of developmental psychology, including Heinz Werner, Bernie Kaplan, Ludwig von Bertalanffy, and Joachim Wohlwill. Professor Overton has notably continued this degree of influence in his own career. Following his time at Clark, Overton began a tenure-track faculty position at State University of New York (SUNY), Buffalo and was tenured there in 1971. The next year he moved to Temple University in Philadelphia, PA to assume the position of Director of the developmental psychology program. He was promoted to Full Professor at Temple in 1975, and served as Director of Graduate Studies (1999–2001) and then Department Chair (from 2001–7) before his retirement in 2013. During this time Professor Overton held visiting scholar positions at a number of American and international universities (in the Czech Republic, Germany, The Netherlands, Poland, and Switzerland), a testament to the reach of his influence on the field. He was also active in clinical psychology, supervising interns at the Institute of Pennsylvania Hospital. Until its closing, he was Senior Research Scientist at the Institute of Pennsylvania Hospital.

As his career progressed, Professor Overton made major contributions to developmental psychology in philosophy/metatheory, development of reasoning, development of symbolic representation, theory of mind, executive function, and wisdom. He is perhaps best known for his metatheoretical contributions, in particular his PR-RDS paradigm and metamodel. Early in his career he co-authored (with Hayne Reese) two groundbreaking papers on developmental theory and methods, now rightly recognized as classic papers (with over 1,000 citations; Overton & Reese, 1972; Reese & Overton, 1970). These papers placed emphasis on the importance of metatheoretical assumptions (models) and how these assumptions form the context for endorsing a particular philosophy of science, constructing specific theories, and employing specific methods of scientific investigation. Professor Overton has continued to lay bare the impact that metatheoretical assumptions have on our theories and methods in several editions of the *Handbook of Child Psychology*. In these contributions, Professor Overton outlines the fundamental biases that are brought to bear in science. Notably, Professor Overton has attempted to "heal" the mind–body dualism, which, in its modern form, results from Descartes' characterization of mind and body as qualitatively different substances. The mind–body dualism is an enduring philosophical problem with no easy solution, and it is, for this reason, often minimized or ignored by contemporary developmentalists. Professor Overton's work supplies the guiding principles that are used by experimentalists and theoreticians in the field, and his writings are regularly assigned in graduate courses covering theory and methods in developmental science. In contemporary developmental psychology, there is a movement away from primarily reductionistic/mechanistic explanations of development to primarily developmental-systems explanations, which

recognize the relational contributions of multiple, holistic coactions among person-level, biological-level, and environmental-level factors. This can be attributed in large part to the influence of Professor Overton's scholarship in this area.

In addition to his metatheoretical, theoretical, and methodological contributions, during his career Professor Overton crafted one of the most influential theories on the development of reasoning (laid out most comprehensively in his edited text *Reasoning, Necessity, and Logic: Developmental Perspectives*). Professor Overton's theory is a dual-systems/dual-process theory which has been supported by dozens of empirical papers examining the development of reasoning in young children through adolescence. His dual-process theory continues to stand as one of the major theories of the development of reasoning (reviewed in Ricco, Chapter 13 of this volume).

Professor Overton has, through his understanding of the integration of philosophy, theory, and method, and his empirical contributions, provided the field of developmental science with unique leadership. He has edited several high-profile books (e.g., two *Handbooks of Child Psychology* and *Reasoning, Necessity, and Logic*, mentioned above). In addition, from 1999 to 2006 he was the editor of the flagship publication in developmental science, the *Monographs of the Society for Research in Child Development*. He was Associate Editor of the journal *Developmental Psychology*, and has served on numerous editorial boards including *Child Development*, *Cognitive Development*, *Development & Psychopathology*, *Human Development*, *Journal of Experimental Child Psychology*, *Journal of Adult Development*, *Journal of Research on Adolescence*, *International Journal of Behavioral Development*, and *Psychological Inquiry*. He has served as President and Past-President of the Jean Piaget Society, receiving the Lifetime Achievement Award from that Society in 2011, and as President-Elect, President, and Past-President of the Society for the Study of Human Development. Reflecting his influence on many areas of psychology, he has been elected Fellow to American Psychological Association (APA) Divisions 7 (Developmental Psychology), 12 (Society of Clinical Psychology), and 20 (Adult Development and Aging).

Through all of this Professor Overton has been a kind and patient mentor and colleague. Many of his students have gone on to successful careers in developmental science at internationally respected institutions of higher learning, and in recognition of this a number of them have contributed to this volume. These contributions accompany those from other authors who represent the very best in their respective fields. This volume reflects the breadth and depth of Overton's published interests and the personal relevance of his work to the contributors. The framework of Overton's PR-RDS paradigm and metamodel echoes through each chapter of this volume. This is Overton's signature contribution to the field—the establishment of a metatheoretical framework on which to build a new developmental science. It is to this contribution that we now turn in greater detail.

The Process-Relational Paradigm and Relational-Developmental-Systems Metamodel: Professor Overton's Signature Contribution

To understand Professor Overton's contributions, we must take note of the fact that the study of development as a dedicated science only really began in earnest in the late nineteenth and early twentieth centuries. The writings of Baldwin (1897), Piaget (1926), Lewin (1931), Cottrell (1942), Vygotsky (1962), and others covered the early conceptual challenges and framed the early approach, and their influence still looms large on the field. But the first *Handbook of Child Psychology* was not published until 1931, more than four decades after the establishment of the first psychology laboratory (in 1879) and the establishment of the American Psychological Association (APA, by pioneering developmentalist G. Stanley Hall in 1892). The establishment of the Society for Research in Child Development

(SRCD) occurred after that, in 1933. Further, some of the most influential work (e.g., from Vygotsky) did not achieve wide attention in the United States until the 1960s. Thus, relative to other branches of psychology, the study of human development is young. Despite this, it permeates the psychological sciences, acting at the crossroads of other disciplines. In fact, for almost every sub-discipline in psychology there is a "development" component that establishes its own society, division of the APA, journal, or graduate program.

But without steady guiding hands, a discipline, especially in its early genesis, can become unmoored, meander into unproductive waters, and sometimes even stumble into irrelevance (this was arguably the case with various instantiations of and reactions to early twentieth-century neopositivist approaches in science). Since his early career, Overton has worked to provide much-needed conceptual guidance to the study of human development. In doing this he has advocated the position that it is perilous to marginalize discussions of and reflection on the conceptual frameworks that necessarily influence the nature of scientific investigation. Overton's alternative is the recognition, put succinctly by Hanson (1958), that researchers do not always appreciate the same data in the same way (i.e., "all data are theory-laden"). Thus, the biases, views, and pre-existing conceptual contexts all influence the practice of science, the establishment of what is meaningful and what is not, and ultimately what scientists regard as "truth." Overton's contribution has been to bring to the forefront the significance of these background assumptions, in the process providing a framework on which to build a new developmental science. As this volume will attest, scientists studying human development have generally embraced the PR-RDS paradigm and metamodel promoted by Overton and his colleagues (Lerner, Agans, DeSouza, & Hershberg, 2014). In essence, beginning in the early 1990s to the present, the study of human development has "caught up" to the proposals that Overton introduced over forty years ago, and the field has experienced a paradigm shift in the proper Kuhnian sense (i.e., a re-analysis of the central guiding concepts of the field, and the generation of new data/methodological tools based on these concepts).

The scientific field born from this shift—*developmental science*—materialized out of more traditional developmental psychology, and grew, in part, because of a need to take a cross-disciplinary perspective on development. It thus encompasses a broader research domain than more traditional developmental psychology. By various definitions, developmental science is an interdisciplinary scientific field dedicated to understanding and explaining developmental processes, the coactions—often inappropriately termed "interactions"—of these processes at several levels of analysis over ontogeny, and the optimization of adaptive development of individuals (Lerner, 2012; Magnusson & Cairns, 1996). Developmental science thus lies at the interface of developmental psychology, developmental biology, molecular biology, physiology, cognitive neuroscience, behavioral neuroscience, clinical science, social psychology, sociology, anthropology, and other allied disciplines (Bergman, Cairns, Nilsson, & Nystedt, 2000). This volume endorses and reflects that broader view. It also attempts to situate contemporary developmental science firmly within the PR-RDS metamodel.

The Process-Relational Paradigm and Relational-Developmental-Systems Metamodel

Metatheoretical assumptions are often-silent background assumptions that establish the context within which theoretical and methodological concepts are formulated. Metatheory determines the meaningfulness/acceptability or meaninglessness/non-acceptability of these concepts and methods. Overton has written extensively on the importance of recognizing these metatheoretical assumptions, and how they fundamentally influence the way developmental scientists conduct research. We cite his most recent and comprehensive works on this subject here (Overton, 2014, 2015) and summarize the important concepts below.

Over the last half-century the study of human development, in forming a new field of developmental science, has essentially moved from the endorsement of what Overton termed a *split* metatheoretical approach to a *relational* metatheoretical approach. Split and relational metatheories order the world in different ways; split metatheory orders the world as aggregates of additive elements, while relational metatheory orders the world as systems of dynamic, changing part–whole relations.

The *split metatheory* originated from Descartes in the thesis that subject and object (mind and body) constitute two pure and, hence, independent forms—thus being split from each other—and the further thesis that there is a rock-bottom base or "foundation" of reality, hence a "foundationalism." The consequence of this is that the world becomes dichotomized, with one member of the dichotomous pair being elevated to a privileged position while the other is marginalized. The psychological sciences are replete with examples of this: subject versus object, mind versus body, nature versus nurture, continuity versus discontinuity, stability versus instability, or basic versus applied science. This is, in fact, the framework for a reductionistic approach to inquiry, whereby the concepts of one domain are defined in terms of another domain so that the meaning of one domain is completely captured by the other, with the result that the reduced term becomes unnecessary (i.e., mere appearance; Miller & Keller, 2000). This reductionism is often implicit, as when investigators use terms such as "underlie" to describe the relation between biology and psychology. In this example, the implication is that the biological explanation is foundationally more basic. Another example is the relation between evolution and individual ontogenetic development. From a split metatheory, the two processes are not co-dependent—genetic expression influences development, but not vice-versa. The field of epigenetics, for example, challenges this assumption.

The alternative to the split metatheory is the *process-relational metatheory*. A relational perspective casts all explanations (for example, cultural, biological, psychological, genetic) as complementary. Further, although complementary, they are differentiated, but still indissociable because no explanation is more foundational than any other. The challenge for this perspective is to define the part–whole relations in a manner where the parts are distinguishable yet remain integrated in and subordinated to the whole. The relational approach is thus, above all else, a commitment to *holism*. The relational approach represents the basic units of analysis as parts of a dynamic functioning system. The metatheory endorses part–whole analyses rather than atomistic reductionism. Thus, each part of the system both defines and is defined by the others, and by its relation to the whole.

Given this commitment to holism, there are three subsidiary principles that constitute the operational methodology of relationism. The first is a moment of analysis called the *identity of opposites*. In a traditional analysis, parts of a whole are separately defined (i.e., the law of identity; A cannot equal not A). However, within the relational perspective a first moment of analysis entails accepting the notion that pure forms or parts are co-determined rather than separately defined—that is, parts of a whole are mutually constituted by one another. Overton prefers to reference, by analogy, the famous sketch by M.C. Escher titled "Drawing Hands." In this sketch, a left and a right hand assume a relational posture according to which each is simultaneously drawing and being drawn by the other. Each hand is identical to the other in the sense of each drawing and each being drawn (identity). At the same time each hand preserves its own identity in the sense of there being a left and a right hand (opposites). The key to understanding this notion, and one that is often lost on students, is the idea that this occurs in the context of a dynamic system—the hands are performing the action of *drawing*. Another analogy that drives home this point is that of a hurricane. The eye of the hurricane and the arms (or spiral rain bands) of the hurricane can both be examined as opposites, but it is only because of the constant movement of air in the hurricane that this is so. The constant motion of the hurricane allows the eye to define the arms, and vice-versa, and, indeed, if the air in

the hurricane ceased to move, the hurricane as a whole, the eye, and the arms would cease to exist. At the same time, the organization of the hurricane, and its potential to cause damage in its path, is more than simply the aggregate of air molecules—the same air molecules organized in a different way, and interacting in a different way, would lead to a different result. The relational principle of the identity of opposites establishes the metatheoretical position that parts of a whole operate in a truly *interpenetrating* manner, and not simply as a conventional interaction of elements of each.

Suspending the law of identity establishes the interpenetration of causal forces across various explanatory levels—biological, genetic, cultural, psychological, etc. However, reasserting this law in a second moment of analysis is necessary to establish stable bases or *standpoints* for inquiry. This is the moment of the *opposites of identity*. At this moment the focus switches back to the oppositional quality of the relational pair. It is the recognition that, despite the identity of the two parts, there are differences; the left hand of the Escher sketch *is* the left hand and *not* the right, and one may examine the whole from the standpoint of either the left hand or the right hand. Each standpoint will present a different, but interrelated, perspective on the same whole. Another example is that of two people standing at opposite sides of a room. Each has a view of the whole room, but each sees the room differently as well. Truth lies in the coordination of their perspectives and not in denying any one of these perspectives. Adequate explanation resides in the coordination of various explanations, not in the reduction of one to the other.

A final principle, the *synthesis of wholes*, is fundamentally a reminder that for any relational pair, a third member coordinates the two. This step is necessary for a new integration to emerge from the differentiation of its component parts. Synthesis may involve more than two components or categories (e.g., the biology, person, and culture can be synthesized into a biopsychosocial model of development). Notably, this is also a dynamic process, and it is always incomplete. In this sense, the organism is essentially in a constant state of development, or, in the parlance of dynamic systems, is a dynamic open system that is moving toward but has not yet reached equilibrium (i.e., entropy). The concepts of inherent *activity*, *process*, *change*, and *necessary organization* constitute the major ontological categories of a PR-RDS scientific paradigm and metamodel.

The PR-RDS approach also challenges scientists to move beyond the notion that the discovery of contingent causality is the primary goal of science. This is the prescription of a split metatheory, which defines scientific explanation narrowly as a search for causal antecedents. However, the articulation of dynamic patterns, systems, or processes is increasingly recognized as legitimate explanatory enterprise that is as fundamental as, and logically prior to, the discovery of contingent causes.

Pattern or system explanation entails the discovery and specification of both *formal* (i.e., the dynamic form or organization of a phenomenon) and *final* (i.e., the direction of change of the phenomenon across time) patterns that systematize the phenomenon of interest. Each of these pattern explanations constitutes a principle of intelligibility, rather than a cause. That is, each establishes the (immediate and temporal) meaning of the object of study and offers context within which further empirical investigation can proceed. Formal principles establish order, constancy, and coherence of an activity at particular points in time, while final principles do the same across temporal sequences. This distinction is especially important for developmental theories as final principles are explanations of why development occurs (i.e., movement toward a specified end), and formal principles are explanations of what develops.

Students who are taught within the Cartesian split-mechanistic paradigm often see pattern explanation as simply descriptive rather than explanatory. This is a consequence of this particular paradigm. But as Witherington (Chapter 4 of this volume) and Overton (1991) show, patterns are explanatory because they introduce composition, regularity, and form to the

sphere of inquiry. In addition, pattern explanations are important because they complement the analytic decomposition of a system into components by defining how these constituents work together. The organization of the whole constrains these relations in a dynamic fashion (Witherington, Chapter 4 of this volume). This is the *process* in the Process-Relational paradigm. Thus, when Whitehead (1920/2007) says "[n]ature is a process," he is emphasizing the fact that there is no fixed "real" to nature. The latter is an assumption of the Cartesian framework. Rather, nature is in a constant state of unfolding—becoming and then passing away. From this perspective, the research focus shifts from concentrating on the constituents to concentrating on the *relations* among the constituents situated within the system. Systems or organizations are essentially defined as this relational set of processes.

This PR-RDS framework has the theoretical implications we have discussed, but it also has methodological implications. Thus, pattern principles are arrived at and assessed through an abductive or retroductive process. Abduction begins with an observation, and an inference is made to a pattern explanation. Then the observations are checked against the expectations. At first blush, this is viciously circular. However, vicious circularity is avoided by establishing criteria that allow for selection among alternative explanations. Examples of this approach can be found in the natural sciences (e.g., the structures of the atom, DNA, the universe) and in the biological and psychological sciences (e.g., the biological structure of consciousness; network theory; reasoning and decision making; conceptual and cognitive development). In these and all other pattern explanations a model (system) is initially proposed to account for the activity of interest. The model is empirically assessed through observations of the fit between the model and data sets that extend beyond the data set that formed the basis for the original pattern inferences. To the extent that the novel data sets are consistent with the model, the pattern explanation is supported. Extending the scope (novel data sets) as well as assessing the precision of the model strengthens the claims of the model as a rich, powerful, and valid explanation. Failure to observe a fit between model and data sets weakens support for the model and may lead to its modification or abandonment.

In summary, the PR-RDS paradigm and metamodel constitute a particular framework for conducting research in the developmental sciences. To date it has been an extremely successful framework, and has in recent years been a guiding model for a number of important contemporary advances in developmental science, including epigenetics, developmental and dynamic systems approaches, embodiment, systems-science analytic methods, and individual–context relations. These approaches, and others, are reviewed in the present volume, and represent the very best in contemporary analysis of the particular topic area. A brief summary of each chapter, which we provide below, describes the framing within the PR-RDS paradigm and metamodel, and the specific contributions to developmental science.

The Contributions to This Volume

This volume is divided into two major Parts to emphasize theoretical and methodological contributions on the one hand, and contributions to specific research domains on the other. Müller and Graves begin the first Part, Theoretical and Methodological Issues in Development: A Relational Perspective, with a question: What is development? Although this seems like a simple question, Müller and Graves show that the issues inherent in asking such a question are actually quite complex. For example, development is more than simply "change over time." A number of factors, including the organization, order and sequence, direction, epigenesis and emergence, and relative permanence and irreversibility of processes must be considered in the definition of development. The authors close by arguing that the process philosophy embodied by the PR paradigm is a promising framework for thinking about development.

In the next chapter, Marshall discusses the notion of embodiment, with a focus on whether the contributions of the body are constitutive of cognition, as opposed to enabling (i.e., simply a vessel). Marshall works within the PR-RDS framework and endorses a particular view of embodiment that seeks to incorporate various levels of analysis (neural, individual, sociocultural), rejecting an earlier notion of cognition that sees the body (or hardware) as largely irrelevant to the way in which cognition (the software) operates. Marshall also details various flavors of embodiment, which emphasize to varying degrees how the organism's action within the environment shapes the development of cognition and the construction of meaning. He concludes with an appeal to an RDS approach in which the embodied organism—the person—is maintained as a focus of investigation in modern developmental science.

Witherington continues this focus in his chapter on dynamic systems theory. Dynamic systems theories can be tricky to understand for the uninitiated, but Witherington's clear exposition is very accessible. Witherington shows that dynamic systems models of every flavor are fundamentally relational models that emphasize process. However, he also shows that even starting from a process standpoint can lead to endorsement, or alternatively denial, of the ontological status of the notions of organization and structure. As Overton shows, within the PR-RDS paradigm and metamodel, organization and structure are legitimate forms of explanation. However, if the process is seen as the explanatory "real" at the expense of the structure of the system (i.e., the structure is epiphenomenal, or a byproduct), as it is in some specific dynamic systems models, then the notion of pattern as explanation is rejected. Witherington argues that this contextualist approach to dynamic systems entails regression to the Cartesian split-mechanistic paradigm that stands in opposition to the Process-Relational paradigm. The chapter concludes with an appeal to an inclusive approach to dynamic systems.

In their respective chapters, Lickliter and Dick tackle the biological level of analysis from an RDS framework. Lickliter explicates his view that a developmental perspective is necessary to understand the relation between genotype and phenotype. He states that "all phenotypic traits are generated, constrained, maintained, and reorganized through the activities of an historical, embodied organism actively engaged with its surround." Lickliter explores the evidence from epigenetics to drive home this point. In his chapter, Dick also emphasizes the action of the embodied organism situated in its environment, and introduces the network science conceptual and methodological framework for exploring the neurobiological system as a whole in contributing to behavior. Both authors emphasize that development at the biological level unfolds, bringing to the forefront concepts of process and self-organization in the neurobiological systems of the organism.

von Eye concludes the first Part with a discussion of statistical modeling, and how this contributes to theory construction in developmental science. von Eye contrasts a traditional null-hypothesis testing framework with statistical modeling, showing that theory construction can proceed by testing the data against the hypothesized model. This is essentially the statistical instantiation of abductive or retroductive reasoning that Overton advocates for within the PR-RDS framework. A model is proposed, and the data are tested to see if they fit the proposed model. The model can be refined based on statistical tests of the model parameters. Thus, modeling is both guided by theory and guides theory development. von Eye shows that statistical modeling has the added advantage of allowing flexibility in testing a variety of relations inherent in developmental data, including reciprocal relations, temporal relations, and linear and non-linear developmental trajectories. These relations are not so easily established in the context of regression and analysis of variance (ANOVA) models used in the traditional null-hypothesis testing framework.

In the second Part of this volume, The Relational Perspective: Cognitive and Social-Emotional Development in Context, the chapter authors explore how the PR-RDS approach frames inquiry in specific domains. In their chapter on moral development in context, Turiel

and Nucci present their social domain theory to suggest that the moral domain is fundamentally different from the social domain and the personal sphere. They present data to suggest that even very young children make moral judgments in ways that are fundamentally different from other social judgments. They also show that children take advantage of contextual cues, and that they evidence age-related continuities and discontinuities in their moral development, which depend on the type of moral judgment. Turiel and Nucci emphasize the relational nature of moral development, and suggest that the PR-RDS approach avoids binary oppositions (e.g., contextual versus judged features) in favor of a reciprocal understanding of the features affecting the development of moral reasoning.

In their chapter, Zelazo and Carlson review their work on executive function, pretense, rule use, and creativity in the context of the Iterative Reprocessing model. This model focuses on the child's developing ability to "reflect" or "step back" to achieve psychological distance from the immediate experience. This and other related models (e.g., the Cognitive Complexity and Control model) fit well within the PR-RDS framework as they consider multiple, interacting levels of analysis in explaining development in these domains, at both the psychological and biological levels.

Brown and Lamb explore memory development in a relational context. The thrust of their argument is that memory formation and retrieval are determined by a number of contextual factors that include both the child's internal cognitive and affective state, and external factors such as the immediate environment, the actors present during the memory formation and recall, and the events being described. Additionally, the age of the child has an enormous effect on how each of these factors contributes to memory formation and retrieval. Using child eyewitness testimony as an example, the authors show that one cannot understand this phenomenon without taking into account the fact that memory retrieval in these situations is truly constructive, and occurs as the joint product of the dynamic interactions of the interviewer and the child. Further, one cannot conceptualize children's testimony without considering the nature of the event under investigation, the nature of the investigative process, and the layers of influence on memory formation and retrieval (e.g., child, family, social systems). In the context of child eyewitness testimony, the relational perspective allows researchers to consider the systems within which the children, the interviews, and the interviewers are nested, and how this affects memory formation and retrieval.

Pruden and Odean present an overview of language development, focusing on children's learning of relational terms (i.e., verbs). Within an RDS framework, the authors explore development in this domain at several levels of analysis, namely the psychological, cultural, and biological. They show that the relational approach is fruitful for exploring a domain within a specific level of analysis (e.g., cultural), and integrating the results attained at this level with those from other levels. The concept of interdependence that is emphasized in the PR-RDS model is expertly applied, and the result is an excellent example of how research in a focused domain of inquiry can benefit from the recognition that multiple levels of analysis are required to construct a complete explanation of development in that domain.

Carpendale explores social development with an emphasis on communication by considering two contrasting perspectives or worldviews. From the first perspective, the starting point and source of social development is the individual. From the second perspective, the process of social interaction is the starting point and the individual is the outcome of this process. The latter viewpoint is indebted to the Process-Relational paradigm, in which early communication is conceptualized as the coordination of activity between the infant and the caregiver. From this approach, the explanation of communication development consists in tracing the history of interaction, such that documentation of the increasing complexity of coordination between infants and caregivers is the best way to understand social development. Carpendale illustrates the application of this approach through examples

and also shows how the approach has implications for other areas of research, such as moral and cognitive development.

In the next chapter, Ricco reviews theories of the development of deductive reasoning, which is reasoning from premises to a logically certain conclusion. Ricco focuses on a number of models of reasoning development, distinguishing among mental logic accounts, metacognitive accounts, mental models accounts, and Bayesian or probabilistic accounts. For example, Ricco reviews in detail Overton's (1990) competence-procedural theory. According to this theory, deductive reasoning development depends on the one hand on the development of mental operations that are stable and enduring (the *competence*), and on the other hand the real-time processes (*procedures*) that must be called upon during reasoning. In this model the competence system develops to form a coordinated system of propositional operations, which can be implemented in any number of ways during performance (such as by using mental models or representations of the reasoning problem, which tax procedural components such as working memory). The chapter provides several examples of how a phenomenon such as deductive reasoning can be investigated from multiple legitimate standpoints of analyses, none being necessarily reducible to the other.

In their chapter, Liben and Coyle take a relational approach to gender development. One of the most important contributions of this chapter is the clear explication of just how influential gender is to the child's development, and to his or her experiences, advancement, and accomplishment in a large number of seemingly unrelated domains. Liben and Coyle address several questions, including why gender differences appear, what makes them persist, and what are the processes that might result in their modification. Throughout the chapter the relational approach is emphasized—gender development is seen as a relational process in which children and the context in which they are embedded mutually inform each other. The chapter concludes with a call to avoid a research approach that isolates individual from context, and instead to embrace one that tries to understand how the child and context codetermine gender development.

J. Lerner and Callina present a positive youth development (PYD) approach to adolescence. PYD endorses a focus on the developmental process, with a commitment to emphasizing the strengths of youth rather than their deficiencies, as is the case in more traditional "deficit models." One important goal of PYD is to establish a set of practices for youth programs and organizations designed to foster healthy development and thriving of youth. Lerner and Callina review various theories of PYD, focusing on the Lerner et al. (2005) formulation and its application to research (specifically the longitudinal 4-H Study of Positive Youth Development). Lerner and Callina show how this approach is embedded within the overarching Process-Relational paradigm, and how the theoretical and methodological advances in systems science can be applied to studying PYD, and to youth development programs designed to promote thriving in adolescents.

Takahashi adopts a lifespan and cross-cultural perspective to examine conceptualizations of wisdom, and to discuss the relation between wisdom and happiness. He traces in great detail the different historical definitions of wisdom, ultimately endorsing an approach that regards wisdom relationally and situated within a broader cultural and experiential context. Takahashi also explores the relation between wisdom and happiness. He shows, using older adults in Japan as an example, that the two are not always positively correlated. He closes by examining how balancing individualistic and communal attitudes can affect happiness in old age.

In the next chapter, Webster, Ajrouch, Wan, and Antonucci discuss how the environment and social relations impact the emergence of health disparities across the lifespan. Within the RDS framework, Webster and colleagues offer an expansion of the Convoy Model of Social Relations to explore how environmental and interpersonal contexts are important co-determiners of health disparities. Thus, the authors review both environmental (e.g., access to

nutrition, housing quality, crime rate) and social (e.g., social relations, social support networks) influences on health disparities, and integrate these within a modification of the Convoy Model to show that the environment can be both a resource and a source of stress. The environment is thus re-envisioned as a situational characteristic that influences health through social relations. This is an interesting advance on the Convoy Model, and provides a nice illustration of how the RDS metamodel acts as a catalyst for theory construction in a specific domain of inquiry.

Lawrence addresses, from a relational perspective, how people develop in the globalized environment of competing cultures, which can affect both the person and the broader culture. Her chapter presents a historical overview of various notions of culture, the significance of culture as a context for people's developmental experiences, and how the study of culture should be integrated into developmental science. She also discusses how older Australian Aboriginal women and their children attempt to maintain traditional cultural practices in the face of assimilation to the broader Australian culture. This example is used to demonstrate how persons are part of culture, and also how they change culture by modifying their interpenetrations and coactions with others in the community.

In the final chapter, Sokol, Chandler, Hammond, McEnerney, and Marle examine the development of identity and moral character from the RDS perspective. In critiquing more simplistic notions of moral character (e.g., a listing of traits), Sokol et al. favor a definition that views character as the dynamic intersection of multiple psychological and social processes that enable individuals to function as competent moral agents and socially responsible community members. From the RDS perspective, Sokol and colleagues explore several psychosocial domains—self-regulation, perspective taking, autonomy, and identity/self-continuity—and how these may go through periods of alignment and misalignment over the course of development. They provide identity formation and suicide among First Nation Adolescents as an example to illustrate how the relational approach can be used to understand the factors that may repair misalignments in different domains, with the effect of promoting positive identity and moral character development.

Conclusion

The contributions of this volume exploring philosophy, theory, and method in developmental science speak to the success of the recent paradigmatic shift in the field endorsing a PR-RDS metatheoretical approach. This shift in scientific paradigm is reflected in the increasing interest in understanding the development of individuals situated in a historical and environmental context, in the notion of development as a dynamic process and the endorsement of the concepts of *process* and *system*, in the validation of pattern-level explanations that complement but stand in equal measure to mechanistic-causal explanations, in the increasing use of statistical models that are person-centered to supplement models that are variable-centered, and in the rejection of reductionistic explanations of developmental change. Hopefully the reader will agree that the endorsement of the Process-Relational paradigm and rejection of the Cartesian split-mechanistic paradigm have significant implications for scholarship in developmental science, and will provide investigators with a comprehensive suite of conceptual and methodological tools to describe, explain, and optimize intraindividual change across the lifespan.

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Part I

Theoretical and Methodological Issues in Development

A Relational Perspective

2 What is Development?

Ulrich Müller and Abigail Graves

Introduction

Developmental psychology, lifespan development, and developmental science are various terms used to delineate a field of study that deals, according to an influential definition, with "the description, explanation and modification (optimization) of intraindividual change in behavior across the lifespan, and with interindividual differences (and similarities) in intraindividual change" (Baltes, Reese, & Nesselroade, 1977, p. 4). Thus, the subject matter of developmental science is how a person changes over the life course, and how the process of change is different and similar across persons. This definition, however, does not address the question: what type of change should be considered development? Should any type of change be considered development, or are additional criteria necessary that need to be met for change to qualify as development? Though foundational to the very field of developmental science, this question is rarely discussed. Incidentally, the answer to this question is rather complicated because in trying to answer it, one is immediately entangled with complex issues such as whether development is directed toward a fixed end state, or whether the notion of development is based on values and is thus a normative concept.

For more than four decades, Professor Overton (e.g., Overton, 1991, 2010, 2015; Overton & Reese, 1973) has worked on clarifying basic developmental concepts to lay a solid foundation for developmental science. Among the central questions he has addressed in this context is that of what type of changes should be characterized as development. His answer to this question is multifaceted and he does not eschew addressing complicated philosophical questions that arise in this context of this discussion. This chapter is indebted to his work on this topic in many ways.

This chapter will address the following. First, we show that the concept of change is too broad to capture development accurately. Next we discuss the five features that Overton identifies as being necessary for development, and we discuss the philosophical implications of these features. In the final section, we suggest that a process philosophy is a promising framework for thinking about development.

Development is More Than Change

It is common to define development by tying it to change. For example, Paul Baltes tells us that "[l]ife-span developmental psychology involves the study of constancy and change in behaviour throughout the life course (ontogenesis), from conception to death" (Baltes, 1987, p. 611). To notice a change we need to be able to detect a difference in an aspect of functioning between two different time points. However, in lifespan development, not every change would be considered development. For one, cyclical change would not be considered development. Examples of cyclical change include the sleep–wake cycle and hunger–satiation cycle. Transitory change or change that is easily reversible would also not qualify as development. Transitory change includes changes such as (a) becoming unconscious as a result

of a blow to the head, (b) learning something and then immediately forgetting it again, or (c) training a dog to fetch a stick and then training the dog not to fetch the stick anymore (see Overton, 1991, p. 264). Finally, changes that, in the long run, are regressive would not be considered development. A child who appeared to develop typically but then started to lose speech and social skills would be an example of regressive change (we will discuss regressive changes, including aging, in more detail later on). In the cases of cyclical, transitory, reversible, and regressive change, there is clearly a difference in some aspect of functioning between two time points, but this criterion is not sufficient to qualify these changes as development.

Now it might be argued that a difference between time points qualifies as developmental when this difference is age-related. However, in a trivial sense, every change is related to age by virtue of the fact that we exist in time and measure the duration of our existence in conventionally agreed-upon temporal units (Overton, 2010). A stronger claim is that development refers to the type of change that is a function of, or caused by, age. Such a suggestion, however, is confused as age itself is not a cause, but is a "shorthand for the set of variables acting over time, most typically identified with experiential events or conditions, which are in a direct functional relationship with observed developmental changes in behavior" (Wohlwill, 1970, p. 50). For example, the fact that a child is, say, 14 months old does not cause her to produce words; rather, word production is the result of a number of psychological, biological, and social processes and conditions that act over time (see Pruden and Odean, Chapter 11 of this volume, on the processes involved in motion verb production). Rather than viewing change as a function of age, Wohlwill (1970) suggested that age be viewed

> as a dimension along which the behavior changes which are the concern of the developmentalist are to be studied, that is, it is incorporated into the definition of the *dependent* variable of interest to him. Thus, to the extent that the investigator confines himself to charting such changes within a Behavior = f (Age) paradigm, he is only *describing* a set of phenomena which are the subject of study for him.
>
> (p. 51, emphasis in original)

Wohlwill's proposal does not (and was not intended to) solve the problem regarding which behavior changes should be considered developmental; rather, it presupposes that such a question has been answered.

Let us now turn to the five features Overton (2010) suggests are necessary for change to qualify as development:

1) organization of processes (structure and system);
2) order and sequence;
3) direction;
4) epigenesis and emergence; and
5) relative permanence and irreversibility.

Organization of Processes

The first feature emphasizes the idea that development, rather than involving isolated and haphazard surface-level changes in behavior, consists of systematic changes in deeper (structural) levels of organization. Let us use two examples to illustrate this idea. The first example is from social cognition and involves the emergence of the explicit understanding—around the age of 4 years—that oneself or another person may have a false belief. Explicit false belief understanding is indicated, for example, by answering correctly where a person would look for an object that the person has placed in one location, but that then, unbeknownst to the person, is moved to a different location (e.g., John puts his chocolate into the fridge;

his mother moves it, unbeknownst to John, to the cupboard). A common view is that the emergence of false belief understanding is not accurately described as a simple change in the response to a test question, but rather reflects a deeper (conceptual) change that signals children's ability to distinguish between what goes on in the mind and what goes on in the world (Astington, 1993). For example, Perner and colleagues (2002) suggest that false belief understanding requires the ability to represent the same situation from two conflicting perspectives simultaneously (e.g., the child's own perspective and John's perspective). Because the different beliefs in a false belief task refer to the same situation, they can be "integrated in a single representation only by marking them as different perspectives" (Perner et al., 2002, p. 1466), and this entails the understanding that the same situation can be described differently under different perspectives. These deeper-level, structural changes in social cognition are not limited to the false belief task but are manifest also in a variety of other aspects of children's behavior (e.g., keeping a secret, hide and seek games; see Peskin & Ardino, 2003).

The second example of deeper, structural change comes from Piaget's theory. In fact, Piaget championed the idea of structural change and drew on logical-mathematical theories to describe structural changes that occur in the process of development. One structure that emerges in middle childhood is the grouping structure, which we will illustrate using class inclusion as an example (Inhelder & Piaget, 1959/69). Class inclusion refers to the relation between two classes in which all members of one class (subordinate class) are included in the other (superordinate class). To assess the development of class inclusion, children are typically asked to compare the number of objects in the superordinate class with the number of objects in the most numerous of two of its subclasses. For example, given 12 daisies and 4 roses, children are asked, "Are there more daisies or more flowers?" The correct answer requires that children conserve the including class (B) while making the quantitative comparison between it and the included class (A). Although this may sound simple enough, such a comparison actually involves a multistep process in which children must not only be able to construct the including class but also be able to reverse this additive operation by properly decomposing it. The first step involves being able to combine two subclasses to form a superordinate class, or A (daisies) + A' (roses) = B (flowers). The second step involves performing the inverse (negative) operation associated with this combination of subclasses. This entails subtracting each subclass from the superordinate class such that A = B − A' and A' = B − A. The inverse operation, thus, implies that children construct each subclass through negation under the including class. Through this negation children realize that the subclass A is an autonomous whole, which enables them to recognize that there are some B's that are not A's (e.g., there are some flowers that are not daisies) and that, therefore, there are more B's than A's. The emergence of class inclusion does thus reflect the coordination of two operations (addition, negation) at a deeper level, and is not adequately captured by attributing it to a simple change in a verbal response.

The feature of organization has implications for the relation between development and learning, with learning here referring to the acquisition of skill or knowledge through instruction or being taught (Piaget, 1964; Vygotsky, 1978). Learning a particular skill or piece of knowledge presupposes that the child is ready and prepared to learn; that is, has already attained a level of knowledge that places her in a position to benefit from instruction. This does not preclude the possibility that learning may, in turn, foster development. For example, if instruction is pitched at an adequate level and engages the child's knowledge structures, it may lead to the coordination of operation and thus the emergence of a grouping structure (Morf, 1959; Inhelder, Sinclair, & Bovet, 1974). Still, learning would be considered a function of development.

The feature of organization also raises the question of the generality of structures, and whether they define a child's behavior in a variety of areas of cognitive functioning. This is an issue often discussed under the topic of stage theory. Following von Glasersfeld and Kelly (1982), a stage is

> constituted by a stretch of time that is characterized by something that remains constant throughout it. This may be the presence or the absence of an item (property, state, activity, or anything that can be isolated) that is considered a change because it is absent or, respectively, present in the preceding or subsequent stretch of time.
>
> (p. 155)

If we conceive of this as something that characterizes a stage broadly, it should influence each and every aspect of behavior and we should observe homogeneity in the child's functioning. For example, the child should display behavior consistent with Piaget's preoperational stage in each area of functioning (e.g., spatial reasoning, causal reasoning, logical reasoning). However, homogeneity in functioning is rarely the case; rather, what is usually observed is heterogeneity in functioning, and this heterogeneity has sometimes been taken as evidence that stage theories of development (particularly Piaget's) are flawed. Nonetheless, there is no reason to require homogeneity of functioning, and consequently this is also the case for Piaget's theory, as Piaget often made the point that heterogeneity in functioning should be expected (Chapman, 1988). We will further discuss the concept of stage in the next section, but here we would like to note that homogeneity is not one of its defining characteristics.

Order and Sequence

The second necessary feature, order, emphasizes the cumulative and sequential nature of development. "Later forms build on earlier foundations that are themselves transformed in the process" (Sroufe, 2009, pp. 179–80). The different forms or structures follow each other in an orderly pattern and constitute a sequence or stage law such that, to arrive at a later form Z, the organism must have been in the earlier forms X and Y. For example, to arrive at the stage of formal operations, the child must have gone through the sensorimotor stage, the preoperational stage, and the concrete operational stage, in exactly this order. Orderly sequences or stage laws play an important part in developmental explanations (Kitchener, 1983). They explain a particular stage by showing that it is part of a larger temporal whole and that it contributes to the attainment of the whole in a formal or non-causal way. For example, the stage of concrete operations has a functional role vis-à-vis the whole pattern of the development of logical reasoning and contributes to the attainment of the final stage of formal operations (similar to a brick being a constitutive part of a larger pattern such as a house).

> To say that a particular stage S contributes in this formal way to a larger unit (as part to whole) is (partly) to say that the latter conceptual entity entails or includes the earlier conceptual stage in the way, for example, that the concept of a mathematical or logical axiomatic system includes the concept of a theorem, or the way a language includes the notion of a grammar. . . . Thus, an earlier cognitive stage is a necessary condition for a later, more inclusive cognitive stage, but since it is only a part of this latter stage it cannot be a sufficient condition for it.
>
> (Kitchener, 1983, p. 802)

Furthermore, a particular stage does not merely contribute in a formal or structural way to the overall pattern; rather, stage laws imply that a particular stage contributes to the overall sequence in a generative way (Hamlyn, 1975; Kitchener, 1983). Kitchener (1983) suggests that this generative contribution is particularly marked in dialectical conceptions of development according to which contradictions (e.g., between different parts of the developing organism) at each stage are the driving force behind the construction of a higher, more complex stage that resolves the contradiction by integrating the parts into a more inclusive

whole. The feature of order and sequence implies that there is a direction to development. We turn to this feature next.

Direction

The feature of direction is implied by the notion of order: "[A]ny ordered system implies an *orientation toward a goal* or end state" (Overton, 2010, p. 5, emphasis in original). The notion of directedness and orientation toward a goal (telos) raises many issues, of which we will discuss three:

1) the concept of teleology;
2) multidirectionality; and
3) the value-ladenness of the concept of development.

Teleology

A teleological explanation accounts for development in terms of a directive principle or end state. Teleological explanations were championed by Aristotle, who argued that directedness toward an end goal is intrinsic to nature. For example, provided certain conditions are met (e.g., availability of nutrients), it is the natural telos of an acorn to grow into an oak tree. One objection to this type of explanation is that teleological explanations are unscientific because they attribute human-like plans to nature (Howard, 1990). In this context, Overton's (1991, pp. 277–8) distinction between subjective and objective teleology is useful: "Objective teleology involves the construction by the scientist of a principle that is designed to explain the phenomena under investigation. Subjective teleology involves subjectively held 'purposes', or 'aims', or 'goals'." For example, a subjective teleological explanation would ascribe the intention to the organism or person to acquire, say, formal operations. By contrast, an objective teleological explanation would identify an end state (e.g., hypothetico-deductive reasoning) and then use principles or rules (e.g., the equilibration process) to conceptualize different stages as being ordered in terms of this end state. Objective teleological explanations are pattern explanations; they connect and integrate the different stages: "To see a state of a thing as a stage in its development we must be able to see it as connected essentially in some way with an end-state which is in some way the rationale of the thing itself" (Hamlyn, 1975, p. 32).

Based on the assumption that a teleological model implies only one fixed endpoint, Chapman (1988) suggested a non-teleological model of development. In Chapman's (1988) model, "progress is measured not in the distance that remains in development toward some predetermined end state, but in the distance that has already been covered in developing away from an initial point of reference" (p. 93). However, to measure the distance from the initial point of reference, it is necessary to fix an endpoint in the direction of which the developing person has traveled. Even if this endpoint is only provisional, it still provides the direction and is, following Overton (2010), an interpretative rule that makes developmental phenomena intelligible. Thus, Chapman's (1988) model presupposes an objective teleology.

Multidirectionality

Three common criticisms of stage theories are that they presuppose the following ideas: 1) development is universal (i.e., proceeds in the same manner regardless of cultural context); 2) development is unidirectional (i.e., proceeds in the same way toward the same endpoint); and 3) development is predetermined or preformed (i.e., developed states are genetically predetermined; cf. Chapman, 1988; Lerner & Kauffman, 1985). It has been argued, however,

that empirical evidence refutes these ideas (Chapman, 1988; Gottlieb, 2007; Lerner & Kauffman, 1985; see also Lawrence, Chapter 18 of this volume). Furthermore, it has been argued that stage theories reflect the values and norms of a particular sociocultural context, and that it would be inappropriate to apply these theories to a different cultural context. For example, with respect to stage theories of cognitive development, Chapman (1988, p. 93) claims that

> [m]easuring the cognitive performance of individuals in one socio-cultural context with a developmental yardstick belonging to some other context easily confuses adaptive variations in cognitive activity with developmental immaturity. Individuals who have developed modes of cognition appropriate to the contexts with which they are familiar are likely to be judged as developmentally primitive relative to the mature members of the culture used as a reference.

In reaction to universal and unidirectional stage theories, multidirectional models of development have been proposed. For example, Baltes (1987) suggests that ontogenesis is characterized by considerable pluralism in the directionality of change, implying that development does not only proceed in a forward direction. Generally, gains realized come at the cost of related losses. For example, to gain something more elaborate, something less elaborate is lost. Development includes the simultaneous emergence of some new adaptive capacity and a loss of a previously existing capacity. The relative gain/loss value within any given domain is a function of developmental time. For example, during infancy, more gains (e.g., acquisition of skills) and fewer losses (e.g., loss of possibility to take alternative developmental pathways) are realized, with the reverse pattern observed in late adulthood. Further, developmental changes demonstrate considerable plasticity. Some age-related declines can be compensated for by developing new mechanisms for handling a task or problem (e.g., older expert typists have been shown to compensate for a decrease in reaction time by processing words and sentences differently than younger typists; see Salthouse, 1984).

Universality and undirectionality are only implied by stage theories if it is assumed that the telos is part of the essential nature of our species. This implies that, given natural conditions (e.g., nutrients), some sort of blueprint or program guides us toward the end state (Hamlyn, 1975; Kitchener, 1983). This assumption would be consistent with the idea of a predetermined epigenesis according to which "genetic activity gives rise to neural (and other) structures that begin to function when they become mature in the unidirectional sense of genetic activity→structure→function" (Gottlieb, 2007, p. 1). However, recent findings support the idea of probabilistic epigenesis: development results from the reciprocal interplay between different internal levels within the organism (genes, brain, etc.), and between the organism's behavior and the environment (Gottlieb, 2007; see also Lickliter, Chapter 5 of this volume). Furthermore, the plasticity of human ontogeny is inconsistent with the assumptions of universality and unidirectionality. Take, for example, the fact that human ontogeny is characterized by a protracted period of development. As a result, the human brain undergoes considerably more extensive development from infancy to adulthood than the brain of other primates (Parker & McKinney, 1999; Portmann, 1944/90). It has been suggested that a consequence of the unique human ontogeny is that development is more plastic and may be more heavily influenced by sociocultural context than in other species (Portmann, 1944/90).

Chapman (1988) suggested an interesting multidirectional model of development that integrates multidirectionality and progressivity, proposing that development can proceed in different directions depending on the local context, but can nevertheless be characterized as progressive *within* each context. Chapman uses aesthetic (characteristic of Eastern cultures) and theoretic (characteristic of Western cultures) knowing as examples to illustrate the multidirectionality of development (see also Takahashi, Chapter 16 of this volume).

Contextuality of development does not preclude its directionality, nor does it preclude the idea that development is directed toward an end state. This end state would just differ across cultures. An additional possibility is that, at some abstract level, the structures underlying the different stages are the same. Take, for example, young children's sorting behavior. Twelve-month-old infants start to put two or more objects that are alike into a spatially separated group. Sugarman (1983) terms this a *single iterative phase*: individual elements are related to one another because of their functional properties or visual similarities. Children compare objects on one dimension and realize that an object (x) is like *a* or not like *a*. During the second year of life, children begin increasingly to compose two sets by first grouping all the objects belonging to one class and then the objects belonging to the second class, which implies that at one point of time objects are evaluated in terms of their similarities and differences on only one dimension. Successive grouping of objects into two different groups involves a flexible shift from one similarity relation to another similarity relation. This cognitive organization may be described as follows: an object (x) is like *a* or not like *a*—shift to another dimension *b*—an object (x) is like *b* or not like *b* (Sugarman, 1983).

At the end of their second and in their third year of life, children recursively shift between groups when they construct two groups (Sugarman, 1983). Their advanced sorting behavior suggests that they have judged an object as not belonging to one class, but still consider it as a possible member of another group: what is not like *a* may be like *b* (Sugarman, 1983). The iterations that were previously executed successively become coordinated, and children order objects according to two schemes at once, thereby generating relations between relations (Langer, 1986). Children now make comparisons on two dimensions simultaneously, although these comparisons are still made on a step-by-step basis (i.e., inductively; Sugarman, 1983).

At a more abstract, structural level, the development of sorting behavior can be described as moving from the construction of relations between objects to the construction of relations between relations. It might well be the case that such an abstract description of development applies to different content areas (Müller, Sokol, & Overton, 1998), and to developmental sequences that result, at a content level, in very different end states.

Finally, multidirectionality is also compatible with the possibility that these different trajectories are produced by the same developmental processes (Brandtstädter, 1988). For example, Werner's (1957, p. 126) orthogenetic principle states that "wherever development occurs it proceeds from a state of relative globality and lack of differentiation to a state of increasing differentiation, articulation, and hierarchic integration." The orthogenetic principle does not predict specific ontogenetic trajectories and is thus compatible with multidirectionality (see Werner, 1957, pp. 130–1). Therefore, multidirectionality does not have to exclude universality at either an abstract structural level or at the level of process (the same argument can be made with respect to plasticity).

Value-Ladenness of the Concept of Development

With respect to the feature of direction, a controversial question is whether the concept of development is intrinsically value-laden and implies reference to a positive value. On the one hand, Hamlyn (1975, p. 27) argues that this is not the case because in ordinary English usage the expression that a person developed into an empty and worthless person is not nonsensical (which it would be if development connotes a positive value). In a similar vein, Rapp (1992; see also Rosslenbroich, 2006) distinguishes a genetic and a normative concept of historical progress. The genetic concept of progress expresses the effect of the past on the present, the temporal succession of changes, and the generation of something new, which is understood in a value-neutral way. The normative concept of progress builds on and goes beyond the genetic concept in the sense that it makes evaluative judgments about the direction.

> The normative concept of progress tells us that every progress is essentially directed toward something more advanced and better. The relation between both concepts of progress is asymmetrical. The stronger, normative concept of progress presupposes the genetic concept of progress, which then, in turn, is made the object of a tacit or explicit positive valuation.
>
> (Rapp, 1992, p. 27, our translation)

In a similar vein, the concept of development could be conceived of as a genetic concept that describes, in a value-neutral way, the irreversible flux of time and the effect of the past on the present. Furthermore, normative aspects would not be intrinsic to the concept of development.

By contrast, Kitchener (1983; see also Kaplan, 1992, 2005) argues that the end state or goal that development is oriented toward is typically thought of as something good for the organism or person to attain. Indeed, children who deviate from the typical developmental trajectory are classified as atypical, which suggests that we place a positive value on the end state and the trajectory leading up to it. Arguably, if the concept of development requires some sort of orientation toward an end state, then it also involves reference to value because the end state is posited for a reason (e.g., because it is thought to indicate a healthy or good developmental outcome). Consequently, the value of a particular developmental end state can be challenged and needs to be justified.

Epigenesis and Emergence

The fourth necessary feature to qualify change as development is epigenesis and emergence. In conscious distancing from the idea of preformation, the notion of epigenesis emphasizes the probabilistic nature of development. Probabilistic epigenesis is a holistic concept; it involves the reciprocal interaction between different levels of the organism and the environment (Overton, 2010; see Lickliter, Chapter 5 of this volume). The exchange process with the environment results in the emergence of new system properties. Overton (2006, 2010, 2015) refers to change that results in something qualitatively new as *transformational change*. A classic example of such transformational changes are the different stages in the life cycle of a butterfly (egg, caterpillar, pupa, adult form [what we think of as butterfly]). Qualitative change can be contrasted with quantitative change; that is, change in magnitude, efficiency, or frequency of occurrence of a newly acquired behavior (Overton & Reese, 1981; Werner, 1957).

Frequently, qualitative changes are equated with discontinuity and quantitative changes with continuity (e.g., Brainerd, 1978). However, as Werner (1957) elaborates, continuity and discontinuity are differently related to qualitative and quantitative change. With respect to quantitative change, the continuity–discontinuity issue refers to the magnitude or abruptness of change; discontinuous quantitative change is characterized by abrupt change ("gappiness"), whereas continuous quantitative change is characterized by gradual change. By contrast, the defining characteristic of qualitative change is emergence (i.e., the irreducibility of the properties of the later stage to those of an earlier stage). Continuous qualitative change is characterized by intermediate or transitional stages, discontinuous qualitative change by the absence of intermediate stages.

Werner (1957) explains that qualitative changes do not need to be abrupt:

> Thus, a change may be discontinuous in terms of quality but may become distinguishable (e.g., measurable) only gradually; i.e., there may be a continuous quantitative increase, such as in frequency of occurrence or in magnitude. For instance, the attempt of the young child to walk on two legs is discontinuous with four-limb locomotion, though the successive actual attempts may show gradual progress toward precision and success.
>
> (p. 134)

Werner's distinctions imply that qualitative change cannot be derived from quantitative change (see Overton & Reese, 1981; von Glasersfeld & Kelly, 1982), but requires a judgment of whether the properties of a new stage can be reduced to those of a former stage. Whether a particular change is considered a qualitative change also depends on the theoretical framework and level of analysis (Flavell, 1971; von Glasersfeld & Kelly, 1982). To use an example provided by Werner (1957), at the level of physics, differences between color hues are quantitative and continuous, but at the level of psychological description, the change from one color to another is qualitative and discontinuous.

Clearly, qualitative change and stage necessitate each other; without qualitative change there is no stage sequence, no stage law, and no need for teleological explanation. We will return to the relation between qualitative and quantitative change in the conclusion.

Relative Permanence and Irreversibility

The final feature captures the relative permanence and irreversibility of developmental changes in the structure (transformational change) and sets it apart from cyclical or transitory change. We stated above that changes that, in the long run, are regressive (e.g., decline in language skills that results in diagnosis of developmental disorder) would not be considered development. Short-term regressions, on the other hand, are part of development. In fact, often a child's performance on a task may deteriorate as the child gets older only to improve again later on, a phenomenon known as U-shaped development (Siegler, 2004; Strauss, 1982). The regression may indeed be crucial for further development (Werner, 1957). However, short-term regression itself does not constitute development. It becomes part of a developmental process only in the context of directional trend toward a positive developmental outcome (e.g., acquisition of a skill). Similarly, long-term, permanent regression, as is the case with some developmental disorders, does not constitute development; rather, it is qualified negatively, as deviating from the progression that typically characterizes development.

A more complex question that arises in this context is how to treat development in old age. As Overton explains,

> [i]f it were found empirically that there were declines in middle to late adulthood in behaviors associated with transformational systems (e.g., if the form of thinking deteriorated or regressed to an earlier form), would this change be considered something other than development? Would it be necessary to introduce two radically different processes into our lifespan understanding such as "development" on the one hand and "aging" on the other?
>
> (Overton, 2010, p. 9)

Overton (2010) does not think so and suggests that lifespan development should be conceptualized as one process with two trajectories:

> It is entirely consistent with the concept of a single life-span developmental process that life begins on one broad trajectory and at some point during some epoch moves on to another trajectory. Despite the change in direction, features associated with the processes, including sequences, order, directionality, epigenesis, and irreversibility, are all retained. . . . Thus, the relational developmental system has two *telos* [sic]: one an inclined plane leading to maximum complexity and efficiency, and the other a declined plane leading to a final equilibrium.
>
> (pp. 24–5)

The difficulty with Overton's proposal of two teloi is that the final equilibrium is death and it is somewhat strange to think of death as the goal of life and the different stages along the

way as means to this end (Spaemann & Löw, 1985). The positive, normative (value-laden) connotation of development is not captured by Overton's proposal. However, maybe it is time to reevaluate the norms underlying our concept of development. For example, it could be argued that children who develop atypically may not be worse off, but just have a different mix of strengths and weaknesses. Overton's proposal might thus pave the way for a new, more nuanced concept of development.

Another possibility for an integrative conceptualization of lifespan development is to explore new ways of defining the developmental trajectory. One strategy that may be worth pursuing in this context is to adopt various conceptualizations of progress that have been suggested with respect to organic evolution (e. g., increasing autonomy, adaptability, increasing possibilities to exert impact on the environment; see Hahlweg, 1991; Piaget, 1967/71; McShea, 1998; Rosslenbroich, 2009, 2014). Applied to ontogenesis, such a conceptualization would extract an invariant that is immanent in the process of the interaction between organism and environment over time, and not, as the final equilibrium, external to the process (Spaemann & Löw, 1985). In addition, such a conceptualization would have to identify structures that instantiate the invariant and explain how structures, in realizing the invariant, build onto each other and form a sequence. Moreover, the structures at each point are reciprocally related to the environment: with each action of the organism, the environment itself changes. Changes of the organism (including bodily changes) and environment go hand-in-hand and the reciprocal (transactional) relation between organism and environment needs to be considered when formulating the invariant and identifying the developmental sequence.

Process Philosophy

An important point that has been raised by Overton for over 40 years is that the idea of change takes on a very different meaning depending on whether reality is primarily viewed as static and fixed or as active and changing (Overton, 2015; Overton & Reese, 1973). The former view ("substance metaphysics") has been dominant in Western philosophy for centuries. The latter view ("process philosophy" or "process-relational world view") is currently gaining more attention. As Overton (2015) explains, compared to substance metaphysics, a process-philosophical viewpoint flips how stability and change are viewed: "Change is imminent (sic) and necessary. A new seemingly stable object is a moment—that has endurance, duration—in the coming into being and passing away of process. Hence, *Being* is found in *Becoming*, *Constancy* is found in *Change*" (Overton, 2015, p. 35; emphasis in original).

From the point of view of a process-relational worldview, change does not need to be explained by invoking particular causes. Provided certain background conditions are met, change and development will occur (Kitchener, 1983; Overton, 1991, 2015). Efficient causes (e.g., variable X causes Y) are induced to explain individual differences in, for example, the rate of development (e.g., child X develops faster than child Y because of a more stimulating environment) and abnormal development (e.g., child Z regresses in language development because of erratic brain development). In developmental explanations, efficient causes are subordinate to final causes (i.e., teleological explanations) because the "latter indicate why development has the overall pattern it does, what sequence of stages must occur if the end is to be attained, and what function each stage has in this development" (Kitchener, 1983, p. 807).

The process-relational worldview also provides a different perspective on what remains the same throughout development. If there is thoroughgoing, transformational change in the course of development, in what sense does the subject of which we predicate this development remain the same?

Plessner (1926) articulated the complexity of thinking about sameness in the context of pervasive change. According to Plessner (1926, pp. 132–46), life is a process that consists

of (a) a being (i.e. persisting) that turns into becoming without dissolving itself in, and losing itself to, this becoming, and (b) a becoming that turns into a being (i.e. persisting), and becomes something without being impeded by this something and losing its identity. The process of life, then, unites both a cyclical running back on itself (a closed circle) and a perennial progression (a straight line):

> On the one hand, the living being remains what it is; on the other hand, it transforms itself into something that it is and is not. . . . The process must run against itself. Were it to run radically against itself, it would become what it cannot be: a closed circle, a standing process. . . . The line of linear progress must be integrated with the line of the closed circle in order to generate the line of cyclical progress: a spiral.
>
> (Plessner, 1926, pp. 139–40)

Overton (2010, 2015) provides a thoughtful answer to the question regarding the subject of development. He proposes that the subject of change is the living, active, open, self-organizing, and self-regulating system of processes. Self-organization is the process by which a system perpetually reconstitutes its processes (e.g., metabolic cycles) and elements (e.g., cells) to preserve its continuous functioning. This self-organizing activity is not something additional or external to the living system; rather, it pervades matter as an active form and it regulates, in exchange processes with the environment, the reproduction of the organization of the living system, which is its self-organization. Living systems are thus characterized by the fact that final cause and formal cause are fused together: the goal or telos is the form of the thing; the form of a living being is the continuous self-organizing activity; therefore, the telos of the living being is to preserve its form (Aristotle, 1970, 199b, pp. 27–32; see also Mossio & Birch, 2014). Self-organization thus integrates organization and activity and captures the dynamic nature of development (see Witherington, Chapter 4 of this volume).

Conclusion

In this chapter, we discussed and elaborated on the five features that Overton (2010) proposed as necessary for the concept of development. According to these features, development can be characterized as transformational change that is oriented toward an end state. The notion of transformational change implies that the change takes place at a structural level, involves novelty, and is relatively permanent. We also suggested that the concept of development is compatible with multidirectionality and is inherently value-laden.

Our discussion raised the question of how to define lifespan development and whether it is compatible with the notion of transformational change. Furthermore, if development is defined in terms of transformational change, are other types of change (e.g., variational change) irrelevant for development? Clearly, they are not, and Overton (2010, 2015) explicates different ways in which different types of change can be considered as complementary.

We pointed out that developmental explanations are teleological in that they provide an interpretive rule that makes developmental changes intelligible. However, the end state identified in teleological explanations may always be provisional as new ways of interacting with the world may open up new possibilities. The possibility of end states and thus developmental trajectories that differ depending on sociocultural context also raises questions about the effect of the environment on development. Can the environment cause developmental trajectories? This question only makes sense from the standpoint of a split metatheory. Clearly, both organism and environment influence development. Nonetheless, the environment cannot instruct the organisms because the organism is self-organizing and regulates its interaction with the environment according to its own rules and processes. As it were, efficient causes

(how the environment influences the organism) are subordinate to final causes (the rules and principles by means of which the organism organizes itself). Still, the environment can perturb developmental trajectories. If the perturbation occurs at developmental branching points, then the trajectory can move in an entirely different direction. Environmental input can also lead to the temporal uncoupling or coupling of processes, which would affect development trajectories (Parker & McKinney, 1999). Undoubtedly, the way in which the environment influences developmental sequences needs further attention.[1]

Note

1 Overton (2015) recently added embodiment to the features that define development. We certainly agree that embodiment is crucial for development (see Marshall, Chapter 3 of this volume), but we do not think that it contributes to demarcating development from simple change (i.e., the concept is not necessary to dissociate development from change).

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3 Embodiment

Peter J. Marshall

The field of embodied cognition encompasses various empirical approaches that are connected through a shared recognition of the importance of bodily factors in mental life (e.g., Anderson, 2003; Foglia & Wilson, 2013; Shapiro, 2011, 2014; Wilson, 2002). The implications of embodiment continue to be the focus of much debate, particularly in terms of the extent to which the body plays a constitutive versus simply an enabling role in cognitive processing (Menary, 2010b; Müller & Newman, 2008; Rowlands, 2010; Wheeler, 2005). The current chapter initially examines similarities and differences between two particular approaches to embodiment, specifically the functionalist and enactive accounts. The discussion will then turn to considerations of embodiment in the process-relational developmental systems metatheory (Lerner, Agans, DeSouza, & Hershberg, 2014; Overton, 2014). In the process-relational approach, embodiment is a construct that integrates the various standpoints (neural, individual, sociocultural) from which human mental life can be studied. It will be argued that the inherently ontogenetic orientation of this approach, which is less apparent in other views of embodiment, can facilitate progress toward a truly integrative developmental science of psychological life.

One major impetus for the rise of embodied cognition as a field of study stems from a loss of confidence with the cognitivist emphasis that came to dominate cognitive science during the second half of the twentieth century (Miller, 2003). From the cognitivist perspective, the physical body is irrelevant to the understanding of cognition. Instead, cognition consists of computations, or the manipulation of symbols to which meaning has been pre-assigned by a programmer or designer. Whether or how these computations might be implemented in biological systems was deemed unimportant, with the primary goal instead being to develop algorithmic routines that transform inputs into outputs (Marr, 1982). This line of reasoning was partly a pragmatic response to the barriers presented by the immense complexity of the brain and nervous system. It was also buttressed by the philosophical argument known as functionalism, which stated that the specific way in which problem-solving routines are implemented (e.g., on a machine versus in a living organism) is less important than the problem-solving process itself. These arguments led both to a neglect of neuroscience in cognitive science and to a sustained lack of consideration of the role of the body in mental life (see Marshall, 2009, 2015).

Reactions to the disembodied nature of cognitivism began to be more visible in diverse theoretical initiatives appearing in the early 1990s that pushed for a paradigm shift in the way that cognitive processes are conceptualized (e.g., Brooks, 1990; Hutchins, 1995; Varela, Thompson, & Rosch, 1991). These initiatives stimulated wider interest in the ways in which the body might play a role in mental life, and led to the emergence of embodied cognition as a field of study. Various efforts have since been made to delineate the similarities and differences of the various main approaches within the field of embodied cognition (Anderson, 2003; Shapiro, 2011). In a useful summary, Kiverstein (2012) distinguishes between three

broad views that he calls *body-conservatism*, *body-functionalism*, and *body-enactivism*. From the *body-conservative* viewpoint, the implications of embodiment are limited. Research from this perspective acknowledges a role for the body in cognition, but only by virtue of providing inputs for computational processing within the brain and as the vehicle for carrying out efferent motor commands. In this respect body-conservatism does not differ substantially from the traditional cognitivist model and will not be discussed further here.

The other views discussed by Kiverstein (2012) are *body-functionalism* and *body-enactivism*. Both of these views center on the proposal that cognition does not reside primarily "in the head" but instead is a process that encompasses body, brain, and environment. There are various arguments for this claim, which is related to a historical debate within philosophy between proponents of internalist (in-the-head) cognition and those who favor a more externalist view of the mind (see Carter, Kallestrup, Palermos, & Pritchard, 2014). Within the analytic tradition of the philosophy of mind, this debate was stoked by the proposal that meaning cannot exist solely in the head, and that the study of individual, isolated brains would not suffice for understanding human mental life (Burge, 1979; Putnam, 1975). In subsequent iterations of the externalist viewpoint, the radical notion was raised that cognitive processes are extended out of the boundaries of the brain due to the interdependence of nervous systems, external artifacts, and other agents. There is some variation in the type and breadth of externalist claims, although a shared theme is that the work of cognition is not carried out solely in the head but is spread across the wider brain-body-environment system (Clark, 2008; Hutchins, 1995; Rowlands, 2010; Rupert, 2010; Susswein & Racine, 2009).

This chapter will focus initially on the distinction between the body-functionalist and body-enactivist approaches. While these approaches share an externalist bent, it will be seen that they differ significantly on the nature and implications of embodiment. A further discussion of body-enactivism will focus on one particular approach (autopoietic enactivism) that has roots in biology, philosophy, and cognitive science. Connections between this approach and the process-relational developmental systems framework of Overton and Lerner will then be considered.

Body-Functionalism and the Extended Mind

One particular externalist position that has inspired a great deal of discussion and debate is the *extended mind hypothesis* as put forward by Clark and Chalmers (1998), who proposed that mental states such as beliefs can extend outside of the body and brain. The extended mind hypothesis relies on the notion that

> if as we confront some task, part of the world functions as a process which, were it done in the head, we would have no hesitation in recognizing as part of the cognitive process, then that part of the world is . . . part of the cognitive process.
>
> (p. 8)

Among other examples, these authors used the fictional case of an Alzheimer's patient who, to compensate for the deficits in his biological memory, relies on information that he writes down in a notebook. Clark and Chalmers use this particular example to suggest that, in certain cases, external features can stand in for mental representations such as beliefs, when these features play "the right sort of role in driving cognitive processes" (p. 7). Subsequent writing by Clark (2008) further outlined this view, which Kiverstein (2012) calls the *body-functionalist* account.

Given its seemingly radical nature, it is hardly surprising that the status of the body-functionalist account has been subject to a good deal of criticism, ranging from disagreement on emphasis to outright rejection of the basic premise. On the milder side, Sterelny (2010)

acknowledges the utility of the body-functionalist approach, but sees the extended mind model as occupying one corner of a much larger space in which "the most critical, mind-and-brain-shaping environmental supports for cognition are those cumulatively built, collectively provided tools for thinking" (p. 479). Although outside the purview of this brief chapter, this sentiment connects with a broader view of extended cognition that also redefines the relations among cognition, social learning, and evolutionary processes (Laland et al., 2014). Along these lines, Sterelny (2010) further suggests that the extended mind hypothesis understates the importance of broader cultural and environmental scaffolds by emphasizing "highly trusted, individualized and entrenched, single-user resources" (p. 480) such as the personal notebook example employed by Clark and Chalmers (1998). In response, advocates of the body-functionalist account would argue that it is exactly the trusted and readily accessible nature of these individualized resources that allow them to be considered as parts of what is usually seen as the "internal" cognitive apparatus.

Harsher criticism of the extended mind hypothesis has come from the internalist camp. Adams and Aizawa (2010) maintain that Clark (2008) and other advocates of a functionalist approach cannot show that their purported extensions of the mental apparatus are constitutive parts of cognition, rather than simply being sources of information for central ("in-the-head") processing. A related objection comes from Fodor (2009) who suggests that only internal mental states can have intentional content that is *underived*. According to Fodor, Clark's examples of notebooks and smartphones have only *derived* content. Although he acknowledges that the boundary between derived and underived content is hazy, Fodor (2009) believes that a reliance on internal mental representations is the only way to bridge "the gap between mind and world."

At first glance, the extension of mental states in the body-functionalist approach seems to present a stark contrast to the internalist emphasis that characterizes the cognitivist tradition. However, it is worth noting that body-functionalism and cognitivism are both inherently computational accounts, with the point of departure being in the location of the computations that are posited to underpin mental life: In body-functionalism, these computations are not implemented solely within the head but, depending on task demands and context, are flexibly carried out across a distributed system encompassing brain, body, and environment. Wheeler (2014) brings up this issue as a problem: He suggests that realizing the paradigm shift presented by embodied cognition requires the rejection of the principle that intelligent thought and action are to be explained in terms of content-bearing representations. While body-functionalism sees the body as being relevant to explaining how cognitive processes are implemented, according to Wheeler (2014), it does not herald a fundamental change in the understanding of the relations between material embodiment and cognition. Therein lies a key distinction between the body-functionalist notion of the extended mind and the third view of embodiment outlined by Kiverstein (2012), which is *body-enactivism*. As will be made clear in the following sections, the distinction between extension and enaction (Thompson & Stapleton, 2009) is key to understanding the meaning of embodiment and its associated implications for developmental science.

Body-Enactivism and the Embodiment of Mental Life

Enactivism encompasses various approaches (e.g., Chemero, 2009; Hutto & Myin, 2012; Noë, 2004; Thompson, 2007; Varela et al., 1991) that are bound together by broad theoretical commonalities (see Kiverstein & Clark, 2009). Generally speaking, these approaches share the emphasis of body-functionalism in challenging the traditional framing of cognition as a process occurring solely "inside" the individual. Where the concept of *enaction* differs from the notion of *extension* is through the enactivist emphasis on structural coupling and the co-determined relations between an organism and its environment.

Central to enactivist accounts is the notion of the action feedback loop, such that the actions of the organism modify its relation to the environment, which then influences subsequent actions (Stewart, Gapenne, & Di Paolo, 2010). For the enactivist, the processes of activity and adaptation involved in this loop represent a form of structural coupling between organism and environment, which as a consequence are seen as being co-determined by each other. This emphasis on structural coupling leads to another recurrent theme in the enactivist approach, namely that mental life can be studied without relying on the concept of representation. For proponents of more radical versions of this emphasis, this position stems from the non-linear nature of the coupling between organism and environment. As framed by Silberstein and Chemero (2012):

> Non-linearly coupled animal-environment systems are taken to form just one unified system. This removes the pressure to treat one portion of the system as representing other portions of the system—at least for many cognitive acts. That is, if the animal-environment system is just one system, the animal portion of the system need not represent the environment portion of the system to maintain its connection with it. There is no separation between animal and environment that must be bridged by representations.
>
> (p. 40)

This sentiment takes enactivism in a different direction to the body-functionalist approach, which relies on representations as the vehicle for computation, even if aspects of the computational process are located outside of the head. For the enactivist, representations are jettisoned in the service of finding a model of mental life that is unadulterated by computation in the conventional sense. This goal leads to a further emphasis on the use of tools from dynamical systems theory to model the structural coupling of organism and environment (Carter et al., 2014). For proponents of enactivism, dynamical systems methods are well suited for modeling the coupling of an agent's behavior over time with the changing state of the environment, without relying on the manipulation of symbols or the need to invoke the concept of representation (Chemero, 2009).

As pointed out by various critics, the enactivist emphasis on dynamical systems methods raises certain challenges. One criticism of this emphasis has been that although dynamical systems methods are well suited to modeling some behavioral phenomena, they do not lend themselves to solving the "representation-hungry" problems typically encountered in the study of more complex cognitive tasks (Clark, 1997). As noted by Witherington (2015), another issue is that some developmental approaches relying on dynamical systems methods have inherited the Gibsonian assumption of preexisting environmental structure (e.g., Thelen & Smith, 1994). This assumption is mistaken, since "meaning must be actively constructed and does not inhere in the world . . . the world becomes meaningful . . . only in the context of an organism actively structuring it—assimilating it—and in turn actively accommodating to it" (Witherington, 2011, p. 287). This sentiment would be likely endorsed by developmental scientists who see constructivism as being fundamentally consistent with system approaches (van Geert, 2012; Witherington & Margett, 2011). From a broader developmental viewpoint, how meaning is constructed is the central focus of one particular enactivist approach that will now be discussed in more detail.

Autopoietic Enactivism

From the enactive perspective, cognition is not seen as being located inside the brain—or indeed in any specific location—and arguments about the boundaries of the cognitive system are viewed as meaningless. In a summary of the issues arising from this radical notion, Di Paolo (2009) presents enactivism as an

> intellectual move that that puts traditional intuitions about cognition into question, not just intuitions about boundaries. After the move is concluded, new genuine questions arise: how can we then make sense of a cognitive system as an agent, with a perspective, values, norms, and even subjectivity? After tearing down the boundaries, in what sense can we recover an unprejudiced notion of an *individual* cognizer, a center of activities and perspectives (and responsibilities), if at all?
>
> (p. 11)

The question here is how the notion of "an individual cognizer" can mesh with radical enactivist approaches in which the identity of the individual organism disappears into a diffuse web of dynamic couplings. One attempt to avoid this issue comes from a biologically oriented systems view of embodiment that has become known as *autopoietic enactivism*. Although this account does not specify cognition as being "located" in a particular place, it does place a central focus on the embodied organism as a living, biological agent whose identity is defined by the nature of the interactions it can engage in. For some autopoietic enactivists, this leads to a broad view of cognitive processes as being constituted by those interactions (or perturbations) between the organism and the system it inhabits (Thompson, 2007).

The concept of autopoiesis, as put forward by Maturana and Varela (1980), refers to an organizational characterization of a system, or the relations among the components of a system. An autopoietic system is characterized by a particular pattern of organization that is maintained even as patterns of connectivity are rearranged in response to perturbation of the system. As autopoietic systems, living systems are self-creating and self-organizing in a fundamentally different way to nonliving systems. Central to this approach is the idea that living systems "construct themselves by generating the very boundary conditions necessary for the creation and maintenance of their self-organization" (Witherington, 2011, p. 79). The centrality of self-organization for the autopoietic-enactivist account connects to historical discussions of how a living system perpetuates itself through activity that provides a causally relevant organizational structure that is part of, and not external to, the system itself. These discussions date back to Aristotle, with related ideas being voiced in the writings of the biologically oriented theorizing of Piaget (see Müller, Ten Eycke, & Baker, 2015).

Autopoietic systems construct and actively maintain themselves in the midst of what enactivists sometimes call the *precarious circumstances* in which living organisms exist. One central idea here is that without this property of self-maintenance, the individual processes that make up a system will cease to operate. In other words, without the adaptive, emergent self-organization that characterizes an autopoietic system, the system would cease to exist. This leads to the notion that an autopoietic system is an autonomous system because it "intervenes in its own substrate in order to sustain a form which is made out of the components that paradoxically provide the very tendencies towards the dissolution of the same form" (Di Paolo, 2009, p. 16). This important idea differentiates the concept of autonomy in the autopoietic approach from the usage of the term in other branches of cognitive science. Froese, Virgo, and Izquierdo (2007) highlight a differentiation between *behavioral autonomy*, in which the identity of a system is externally imposed by a designer (e.g., in robotics), and *constitutive autonomy*, which is closely related (but not identical) to the notion of autopoiesis. The processes that characterize a constitutively autonomous system are "related as a network, such that they recursively depend on each other in the generation and realization of the processes themselves, and . . . they constitute the system as a unity recognizable in the space (domain) in which the processes exist" (Varela, 1979, p. 55).

In an extension of his original ideas about autopoiesis into a theory of enaction, Varela (1997) contended that the organizational properties of self-production and self-distinction are key to understanding the nature of an organism's values and norms (i.e., its identity). What Varela was

suggesting is that the process of forming an identity is a fundamental aspect of the individual organism, and that this emergent identity both arises from, and provides a reference point for, the range of interactions that the organism can have with its environment. More specifically, this range of interactions encompasses the perturbations that can result in structural changes in the living (autopoietic) system that includes the organism and its environment. In this view, it is the range of relevant perturbations that enacts, or "brings forth," the cognitive world of the organism. In simpler terms, the identity of the organism is realized (and constrained) by the nature of its embodiment—an idea that will be expanded on below and will be returned to toward the end of this chapter.

The idea that an organism's world is brought forth or enacted through the range of relevant possibilities is connected to a line of thinking about the nature of the organism by philosophers such as Jonas and Plessner (for discussion see Weber & Varela, 2002). In combination with the notion of autopoiesis, the concept of enaction provides a distinctive way of thinking about the biology of cognitive processes by placing an emphasis on autonomy and identity at the level of the individual organism. The autopoietic-enactive perspective makes a connection between the concept of autonomy and the normative engagement of a system with its world, or what has been called *sensemaking* (Thompson & Stapleton, 2009). This notion centers on the idea that as an adaptive agent, the organism possesses mechanisms through which the various possibilities for action or for responding to environmental signals have meaning for that individual organism. The range of responses reflect the way in which the possibilities for action "make sense" in the world that the organism enacts. In turn, this nature of sensemaking for an individual organism is tightly interwoven with its identity. In line with the biological roots of autopoietic enactivism, this principle is seen as being relevant to all living organisms, from bacteria to *Homo sapiens*. Connecting these ideas with those of others such as Jonas (1966), proponents of autopoietic enactivism such as Thompson (2007) have suggested that the process of identity generation is linked to the notion of sensemaking in terms of the normative relation between the identity (the autonomous, agentive organism) and the system. Although the domain of interactions that a bacterium can have with its environment is quite different from that of a fly, a shrew, or a human, the range of possibilities is relevant to—and actually constitutes—the identity of that individual organism. However, while the processes of identity generation for a unicellular organism may simply be about the maintenance of metabolic processes, for more complex organisms the enactivist notion of sensemaking extends to all levels of interactions with the environment, including social aspects (De Jaegher & Di Paolo, 2007).

The construct of sensemaking in the enactivist account presents a move away from the problem of *making meaning* that has hobbled more mainstream, cognitivist approaches in cognitive science. In framing cognition as a disembodied process occurring on an isolated computational device, cognitivism precluded any serious consideration of meaning (Bruner, 1990). By viewing the mind as a computational engine that manipulates representations according to rules that operate on the syntactic, formal properties of representations (i.e., their physical properties) rather than their semantic contents (i.e., their meaning), cognitivist approaches are fundamentally limited in their scope for understanding human cognition (Searle, 1980). This problem, which is also known as the *symbol grounding* problem (Harnad, 1990), was at the heart of arguments that were initially voiced by critics of the cognitivist focus of early work in artificial intelligence (Dreyfus, 1972). According to these critics, the disembodied nature of symbol-crunching computational approaches could not adequately address the question of how these symbols can be meaningful for the device on which their manipulation is being carried out. Early expectations for progress in artificial intelligence through a cognitivist framework were, therefore, misplaced because of the fundamental problem faced

by an isolated computational system in "needing to impose a meaning on a meaningless Given" (Dreyfus, 2006, p. 45). Indeed, the inadequacy of cognitivism to account for meaning has been highlighted by various theorists including Edelman (1992) and Thompson (2007). This same issue is at the heart of Overton's writings on development and embodiment, which will be discussed in the final section of this chapter.

Embodiment and Development in the Process-Relational Metatheory of Overton

In viewing cognition through a systems lens, enactivism has an inherently ontogenetic aspect, in the sense that the structural coupling of organism and environment is continuously modified through the activity of the individual in combination with environmental perturbations. This adaptation introduces a developmental aspect that Vernon (2014) calls the "process of establishing and enlarging the space of mutually-consistent couplings that the cognitive system can engage in" (p. 166). However, despite their central importance, developmental considerations tend to remain in the background of enactive accounts. In contrast, one view of the embodied mind that emphasizes ontogenesis comes through the writings of Willis Overton (2004, 2006, 2008, 2013b, 2015). In particular, the process-relational developmental systems metatheory of Overton and Lerner demonstrates how embodiment can play a key role as an integrative "bridge construct" linking different areas of the study of the person within developmental science.

For scientists interested in moving toward more integrative accounts of mental life, autopoietic enactivism offers a way of moving beyond a split mind–body dualism by challenging the Cartesian conceptions of mind as "a thinking thing." Similarly, Overton does not pit mind and body against each other but instead integrates them into a whole. To use a phrase from his developmental lectures to undergraduates at Temple University, mind is "an active system or organization of cognitive, conative, and affective meanings or understandings, along with procedures for implementing and changing these meanings." This move away from the mind as a thing, combined with a developmentally oriented conceptualization of the relations between structure and process, takes us to an integrative view of mind that can move us beyond the dead-end, split conceptualizations of Cartesian cognitive science.

As well as emphasizing developmental aspects, Overton's writings on embodiment bring out the importance of considering the "lived body" in theorizing on embodiment. Overton (2008) takes the view that our perceptions, thoughts, feelings, and desires are contextualized by our being active agents with a particular kind of body. According to this view, "the kind of body we have is a constitutive precondition for having the kind of behaviors, experiences, and meanings that we have" (Overton, 2013b, p. 55). In turn, this suggestion brings with it a wider view of embodiment as the relationally interpenetrating process among person, biology, and culture. As Overton (2008) points out:

> Embodiment references not merely physical structures, but the body as a form of lived experience, actively engaged in and with the world of sociocultural and physical objects. The body as form references a biological standpoint, the body as lived experience actively engaged references a phenomenological or psychological person standpoint, and the body actively engaged in and with the world points to a contextual social, cultural, and environmental standpoint.
>
> (p. 3)

Within the process-relational developmental systems metatheory of Overton and Lerner (see below), embodiment is therefore a concept that bridges and joins in a unified whole the various standpoints from which human mental life can be studied. This view of embodiment goes far beyond the simple accommodation of bodily factors as inputs into cognitive models, and it starkly exposes the limitations of the cognitivist account of mental processes running on an isolated computational device.

Overton's emphasis on the lived body relates to phenomenological influences on embodiment, particularly Merleau-Ponty (1967), who also distinguished between the kind of structure or forms of behavior that are realized in living and nonliving systems. As part of this endeavor, Merleau-Ponty noted that the processes of active self-creation and self-maintenance distinguish the self-organization of living systems from nonliving phenomena. While this line of thought became central to the autopoietic-enactivist account, self-organization in biological systems has been studied from various other perspectives (Camazine et al., 2003). The overall patterns that arise in self-organizing systems are sometimes considered as originating from the dynamic balance between opposing processes (e.g. inhibition and activation) at the local level, without reference to the global pattern. However, from the perspective of embodied developmental accounts such as that of Overton (2015), it is a mistake to ignore the influence of the global pattern on local processes.

For Overton, the mutuality of local-to-global and global-to-local influences adds an emergent aspect to self-organization in living systems, and puts an emphasis on the causal role of what can be called *pattern explanation*. This type of explanation is allowed by the idea that the structure or organization of the endogenously active system can have more than a descriptive role. A useful way of understanding the causal role of pattern explanations is as top-down constraint, which "involves a lessening of variability, a narrowing of degrees of freedom, and as such plays a critical role in causal explanation by virtue of establishing limitations for what kinds of bottom-up processes . . . are available to a given system" (Witherington, 2015, pp. 89–90). This focus on *emergence* then turns the focus to developmental aspects, and it connects with the suggestion that contemporary developmental science risks an overemphasis on mechanism without acknowledging the causal import of structure (Overton, 2010; Witherington, 2011, 2014).

Although developmental aspects of embodiment are implicit themes in the biologically oriented enactivist approaches, the importance of applying the principles of embodiment to developmental science is increasingly evident (Lerner & Benson, 2013a, 2013b; Marshall, 2014; Marshall, 2016; Overton, 2008). In this respect, embodiment can be considered a core construct of what has become known as process-relational developmental systems metatheory (Overton, 2014, 2015). Rather than being associated with a specific methodology, it is helpful to view process-relational developmental systems as a "midrange" metatheory that combines the broader relational worldview with the tenets of developmental systems theory (Overton, 2013b). More specific constructs and empirical methods can then be viewed as being coherent (or not) with the metatheoretical approach of process-relational developmental systems. According to Overton (2013b), coherence among more specific theories and methods and the midrange metatheory comes through the core concepts of system, action, and embodiment.

In line with the theorizing of Overton (2008, 2013b, 2015), it is suggested here that embodiment can take us beyond the problematic dichotomies that have historically impeded the emergence of a truly integrative developmental science. As such, embodiment enables a coherent account of the development of body, brain, and mind as a differentiated and unified system, operating within a broader sociocultural system. This view of embodiment goes beyond the idea that developmental aspects of embodiment are most applicable to research on physical and motor development in infancy (Needham & Libertus, 2011). While this more

constrained view of embodiment may be useful for some purposes (although see Longo, 2009), the theorizing of Overton (2008) emphasizes the wider and deeper implications of embodiment for lifespan developmental science.

As noted by Overton (2015), embodiment is one of the necessary defining features of the processes involved in developmental change as well as the relational developmental system. From this wide-angle viewpoint, "Embodiment represents the relationally interpenetrating process among person, biology, and culture" and "embodied action constitutes the fundamental process for all developmental change" (p. 50). Development occurs through embodied actions-in-the-world that operate epigenetically and that form complex positive and negative causal feedback loops. Here embodiment is seen as a necessary defining feature of developmental change processes, with embodied action constituting the fundamental process for all developmental change (Overton, 2015). In this view, embodied action is carried out by an enactive agent, not a passive agent, with this distinction echoing the notions of action and autonomy that were discussed in the previous section on autopoietic enactivism.

In the process-relational account, embodiment further introduces an emphasis on the individual that echoes the motivations of autopoietic enactivists to counter what Di Paolo (2009) called "the worrying evaporation of the organism from contemporary biology" through a focus on scientific endeavors below the level of the organism (neuroscience and genetics) and above it (ecological and evolutionary approaches). In many ways, Overton's work helps us work against the disappearance of the *person* in contemporary developmental science. From the perspective of process-relational developmental systems, the focus moves from the autonomous agency of the organism to the "person-agent" as the enactive source of action, with action being the source of meaning (Overton, 2008).

According to Overton, acts can be at the subpersonal level in terms of the activity that characterizes any self-organizing system. Acts at the personal level refer to intentional, goal-directed activity that is instrumental/adaptive and expressive of meanings (conscious or now) and constitutive of the world as known, felt, or desired. As noted by Overton (2008):

> At the agent level, embodiment specifies the characteristic nature of the activity of any living system (e.g., the world of the fly is necessarily shaped by the nature of the fly's embodied acts). At the person level, embodiment affirms that from the beginning, bodily acts constrain and inform the nature of intentionality.
>
> (p. 8)

In this view, while intentionality involves a symbolic, reflective system of meanings, it emerges from a system involving engaged and embodied actions at an implicit, more minimal level of cognition (Bermúdez, 2000). At a psychological level, this emergence may depend in part on aspects of the early-developing body schema, a construct that has been considered from a developmental perspective both in terms of psychological meanings (Gallagher & Meltzoff, 1996) and neuroscience aspects (Marshall & Meltzoff, 2015).

Through the lens of process-relational developmental systems metatheory, we come to see embodiment as a key aspect of understanding the person as a "dynamic, self-creating, self-organizing, and self-regulating system that is embodied, embedded, and encultured" (Overton, 2013a). This statement brings us to a central part of Overton's view of embodiment: that the thread of embodiment runs through transformational developmental change as new capacities for practical, symbolic, and reflective thought emerge in an epigenetic fashion. This emphasis from Overton's work brings important developmental considerations to what has become known as "4E" cognition, which stands for *embodied*, *embedded*, *extended*, and *enacted* (Menary, 2010a). While wider developmental aspects of 4E cognition have sometimes been considered (Stotz, 2014), they have been underemphasized in the literature. It could be

further argued that 4E cognition is not sufficiently balanced for an integrative view of mind. The consideration of three additional "Es" (epigenesis, emergence, and enculturation) in the process-relational developmental systems account allows us to appreciate both the wider implications of embodiment for developmental science, and the implications of development for understanding embodiment (Overton, 2013a). It is hoped that the coming years will see the emergence of this complementarity in the fullest sense.

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4 Dynamic Systems Theory

David C. Witherington

For over 40 years, Willis F. Overton has been at the forefront of efforts in developmental science to both elucidate and ultimately transcend the pernicious conceptual divisions that have long plagued the field (e.g., Overton, 1973, 1984, 1991, 1998, 2006, 2013, 2015; Reese & Overton, 1970). Unparalleled in its cogency and conceptual rigor, Overton's work has systematically delineated the "background concepts," or metatheoretical frameworks, that necessarily "ground, constrain, and sustain" every facet of research on development and developmental process (Overton, 2015, pp. 13, 15). His longstanding critique of the Cartesian-Split-Mechanistic paradigm—a world view that dominated the field's overarching conceptualization and study of development for much, if not most, of the last 100 years—has been instrumental in revealing that metatheoretical framework's core conceptual inadequacies. In its stead, Overton has advanced and fully articulated a *Process-Relational* paradigm, one that heals traditional dualisms of the field and substitutes an explanatory pluralism for the reductionism and foundationalism of the mechanistic split tradition. In short, Overton's work has spearheaded a revolutionary metatheoretical shift in developmental science: from the mechanistic ontology of substance and being to the relational ontology of process and becoming. And more so than any other proponent of this paradigm shift, Overton (2015) has unfailingly emphasized the "necessary indissociable relation" (p. 37) between process and organization (or, more generally, function and structure) in our explanations of developmental stability and change, marrying a focus on the bottom-up dynamics of developmental process with a holistic structuralist emphasis on system organization as explanatory in its own right (Witherington & Heying, 2015).

One of the most prominent approaches over the last two decades to wholeheartedly embrace the anti-reductionist, process orientation of developmental science's revolutionary metatheoretical shift has been the dynamic systems (DS) approach to development (Hollenstein, 2011; Witherington, 2015). At its core, the DS approach represents an application of the mathematics of nonlinear dynamics to the study of developmental phenomena, specifically in the form of a set of analytic tools and geometric modeling techniques for describing and predicting change in all its complexity (Abraham & Shaw, 1992; van der Maas & Raijmakers, 2009). Quantitatively, the mathematics of nonlinear dynamics rely on nonlinear differential and difference equations to model *interdependent* rates of change among a system of variables over time. These nonlinear equations, in turn, reveal how incremental, quantitative change in an iterated set of variables—for which the output of one iteration of an equation feeds back to that same equation for its next iteration—can suddenly coalesce to shift the equation's solution to new levels of patterning. Qualitatively, the mathematics of nonlinear systems rely on geometric modeling of the interdependent motions of variables in a system through construction of a multidimensional state or phase space, with each axis of the space corresponding to a variable employed in the equations of motion that represent the system and its change over time. Those portions of the state space toward which the motions of a system's variables

converge represent the attractors of the system, corresponding to stable "behavior" of the system. Such geometric modeling over time reveals stable patterning in a system of relations among variables as well as qualitative reorganization among those relations, reflected in the emergence of new attractors and the disappearance of others in the topographical layout of the state space (Guastello & Liebovitch, 2009; Kaplan & Glass, 1995; Witherington, 2015).

As an example of the thoroughgoing compatibility between nonlinear dynamics and developmental change, consider a developmental "milestone" like the emergence of reaching in young infants. Thelen and Smith (1998) have detailed how infants' reaching activity at 3 to 4 months emerges from "the continuous processes of moving and perceiving that occur before infants perform the first goal-directed reach" (p. 608). Specifically, infant reaching developmentally emerges from quantitative changes in various *nonreaching* component skills, ones that already characterize infant organization during the first couple months of postnatal life such as developing head and neck stabilization, upper torso control, visual attention, muscle and joint control, arm coordination, and patterns of muscle activation. A gradual change in one component of infant nonreaching activity—for some infants, developing use of their anterior deltoid muscles to raise their arms—prompts a reorganization in the dynamic interrelations of these other component skills, and *through the new interrelations that form among these components*, infant reaching is born.

The mathematics of nonlinear dynamics have revolutionized how we study and understand process. They highlight the critical importance of 1) variability, 2) nonlinear relations among components of a system, and 3) local conditions and activity, for mapping the temporal dynamics of stability and change in any *open* system (i.e., one that exchanges material and energy with its surround), whether organic or inorganic (Guastello & Liebovitch, 2009). As analytic tools and techniques, these mathematical models elegantly instantiate the ontological categories of activity, process, and change endemic to a Process-Relational paradigm (Overton, 2015). However, as a number of DS proponents have emphasized, the tools of nonlinear dynamics can serve many theoretical (and metatheoretical) masters (van der Maas & Raijmakers, 2009; van Geert, 2004). When we move upward from the analytic techniques themselves to the conceptual frameworks that subsume these techniques and that constitute the guiding ontological principles behind the DS approach to development, we encounter some measure of *conceptual* disparity among proponents of the approach. This disparity is manifest in the distinction that van Geert and Steenbeek (2005) have drawn between their "Groningen" approach (e.g., van Geert, 1998; van Geert & Fischer, 2009) and the "Bloomington" approach of Thelen, Smith, and Spencer (e.g., Spencer, Perone, & Johnson, 2009; Thelen & Smith, 1994, 2006). And closer inspection reveals not just surface-level disagreements among DS proponents, but a deep-seated metatheoretical division within the DS approach, belying the DS approach's unifying nomenclature and cadre of mathematical modeling techniques (Witherington, 2007, 2011, 2015). At the crux of this metatheoretical division is the ontological status of organization and structure in explanations of development.

As I will discuss in more detail in the pages to follow, all proponents of the DS approach to development are conceptually aligned in rejecting the *mechanistic* reductionism behind the Cartesian-Split-Mechanistic paradigm, a reductionism that regards organisms as ontologically decomposable into a set of independent, foundational parts (or elemental structures) and their linear, additive relations (Overton, 2013, 2015). Furthermore, all proponents uphold Process-Relational notions of developmental process, in which new levels of organization and structure in an organism arise not from parts inside the organism or from the shaping of a surrounding context but from the reciprocal, nonlinear "coactions" among various intra- and extra-organismic components that comprise the organism-environment system. All proponents, in other words, fully subscribe to the *process* orientation of the Process-Relational paradigm. But their steadfast focus on the dynamics of process leaves

some proponents of the DS approach susceptible to a new kind of reductionism, one that, if seriously entertained, undermines the approach's alignment with a Process-Relational paradigm and instead encourages a Cartesian-Split-Mechanistic view of development (Witherington, 2007, 2011; Witherington & Heying, 2013). This new kind of reductionism is manifest in the *explanatory reduction* of all organization to process, establishing a strict, ontological divide between causal processes and emergent, organizational products (Witherington, 2011). In brief, the DS approach is susceptible to privileging (and taking as foundational) *process over organization* and *function over structure*, ignoring the ontological category of necessary organization and the basic principle of holism that serve as defining features of the Process-Relational paradigm (Overton, 2015; Witherington, 2015).

Overton has long warned that theories and concepts which challenge an orthodox paradigm can easily derail and regress toward the very paradigm they seek to challenge, unless those theories and concepts are explicitly grounded "at the level of ontological/epistemological discourse" (Overton, 1998, p. 128). Conceptual division in the DS approach over the role of organization in developmental explanation trades on precisely this problem, with some DS proponents running afoul of just such a regression. The purpose of this chapter is to review conceptual unity and division in the DS approach and to ground DS division in terms of metatheoretical frameworks for understanding development, with the goal of specifically articulating the conceptual parameters under which the DS approach fully embodies the organization-process reciprocity of a Process-Relational paradigm. To do this, I first turn to an overview of the world view synthesis that defines the Process-Relational paradigm.

The World View Synthesis of the Process-Relational Paradigm

The Process-Relational paradigm relies on what Overton (2015) has termed a "coherent synthesis" (p. 26) of two world views: organicism and contextualism. *Organicism*, also known as the organismic world view, takes as its basic metaphor the organism as active constructor of reality through engagement with the world (Pepper, 1942; Reese & Overton, 1970). In this world view, any living, organized system constitutes an irreducible, integrated whole, and its development is marked by irreversible, directional and qualitative changes in the formal properties of that whole (Overton, 1984; Pepper, 1942). The key to organicism lies in its *formal* explanatory focus: understanding a system and its activity starts with the *system as a whole*—the organization that marks a system's activity—and the explanation that wholes provide (relative to the parts and processes that comprise them) is of a fundamentally different nature than the explanation that parts and their relations provide relative to the whole (Witherington & Heying, 2013). Specifically, understanding in organicism invokes what Overton (1991) has termed *pattern* explanation, which involves explanation *by means of abstracting pattern* and organizational regularities from the spatiotemporal particulars of activity-in-context. Pattern explanations do not "cause" in the sense of serving as temporal antecedents or propelling "forces" relative to a consequent or outcome. Rather, pattern explanations are *atemporal*, *organizational* levels of explanation. They explain without recourse to the flow of time by invoking the organizational constancy that characterizes living systems—namely, the forms and functions that living systems maintain across specific time periods and contexts in the face of continuous turnover in the constituents of the systems themselves—as a means of explanation in its own right (Rychlak, 1988). Pattern explanation targets an understanding of organisms' specific activities in terms of the general organization and directional purposes those activities evince, as a whole. It has explanatory value because "it introduces order and organization into the domain under investigation" (Overton, 1991, p. 220) and thereby provides an important context of meaning within which to make sense of a living system's specific, time- and context-bound activity.

Pattern explanations are commonplace in scientific explanation, though frequently not acknowledged as such. In psychological and developmental science, for example, when we explain real-time organismic activity by means of psychological constructs such as cognitive and personality structures (constructs that capture organismic functioning *as a whole*, across specific actions and contexts); by means of a particular stage or developmental level of organization; the function served by the action; or ideal endpoints and directional sequences of organizational change (ordering our sense of the directionality of development), we invoke pattern explanations (Overton, 1991). Although psychologists routinely explain organismic activity in this fashion, they all too rarely recognize these levels of explanation for what they are, opting instead to reify these holistic forms and functions in concrete, spatiotemporal terms, namely as antecedent, temporal causes of the activity or as concrete parts/structures within the organism (Lourenco & Machado, 1996; Rychlak, 1988). However, appealing to the *organizational* qualities of an organism as a means of explaining that organism's activity does not and should not suggest that the organizational qualities *precede* or *initiate* the actual behavior of the organism or constitute parts of the organism that drive (in antecedent-consequent fashion) the organism as a whole. From the standpoint of pattern explanation, the orderliness that characterizes behavior at a macrolevel—the organizational qualities of the organism, in other words—is itself an abstraction from the specifics of real-time action-in-context and constitutes an explanation precisely by means of its abstraction.

Organicism backgrounds the particulars of real-time action-in-context—the specific *content* of behavior—in favor of abstracting from the ever-changing present organizationally invariant characterizations, or forms, of action within and between general levels of developmental organization (Lerner & Kauffman, 1985). With its focus on explanation by way of abstraction, organicism largely neglects issues of timing, intra and inter-individual variability, and the specific content of action-in-context (Pepper, 1942). *Contextualism*, in contrast, effectively counters organicism's neglect by highlighting the particularities of time and context. "The event alive in its present" succinctly captures the fundamental metaphor for this framework (Pepper, 1942, p. 232). Rather than explain organismic activity in terms of its organization—in terms of abstract, generalizable forms—contextualism grounds itself in the here-and-now, in the real-time dynamics of organismic activity in specific settings and contexts (Overton, 1991; Pepper, 1942). Change and novelty are the defining features of contextualism, and Pepper (1942) writes that "nothing is more empirically obvious to a contextualist than the emergence of a new quality in every event" (p. 256). Contextualism starts with the present event of specific action in a specific context and proceeds to other events immediately past and in the immediate future but never strays far from the spatiotemporal immediacy and content of the present.

From the standpoint of contextualism, organicism's explanation by abstraction loses sight of the process unfolding in the particulars of action dynamically adapted to local context. Understanding development for a contextualist requires a grounding of analysis in the variability that action demonstrates during real-time, adaptive encounters with everyday contexts, for development is continuous with such real-time change, moving from particular to particular (Overton, 1991). Overall, in the realm of explanatory focus, organicism's neglect of the lower-order dynamics of particulars is matched by contextualism's neglect of the higher-order organizational properties of the whole. Both organicism and contextualism are relational in outlook in that they emphasize the relations that exist among components of a system, not the components themselves (in contrast to the mechanistic world view), and both are synthetic in orientation (Overton, 1984; Pepper, 1942). In the case of organicism, with its integrative focus, synthesis exists at the level of higher-order, organismic form. Contextualism's synthesis, with its dispersive focus, remains wed to the dynamic content of the here-and-now, to the level of specific activity-in-context.

The organismic-contextualist synthesis that is at the heart of the Process-Relational paradigm preserves the distinct explanatory foci of each world view while eliminating their neglectful weaknesses (Overton, 2007, 2010, 2015). Within the explanatorily inclusive metatheoretical framework of the Process-Relational paradigm, both organicism and contextualism operate not as absolute modes of truth but as *interdependent*, complementary frames of understanding—each legitimate in its own right, neither privileged as *the* mode of explanation—whose individual meanings necessarily define (and are defined by) one another as differentiated parts of explanation as a whole. Assigning explanatory significance to *both* the pattern explanation of wholes and the dynamic explanation of the part-to-part nonlinear relations that comprise them, the Process-Relational paradigm promotes a perspectivist framework within which "synthesis and analysis, together with reason and observation, operate in an interpenetrating reciprocal fashion . . . in which each individual approach is valued not as a potentially privileged vantage point, but as a necessary line of sight on the whole" (Overton, 2010, p. 18).

From the contextualist perspective, explanation focuses on the "grass-roots" dynamics of a system's real-time activity in a specific context—on the dynamic interrelations that yield the emergence and consolidation of action content as well as the developmental emergence of new system organization. From the organismic perspective, explanation focuses on the abstracted organization of a system that characterizes functioning across a variety of contexts and that necessarily frames the lower-order, local dynamic interrelations on which such organization depends. Though a system's organization is nothing more than its parts and their dynamic interrelations (Kitchener, 1982), such organization—the wholeness of a system—nonetheless captures what the temporally embedded, dynamic part-to-part relations (to which contextualism appeals) cannot: the structural *totality* of a system as a singular, instantaneous whole, across time and context. The organization of systems, as wholes, thus *explanatorily constrains*, in whole-to-parts fashion, the very meaning of a systems' lower-order dynamics and provides a level of explanation that is lost when focus resides solely at the level of the temporal dynamics of part-part interrelations (Deacon, 2012; Juarrero, 1999; Walsh, 2013; Witherington, 2011, 2015). But of course this very organization emerges from the local dynamics of process, the explanatory domain of contextualism. In embracing both world views, therefore, the Process-Relational paradigm is as much about explanation in terms of global-to-local organizational constraint as it is about explanation in terms of local-to-global dynamic process (Juarrero, 1999; Thompson, 2007).

The Dynamic Systems Approach to Development: Conceptual Unity through Self-Organization

Marrying process and organization is a key theme of the Process-Relational paradigm via its synthesis of organismic and contextualist world views. Such a theme is also prominent in the DS approach to development. In fact, reconciling macroscopic, invariant order at the level of systems as wholes ("the view from above") with microscopic variability and ceaseless fluidity of system parts and processes ("the view from below") constitutes the overarching aim of the approach (Lewis, 2000a; Thelen & Smith, 1994, pp. xiv–xvi). To realize this aim (and in keeping with the approach's grounding in the mathematics of nonlinear dynamics), DS proponents are unified behind a particular focus on the local-to-global, bottom-up dynamics of *emergence*: how macroscopic organization *arises* in open systems *through* the dynamic variability of real-time, local processes (Witherington, 2015).

An open system, as already mentioned, involves constant exchange of both matter and energy with its surrounding environment, resulting in a continual production and dissolution of the component parts that comprise the system. Yet, despite this continuous exchange of lower-order components, open systems can assume stable organization at a macrolevel.

It is, in fact, precisely because of their incessant exchange of matter and energy that these systems both maintain their organization *and* establish more complex levels of organization developmentally. Open systems are *far-from-equilibrium*, and in such systems—from the physicochemical systems of whirlpools and hurricanes to the living systems of cells, tissues, organs, and organisms—local fluctuations, or flow processes, increase both in variability and magnitude, due to exchange with the surrounding environment (Prigogine & Stengers, 1984; von Bertalanffy, 1968). Under certain thermodynamic conditions of exchange between these systems and their surrounds, flow processes yield stable regimes of organization, maintainable so long as the fluctuations occupy a given range. But beyond certain thresholds, the same interplay of flow processes amplifies, via positive feedback loops, to destabilize the system's current level of organization, "compelling it to evolve toward a new regime" by opening up new possibilities for macrolevel order (Prigogine & Stengers, 1984, p. 141).

It should be stressed that these general dynamics of open systems apply to both inorganic and organic phenomena. The inorganic physicochemical world, in fact, features numerous examples of spontaneous pattern formation under far-from-equilibrium conditions. Consider, for example, the hexagonally shaped convection cells that arise when a shallow layer of liquid is heated or the cloud formations that materialize overhead under conditions of air saturation. Such spontaneous pattern formation illustrates the concept most central to the DS approach to development: *self-organization*. Self-organization is the process by which organization arises, without design, in any physicochemical system (pushed toward far-from-equilibrium thermodynamic conditions) purely through the lower-order fluctuations and nonlinearity of relations among the components that comprise the system (Kelso, 2000; Lewis, 2000a; Thelen & Smith, 1994; van Geert, 2000). With respect to living, developing systems, the process of self-organization explains the emergence of organization both at the level of real-time activity and at the level of developmental transformation. It explains, in other words, 1) the emergence of particular acts in *real-time* from an established repertoire of acts (given that every act an organism performs is unique and specific to a whole host of contextual parameters, both intra- and extra-organismic); and 2) the emergence of *developmental-time* levels of organization, wherein new modes of activity and relation to the world arise in an organism's repertoire and reorganize the repertoire in the process.

Through self-organization, more *complex* levels of organization in open systems developmentally emerge from the nonlinear dynamics—the local activities—that obtain among the *simpler* component parts of the system (van Geert, 2000). Stability and organization at the macrolevel of a system thus *arise from* and are constantly *maintained by* the ever-present microlevel variability and dynamics of the system, meaning that the source of system organization lies within the local, relational activity of developmental processes themselves. As van Geert (1998) has articulated, "the causes of development are *inside the developmental process*" (p. 144). The microlevel dynamics of developmental process entail reciprocal coactions among a self-organizing system's components such that the identity of each component depends on its relation to other components—this, in fact, is what it means for relations in a system to be *nonlinear*. Part-to-part relations in the system involve simultaneous influence among the components, with any given component serving as both cause and effect because component A is affecting, while simultaneously being affected by, component B, and vice versa (Ford & Lerner, 1992). Given that the system as a whole is multiply determined—with different parts of the whole necessary but insufficient interactants in the joint production of the whole—causality is spread across all of the parts that make up the whole such that each part influences the emergence of the whole without determining it, rendering the whole irreducible to its parts (remember that the system as a whole—its organization—is nothing more than its parts *and* their complex, dynamic interrelations, so at one level of analysis, systems are, in fact, reducible to the dynamic interrelations of its parts; however, from an organismic vantage

point, the system as a whole provides its own, unique level of explanation that is lost when the system is just viewed in terms of these temporally unfolding dynamics). The concept of self-organization thus embodies a distributed, relational view of causality with respect to part-to-part relations of a system (Witherington, 2015). Such a view of causality flies in the face of the absolutist notions of antecedent and consequent—cause and effect—that undergird the mechanistic framework of the Cartesian-Split-Mechanistic paradigm.

By the concept of self-organization, both the real-time emergence of activity-in-context (e.g., reaching for a specific object) and the developmental-time emergence of new levels of organization in an organism's functioning (e.g., transitioning from sensorimotor to preoperational forms of intelligence) constitute *genuine novelties* of content and form in the sense of not being prefigured by any parts of the system (e.g., structures in the brain for controlling reaching) or its environment via rules, prescriptions, or "instructions" (in, for example, the genes) for what patterning of organization will emerge (Oyama, 1985; Thelen & Smith, 1994, 2006). Just as the qualities of water (e.g., its wetness) are truly emergent from the covalent bond between two hydrogen atoms and one oxygen atom and are not in any way prefigured or "informationally" contained in either the oxygen or hydrogen atoms themselves, so every act an organism performs and every level of organization that arises in an organism's development are truly emergent and are not in any way prefigured or informationally contained in any of the organism's component parts or processes; in any of the organism's surrounding environments; or in previous levels of organization in the organism.

The concept of self-organization explicitly rejects the mechanistic idea that independent parts of organisms or their surrounding environments 1) constitute receptacles of "information" for the specification of how an organism acts or of new levels of developmental organization in the organism; and 2) serve as antecedent causal forces acting on the organism to implement transfer of this information, much as the kinetic energy of one billiard ball is imparted to another by spatiotemporal contact. Self-organization rejects this view of development as a process of "transmission," as the transfer of pre-existent information from more elemental causal sources, such as parts of the organism or its context, to the organism as a whole (Oyama, 1985). Such appeals to pre-existent information effectively negate the idea that system organization truly does emerge, as an *irreducible whole*, in real-time organismic activity and over the course of organismic development through the incessant lower-order dynamics of process. Such appeals, in other words, presuppose that a design or "blueprint" of some kind for the generation of real-time organismic action or for the development of organisms *preexists* the actual processes of acting and developing. This invokes the potential for infinite regress since appealing to a blueprint or design to explain development simply begs the question of where the design came from (i.e., what designed the blueprint?) and doesn't really explain anything by itself (Oyama, 1985; Thelen & Smith, 1994, 2006). In self-organization, order arises in a system without design or blueprint, as a function of the nonlinear, relational dynamics endemic to open systems under far-from-equilibrium conditions.

In its focus on explaining higher-order organization *by means of* lower-order temporal dynamics, the DS approach adopts a bottom-up, contextualist lens of inquiry toward development: from the local activity of real-time processes to the global stability of system organization (Witherington, 2015). The core concepts of the approach—emergence through the bottom-up dynamics of self-organization, distributed causality in the part-to-part relations of systems, and the repudiation of rules and prescriptions for either real-time activity or developmental-time organization, meaning that "patterns of behavior [are] 'softly assembled' from multiple, heterogeneous components exhibiting various degrees of stability and change" (Thelen & Smith, 2006, p. 276)—underscore the approach's grounding in time and context, specifically the real-time, local dynamics of activity-in-context that engender both organizational stability and transformation in development (Thelen & Smith, 1994). Such a

contextualist lens of inquiry, as previously detailed, constitutes a critical frame of understanding within a Process-Relational paradigm. But is the conceptual framework that the DS approach brings to bear on the phenomenon of development ontologically bound to this particular frame of understanding—to contextualism exclusively? Or does the DS approach embody a perspectivist framework, in keeping with the Process-Relational paradigm and its organismic-contextualist synthesis?

The Dynamic Systems Approach to Development: Core Conceptual Disparity over Circular Causality

A basic, metatheoretical divide exists among proponents of the DS approach to development with respect to whether DS's contextualist focus constitutes an absolutist, foundational stance (resulting in a split-mechanistic approach to contextualism; see Overton, 2007) or whether its contextualist focus is situated within the more inclusive organismic-contextualist synthesis of a Process-Relational paradigm (Witherington, 2007, 2011, 2015). Those proponents who adopt an *exclusive DS approach* to development—such as Thelen and Smith (1994, 2006) and Spencer (Spencer, Perone & Buss, 2011; Spencer et al. 2009; Spencer & Schöner, 2003)—treat DS's contextualist focus on temporally unfolding process not as *a* focus but as *the* "rock bottom unchanging nature to Reality" (Overton, 2013, p. 38), ontologically establishing these temporal dynamics as the only legitimate mode of explanation for understanding development. For exclusive DS proponents, the core DS concept of self-organization entails a repudiation of the explanatory significance of a system's structure, such that the organization of a system exists only as epiphenomenon, as a "momentary *product* of a dynamic system, not a dissociable cause [i.e., explanation] of action" (Thelen & Smith, 1998, p. 617). System organization thus becomes only an object of study—something *to be explained*—and not a mode of explanation in its own right (via pattern explanation). In their wholesale rejection of the organismic world view and its pattern explanation, proponents of the exclusive DS approach dispense with the idea of alternate, complementary vantage points in favor of reducing all explanation to the concretely grounded, temporal dynamics of bottom-up processes and the contextualist perspective these temporal dynamics entail (Witherington, 2011; Witherington & Heying, 2013). As such, the exclusive DS approach to development regresses to a Cartesian-Split-Mechanistic paradigm (Witherington, 2007, 2011; Witherington & Heying, 2013).

However, those proponents who adopt an *inclusive DS approach* to development—such as van Geert (1998, 2000; van Geert & Fischer, 2009), Lewis (2000a, 2000b, 2005), and van der Maas (1995; van der Maas & Raijmakers, 2009)—treat DS's contextualist focus on the bottom-up, temporal dynamics of construction as a relative vantage point, one that is complemented by an equally legitimate *organismic* vantage point in which system organization is viewed as explanatory in its own right. The inclusive DS approach, in other words, embraces both organization and process as vital to understanding the development of complex systems, consistent with an organismic-contextualist synthesis; for these DS proponents, "local processes are not more real than the emergent structures" to which the processes give rise (van der Maas, 1995, p. 632). Within the metatheoretical framework of the inclusive DS approach, conceiving of self-organization as the bottom-up temporal dynamics behind the construction of system organization captures only one side of a broader explanatory cycle for the study of developmental stability and change. The full explanatory cycle of an inclusive DS approach involves *circular causality* and targets not just part-to-part and parts-to-whole relations in a system but also whole-to-parts relations (Juarrero, 1999; Kunnen & van Geert, 2012; Lewis, 2000a, 2000b).

For proponents of the inclusive DS approach, fully articulating the complexity of emergence in self-organizing systems requires *fully reciprocal bidirectional* (←→) relations both

within and across levels of organization in systems and their development, targeting both "local-to-global determination (the formation of macrolevel patterns through microlevel interactions) and global-to-local determination (the constraining of microlevel interactions by macrolevel patterns)" (Thompson, 2007, p. 336; Witherington, 2015). These relations comprise two basic "directions of influence between scales of self-organization" (Lewis, 2002, p. 186). Lower-order interactions among components of a system yield higher-order forms, both at the scale of real-time self-organization by generating temporary, short-term emergent forms (e.g., organized, task-specific activity) and at the scale of developmental-time self-organization, by generating longer persisting, stable levels of organismic organization (e.g., stages of development). This direction of influence involves what Lewis (2000b) has termed *reciprocal causality*, wherein lower-order components of a system nonlinearly coact with one another in part-to-part fashion to dynamically construct higher-order, macroscopic organization, à la the bottom-up process of self-organization.

But just as critical to understanding development is the directional influence of higher-order, macroscopic organization—both organization that emerges at short-time scales and that characterizes longstanding periods of developmental organization—on its lower-order components and processes (Lewis, 2002). *Circular causality* broadens reciprocal causality by assigning explanatory status to *both* process-to-organization *and* organization-to-process relations in a system. In Lewis' (2005) words, circular causality means that "a coherent, higher-order form or function *causes* a particular pattern of coupling among lower-order elements, while this pattern simultaneously *causes* the higher-order form" (p. 174). Complementing the parts-to-whole perspective of bottom-up dynamic processes, the whole-to-parts perspective of circular causality introduces the notion of organizational constraint, whereby the system as higher-order, organizational whole conditions or topologically constrains the degrees of freedom within which its local dynamics—the reciprocal causality of part-to-part relations—can operate (Juarrero, 1999).

In keeping with the organismic-contextualist synthesis of the Process-Relational paradigm, circular causality assigns explanatory status to both parts-to-whole and whole-to-parts relations in systems and highlights the distinct forms of explanation involved in each, promoting an explanatory pluralism in the process (Witherington, 2011, 2015). Parts-to-whole relations involve temporally based process explanations, the hallmark of emergence through self-organization: antecedent process giving rise to organizational consequences. Whole-to-parts relations, in contrast, involve atemporal pattern explanations: a system's organization—the unitary structure of the whole—meaningfully and necessarily frames the very components and relations among components that comprise the system and thus provides a critical backdrop against which part-to-part system relations are fully understood (Witherington & Heying, 2013).

For proponents of the inclusive DS approach, the abstracted organization of pattern explanation is as integral to explaining systems and their development as the temporal dynamics of real-time processes. Contextualizing, for example, a particular action-in-context (e.g., an infant reaching for a hidden object) in terms of an abstracted developmental level of organization (e.g., stage 4 of Piaget's six-stage object-concept sequence) establishes an essential interpretive framework—the organism as an integrated whole at a particular point in developmental sequence—for that action-in-context.

Endorsement of circular causality—across levels of organizational and time-scale abstraction, as proponents of the inclusive DS approach do—establishes *both* the here-and-now activity of an organism within a temporally specific context *and* the context-general, organizational quality that characterizes the organism in the longer term as distinct but complementary frames of explanation (van Geert & Fischer, 2009). By emphasizing the need to consider whole-to-part relations in addition to part-to-part and part-to-whole

relations, circular causality establishes pattern explanation as a legitimate and critical mode of explanation alongside dynamic process explanation, (Juarrero, 1999; Witherington, 2015). Grounded in the "ontological/epistemological discourse" of the Process-Relational paradigm, the inclusive DS approach fully embraces the reciprocity of structure-function, process-organization relations: process cannot be understood without organization any more than organization can be understood without process. Without such grounding, the exclusive DS approach holds exclusively to a process-orientation, absent necessary organization, and in the process demonstrates how easy it is to lapse into the sorts of reductionism and foundationalism that hamper advancement in developmental science.

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5 Biological Processes and Psychological Development

Robert Lickliter

> Relational thinking . . . means treating the organism not as a discrete, pre-specified entity but as a particular locus of growth and development within a continuous field of relationships.
>
> (Ingold, 2004, p. 219)

Introduction

In biology, as in most sciences, seemingly simple questions rarely have simple answers.[1] "What causes development to proceed?" is a good example. Although recent years have seen considerable progress in our understanding of how a fertilized egg gradually transforms into a fetus, an infant, a child, and eventually a fully functioning adult, the degree of complexity involved in this process has proven well beyond what most biologists and psychologists imagined just a few decades ago (see Davies, 2014). For most of the previous century the standard theoretical interpretation of the remarkable transformation from egg to adult was decidedly reductionistic—genes were thought to directly control the process of development. From this view of development, instructions for building an organism were assumed to be present in the organism's genes and genes were also thought to be the exclusive means by which these instructions are transmitted from one generation to the next. Development was thus widely characterized across the biological and psychological sciences as the process by which genotypic specification is translated into the traits and qualities of individuals, including their anatomy, physiology, and behavior. This gene-centric view dominated biological thought during most of the twentieth century.

Things have changed considerably in the first decades of the twenty-first century. Advances across the life sciences, including molecular biology, epigenetics, developmental biology, psychobiology, and evolutionary biology, have converged to support a much less reductionistic view of how development proceeds. Relational systems thinking, with its emphasis on process, activity, change, emergence, and self-organization, has gradually replaced the mechanistic, gene-centric approach to development that was commonplace until relatively recently (e.g., Lerner & Benson, 2013; Overton, 2015).

The consequences of this broader-based relational approach to understanding the ways and means of development are considerable and far-reaching, including novel ways of thinking about the importance of activity and experience to development, the dynamics of emergent properties, the nature and extent of heredity, the origins of variability, and the relevance of development to evolution. These new directions in how we think about development are providing scientists with novel problems, creating new lines of research, and forging links between what have been seemingly unrelated areas of investigation. Despite the fact that

our current understanding of development is somewhat piecemeal and certainly incomplete, recent conceptual and empirical research efforts using a *relational* perspective are providing key insights into what is involved in the process of development as well as suggesting new ways of thinking about developmental and evolutionary change (e.g., Lickliter & Honeycutt, 2015; Overton, 2015; Oyama, 2000).

The Challenge of Developmental Analysis

In my view, any successful theory of development must ultimately account for three fundamental features: the *emergence of complexity of organization by differentiation*, *the origin and range of variability across individuals*, and *the stability of form and function across generations* (Lickliter & Honeycutt, 2009). Attempts at this intellectual synthesis have engaged (and frustrated) scientists for centuries. Indeed, much of the content of eighteenth and nineteenth-century theorizing about development and evolution focused on explaining the possible mechanisms for these three developmental phenomena (see Depew & Weber, 1995; Mayr, 1982 for useful overviews). In the first half of the prior century, biologists eventually converged on a decidedly reductionistic, bottom-up approach to account for the similarities and differences observed across individuals, holding that genes were the key to understanding the fundamental characteristics of development. Genes came to be seen as the cause for an organism's growth and development as well as the cause for the intergenerational stability and variability of traits and qualities observed within species (see Keller, 2000; Sapp, 2003 for overviews). Widespread application of this gene-centered framework in attempts to explain behavior fostered the growth and popularity of the fields of sociobiology, behavioral genetics, and evolutionary psychology in the last half of the twentieth century.

Although enormously influential for a number of decades, the view of pre-specified or predetermined developmental outcomes is now widely recognized as not being up to the significant task of making sense of the dynamics of the developmental process. Most life scientists now realize that development cannot be simply characterized as the expression of a pre-existent genetic program—rather, *development is the very process by which form and function is generated and maintained* (Ingold, 2004; Oyama, 1985; Robert, 2004). As the astute biologist E.S. Russell (1930) noted more than 80 years ago, *the fault of all preformistic or predetermined theories of development is that they translate the future possibilities of development into "material" predispositions*. However, in actual fact these potentialities are purely virtual and conceptual. Their actual appearance or realization is entirely dependent on the varied internal and external resources and relations that make up the process of development (Lickliter, 2013; Oyama, 1985; Robert, 2004).

Approaching development as a process that is deeply situated highlights the need to specify in detail the variety of physical, biological, and social factors that an organism encounters as it develops over time. Importantly, as an organism develops, its relation to the external world also changes, so that its *effective* environments change as well. One of the strengths of the relational approach to development promoted by Overton over the course of four decades (Overton, 1975, 1994, 2013) is its explicit attempt to elaborate an appropriately dynamic view of the changing fields of relations between the organism and its context. Perhaps the most significant aspect of this conceptual framework centers its emphasis on the roles of activity, experience, and context in the achievement, maintenance, and modification of phenotypic traits (McClelland, Geldhof, Cameron, & Wanless, 2015). Overton has repeatedly emphasized that the *activity* of the organism itself (and the feedback it provides) is a critical but often overlooked contributor to the process of development (Overton, 1976; summarized in Overton, 2015).

Activity, Experience, and Context

Life, said Samuel Butler, the nineteenth-century British novelist, satirist, and amateur biologist, is like giving a concert on the violin while learning to play the instrument. Butler's insight that development occurs "in the middle of things" was a particularly astute observation and highlights a key feature of development that was often overlooked or ignored in the gene-centered views of the prior century—development involves the specific activities, experiences, conditions, resources, and contexts individuals encounter and take part in as they live their lives. This recognition that development is a process that is *situated* and *activity-dependent* represents a major shift in thinking from the more passive and pre-specified view of development that was commonplace across the life sciences until recently (see Kuo, 1967 for an early and useful exception). This shift was facilitated by research spanning several decades in a number of different disciplines across biology and psychology, including epigenetics, developmental biology, developmental psychobiology, ecological psychology, and developmental psychology.

This relational account of development, long championed by Overton, represents a radically different view from that assumed by traditional notions of innate, instinctive, or other internally determined characterizations of the regularities of species-typical developmental outcomes. From this dynamic and contingent perspective, all phenotypic traits are generated, constrained, maintained, and reorganized through the activities of an historical, embodied organism actively engaged with its surround. Rather than assuming the expression of a given behavioral trait or skill is based on some set of internally pre-specified instructions, development is seen as a self-organizing, probabilistic process in which pattern and order emerge and change as a result of ongoing coactions among developmentally relevant components both internal (genes, hormones, neural networks) and external (diet, stress, social interaction) to the organism. As Li (2003, p. 187) put it, "human mind and behavior need to be understood by situating them properly within a brain in a body that lives in an eventful world abounding with objects and people."

Integrating Biology and Experience

From this relational perspective, the passing on of a genome in reproduction, although certainly necessary, cannot serve as a sufficient explanation for any developmental outcome, be it morphological, physiological, or psychological. It has become abundantly clear that gene activity and expression are determined by multiple non-genetic factors, with positive and negative feedback loops between genes, cells, organs, body, and environment (see Gilbert & Epel, 2009; Moore, 2015; Noble, 2006). Genetic *and* non-genetic factors constitute a dynamic, mutually dependent, relational-developmental system within which the various levels and components of the system co-act to promote the emergence, maintenance, or modification of phenotypic traits. Thus, it is not biologically meaningful to discuss gene activity and its influences without also referring to the broader context within which genes are activated and expressed (Bateson & Gluckman, 2011; Lickliter & Honeycutt, 2015; Moore, 2002; Stotz, 2006). Simply put, genetic and environmental factors cannot be meaningfully partitioned, despite claims to the contrary by those that continue to embrace some form of the outworn nature/nurture dichotomy.

To illustrate this fundamental developmental principle, consider the recent work of Cole and colleagues (Cole, 2014; Cole et al., 2007; Slavich & Cole, 2013) indicating that human gene activation is subject to social-environmental regulation. Cole and his collaborators (Cole et al., 2007) were able to identify 209 genes that were differentially expressed in circulating leukocytes from individuals reporting high versus low levels of subjective social isolation

(loneliness), including genes involved in immune activation, transcription control, and cell proliferation. Impaired transcription of glucocorticoid response genes and increased pro-inflammatory transcription control pathways were identified in socially isolated individuals, indicating genome-wide transcription activity can be altered in response to chronically high levels of subjective social isolation. These findings (see also Champagne, 2010) highlight the powerful links between biological and social events and illustrate the dividends of abandoning the long-standing divide between biological and social levels of explanation.

Given that we now know that much of what genes do is react to signals from the internal and external environment (Gottlieb, 1998; Moore, 2015), the strategy of dividing developmental influences into biological and experiential factors no longer seems biologically possible (Bateson & Gluckman, 2011; Lickliter, 2009). That being said, not all developmentalists have embraced this hard-won insight regarding the *interpenetration* of biology and experience. As recently highlighted by Lewkowicz (2011) and Griffiths and Tabery (2013), some quarters of cognitive and developmental psychology still actively embrace a nativistic approach to the study of behavioral development (e.g., Carruthers, Laurence, & Stich, 2005; Gelman, 2003; Landau, 2009; Marcus, 2001; Morton & Johnson, 1991; Spelke & Kinzler, 2007). From this view, a number of perceptual, cognitive, and social skills are thought to have their origins in some form of "core" knowledge, thought to be based in our biology and then elaborated upon by experience over the course of individual development (see Blumberg, 2005 for a useful overview). In other words, "core" predispositions and capacities are somehow passed on to individuals in advance of their life in the world.

In keeping with this assumption, some years ago the developmental psychologists Elizabeth Spelke and Elissa Newport (1998) argued for the differential roles of biology and experience in human development, suggesting that a solution to the nature/nurture debate is the "thesis that human knowledge is rooted partly in biology and partly in experience and . . . that successful explanations of the development of knowledge will come from attempts to tease these influences apart" (p. 323). However, contemporary biological research simply does not support these types of divisions or dichotomies. Biology and experience (or genes and environment) are neither alternative nor independent causes for behavioral or cognitive development. As the relatively new and fast-growing field of *epigenetics* has made clear, and as I review in more detail below, biology and experience are completely fused and cannot be meaningfully separated or teased apart, challenging established theories of development, inheritance, and evolution (Hallgrîmsson & Hall, 2011).

The Epigenetic Revolution in Biology and Beyond

Epigenetics can be defined as the study of heritable changes in gene expression and function that cannot be explained by changes in DNA sequence (Holliday, 1994; Richards, 2006) or more broadly as the study of how the environment can affect the genome of the individual during its development, as well as the development of its descendants, without a change in the coding sequence of the genes (Crews, 2008). Contemporary epigenetics includes the study of how patterns of gene expression are passed from one cell to its descendants, how gene expression changes during the differentiation of one cell type into another, and how experiential and environmental factors can modify how genes are activated and expressed. A growing body of research on these topics has consistently demonstrated that our experiences can "get under the skin" and influence how genes function (Szyf & Bick, 2013). For example, diets and nutrients, toxin exposure, parenting styles, stress levels, social stimulation, and an array of other environmental factors have been shown to influence genetic activity through epigenetic mechanisms that silence or activate DNA (Moore, 2015).

DNA does not float freely in the cell nucleus but is compacted and tightly wound around proteins called histones that are densely packed together in structures called chromatin.

For transcription factors to gain access to DNA to initiate gene transcription, chromatin must be chemically altered to loosen the connection between DNA and histone proteins. This alteration involves the addition or removal of molecules (e.g., acetyl or methyl groups) via enzymes on the histone proteins, thereby altering the overall charge (see Meaney, 2010). Depending on how this charge is altered, the connection between DNA and histone proteins can be loosened or strengthened, thereby making DNA regions more or less accessible for transcription. As summarized by Burian (2005),

> systematic silencing of DNA by methylation and various modifications of histones have thoroughly disrupted the notion that the DNA encodes information or contains a program that can be read out in any simple way. A cellular context is required for DNA to function, and different cellular contexts extract different information from the same DNA sequence. (p. 63)

These advances in our understanding of the series of steps by which genes come to be expressed or silenced are seriously challenging reductionistic and deterministic views of development and providing new meaning to the concept of *biological complexity*. As recently noted by Griffiths and Stotz (2013, p. 2), "genes no longer have a single function closely related to their structure, but respond in a flexible manner to signals from a massive regulatory architecture that is, increasingly, the real focus of research in genetics."

The developmental effects of regulatory epigenetic mechanisms can be far-reaching. A striking example is the case of African Pygmies, who as a population are much shorter than other people. Recent evidence indicates that their very short stature is due to a defective response to human growth hormone during puberty. As a result of very low values of serum GH-binding protein present during puberty, Pygmies do not experience the usual growth spurt associated with adolescence, thus maintaining child-like height into adulthood. These differences in responsivity to growth hormone and growth hormone receptors are not due to differences in gene sequences when compared to other local populations, but rather are the result of epigenetic effects on growth hormone receptor (GHR) gene expression (Bozzola et al., 2009).

In terms of behavior and cognition, epigenetic gene regulation by methylation and histone modification has been shown to be involved in various aspects of the development and function of the nervous system, including cell differentiation and neural plasticity (see Feng, Fouse, & Fan, 2007 for a review). Further, there is increasing evidence that the regulation of histone acetylation and DNA methylation patterns mediates long-lasting synaptic changes in the context of learning and memory (Day & Sweatt, 2010; Levenson & Sweatt, 2005). Molecular epigenetic mechanisms thus provide a means of dynamic gene regulation, allowing the nervous system to make long-lasting changes at the level of neural circuitry and neurotransmission as a result of experience. Such epigenetic changes in synaptic structure and function represent a key mechanism for regulating behavioral plasticity. Clearly, given these advances in our understanding of brain development, learning, and memory, epigenetics research has significant implications for psychological science (see Harper, 2005; Masterpasqua, 2009; Zhang & Meaney, 2010), including undermining the dualistic thinking associated with various versions of the nature/nurture debate. Further, results from epigenetics are suggesting the need for rethinking our concept of the "gene" (Keller, 2000, 2010). As recently noted by Ramirez-Goicoechea (2013, p. 64),

> we need a gene concept that allows for self-organization, the mutual historical constitution of parts and whole, the global dynamics and emergent properties of the cell, signals, and networks of interconnection and intercommunication, the relative coherence of biological processes between contingency and determinacy, and a new lexicon that favors interdisciplinary understanding.

Many accounts of development promoted by twentieth-century biologists and psychologists focused on partitioning an organism's phenotypic traits among those that are "biologically" determined and those that are produced by experience. For example, there has historically been great interest in defining the "heritability index" of specific psychiatric disorders (Rose, 2006). The findings emerging from epigenetic research indicate that no such partitioning is possible. The "organism in the world" (see van Speybroeck, 2000) view supported by contemporary epigenetics emphasizes the organism/environment system as the fundamental level of developmental analysis. As a result, developmental causality can only be understood as distributed and relational, principal tenets of Overton's (2015) process-relational-developmental systems framework. This focus on the complexities of the dynamics of development is bringing together genetics, molecular, cellular, and developmental biology, neuroscience, ecology, and evolutionary biology to forge a more comprehensive explanation of the stability and variability of phenotypic characteristics within and across generations (e.g., Bateson & Gluckman, 2011; Gilbert & Epel, 2009; Lickliter & Harshaw, 2010; Müller & Newman, 2003). As the philosopher Jason Robert (2008) points out, taking a developmental point of view involves understanding that there is more to development than differential gene expression, that development is not a genes-*plus*-environment phenomenon, and that the causal analysis of development is required to understand evolution.

The Rise of Developmental Evolution

For much of the prior century, a cornerstone of evolutionary theory was the assumption that development is primarily internally determined, set on course at conception by genetic programs that have been designed and selected over evolutionary time. Within the behavioral sciences, this framework fostered widespread application of the notion of "innate" or "instinctive" behavior, species-typical patterns of action thought to be genetically determined and hard-wired in the organism at conception (e.g., Alcock, 2005; Lorenz, 1950). This gene-centered framework dismissed any possible role of development in evolutionary change. The last several decades have seen this view gradually shift to accommodate a broader and more integrative perspective on the relation between development and evolution. This critical reassessment of the links between developmental and evolutionary change has contributed to the coalescence of one of the most rapidly growing fields within contemporary biology: evolutionary developmental biology.

Evolutionary developmental biology (often referred to as *evo-devo*) involves a partnership among evolutionary, developmental, and molecular biologists to integrate our understanding of developmental processes operating during ontogeny with those operating across generations (e.g., Arthur, 2002; Hall, 1999; Raff, 2000). In contrast to the reductionistic premises of twentieth-century evolutionary biology, evo-devo views evolution as changes in developmental processes rather than simply changes in gene frequencies. From the evo-devo perspective, explaining the evolution of any phenotypic trait necessarily requires understanding the developmental processes that are involved in its emergence, maintenance, and transformation during ontogeny. This approach includes a variety of concerns, such as how modifications in developmental processes lead to the production of novel phenotypes, the role of developmental plasticity in evolution, and how ecology influences developmental and evolutionary change (Hall & Olson, 2003). These concerns are motivated in large part by the growing appreciation that a wide range of environmental factors are key participants in gene activity and expression, in some cases well beyond the time-scale of individual development. This insight has led to an increasing emphasis on the critical importance of the coactions between organisms and the ecological conditions with which they develop to achieve a deeper understanding of both developmental and evolutionary change (Gilbert & Epel, 2009).

As in the biological sciences, psychological science has also been grappling with how to best characterize the relation between development and evolution in recent decades. Several approaches to this challenge have emerged, including evolutionary developmental psychology (Bjorklund & Pellegrini, 2002; Ellis & Bjorklund, 2005) and developmental systems theory (e.g., Johnston & Lickliter, 2009; Lickliter & Honeycutt, 2003; Oyama, Griffiths, & Gray, 2001). However, behind the commonality of focus on the relation between development and evolution evident in these two approaches, there are significant ontological differences. As pointed out by Witherington and Lickliter (2016), evolutionary developmental psychology (EDP) and developmental systems (DS) approaches promote incompatible views of developmental processes, as well as of evolutionary processes as they pertain to developmental processes. Broadly speaking, EDP proponents view development in terms of transmission and expression. In particular, EDP explanations of phenotypes depend on the evolutionary mechanism of natural selection as the primary creative or shaping force behind the expression of all levels of organized complexity. In contrast, DS proponents view development in terms of construction and emergence. As a result, DS explanations of phenotypes hold that the process of development itself provides the constructive force behind all levels of organized complexity, with the mechanism of natural selection limited to a negative role of eliminating the unfit. In other words, EDP proponents see population-level, evolutionary changes via natural selection as shaping individual development via inherited genetic mechanisms; DS proponents see evolutionary changes as an outgrowth of individual ontogeny and its developmental processes, with an emphasis on the fusion of biology and experience.

The tenets of the DS approach to development and evolution are in keeping with the process-relational-developmental systems framework advanced by Overton (2015) and colleagues (Lerner, 2006; Lerner & Overton, 2008) in that the DS approach views evolutionary change as the result of the developmental dynamics of living organisms, situated and competing in their ecological contexts. This multidimensional approach to evolution is a far cry from the established neo-Darwinian view that defined evolution as a change in gene frequencies of a population (e.g., Dobzhansky, 1937). As noted by Ingold (2001, p. 125),

> there is no link between, on the one hand, changes in gene frequencies, and on the other in the forms and capacities of organisms, that is independent of the dynamics of development. It follows that while natural selection may occur *within* evolution, it does not *explain* evolution. Only by going beyond the theory of evolution through variation under natural selection, and by considering the properties of dynamic self-organization of developmental systems, can we hope to discover the possible consequences of those changes that *can* be explained by natural selection for the evolutionary process itself.

This insight emphasizes that *it is not tenable to partition the question of how organisms evolve from the question of how they develop* (Ingold, 2013; Lickliter & Honeycutt, 2013; Oyama, 1985). As a result, a concern with how development is involved in evolutionary change is now evident among biologists and psychologists working in formally diverse areas of research, including genomics, cellular and molecular biology, developmental biology, evolutionary theory, ecology, and comparative and developmental psychology (see Bateson & Gluckman, 2011; Gilbert & Epel, 2009; Lickliter & Honeycutt, 2015).

Summary and Conclusion

Consistent with the relational-developmental systems perspective briefly outlined in this chapter, a major conclusion to be drawn from advances in the biological sciences is that

causation in biological systems runs in both directions: "bottom up" from the molecular and cellular level (including genes), and "top down" from all other levels, including tissue, organ, organism, and external physical, ecological, and social environments (Keller, 2010; Noble, 2006; Witherington, 2011). These levels of organization reciprocally influence each other, and both the course of development and the impact of a change in development are thus contingent upon the state of the surrounding system. In other words, what happens at one level in a system (genetic transcription, neural activity, or behavior) depends on what is happening at other levels of the system (cellular environment, sensory environment, and so on). A strict emphasis on any single domain or level in a developmental system, be it genes, physiology, neuroanatomy or neurochemistry, social interactions, or culture, will be too limited to successfully address the complexity involved in the emergence, maintenance, or change in behavior, cognition, or other psychological processes.

All developmental outcomes are co-determined by internal and external developmental resources; these should not be viewed as *competing alternatives*. So-called biological factors do not operate independently of (and cannot be meaningfully separated from) experiential factors. As the geneticist Richard Lewontin put it, "it is bad biology to describe some aspects of the organism as resulting from environmental influence and some as the result of genetic effects" (Lewontin, 2000, p. xiii). This is a paradigmatic shift in thinking for both biology and psychology and requires leaving behind the out-of-date notion that developmental causation can exist at the level of the genes, a point of view that discounts the organism, its activity and experience, and the varied features of its physical, biological, and social environment relevant to developmental processes.

As recently noted by Moore (2013, p. 121),

> the biological systems that generate behaviors and psychological states have been found to be extraordinarily complex. This is regrettable, in a way, because this complexity can be intimidating, and in some cases lead to attempts at simplification that are profoundly misleading.

Similarly, Herrmann (1998, p. 125) argued that "inherent in the scientific thought of the past centuries has been the resolve to create a representation of reality that is free from complexity." Bill Overton has persistently worked to move developmental science away from such simplification and toward the challenge of embracing the complexity that is human development. His efforts have addressed developmental metatheory, theory, methodology, and philosophy of science, highlighting the importance of broadening and redefining the scope of developmental inquiry, and in so doing, directing research attention to the essential but often overlooked question of *how* behavioral possibilities and capacities emerge in process.

Note

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6 The Ontogenesis of Neural Networks from a Network Science Perspective

Anthony Steven Dick

> All networks . . . are the result of a growth process . . .. It is impossible to fully understand or interpret the structure of brain networks without considering their growth and development.
> (Sporns, 2011, p. 235)

In this chapter I will review recent conceptual and methodological advances in developmental cognitive neuroscience that have allowed researchers to take on the complicated task of understanding how the developing nervous system contributes to the changes in behavior we see over ontogeny. The chapter will present the *network science* conceptual and methodological framework for studying brain and central nervous system development. As a conceptual framework, the network science perspective breaks from earlier modes of investigation, which typically focus on the function of parts of the system separated from the whole. In contrast, this novel approach allows researchers to study the neural system as a whole, to study brain regions and sub-systems situated in the context of the broader system, and to consider the connectivity of different nodes within the system as an important unit of analysis. This truly network-level perspective, I will argue, allows researchers to investigate questions that were not easily accessible in previous conceptual frameworks. It thus represents an important advance in the field of developmental cognitive neuroscience, and cognitive neuroscience more broadly.

In keeping with the theme of this volume, the chapter is situated within Overton's Process-Relational and Relational-Developmental-Systems metatheory, which emphasizes the importance of recognizing the background concepts that frame scientific investigation. Situated within this metatheoretical context, a network science approach to developmental cognitive neuroscience endorses the concepts of holism, inherent activity of the organism, the notion of nature as process and the indissociable relation between process and organization, the centrality of change and becoming as features of nature, the concept of "necessary organization," and the legitimacy of pattern explanation as a form of explanation. These themes are echoed throughout the volume, and frame the contributed chapters. We will not present them separately here, but they are demonstrated in the chapter, and we recommend Overton's recent theoretical work, which provides a comprehensive overview (Overton, 2015). The reader will also see that these are central features of a network science perspective on brain and central nervous system development.

Framing the Problem

A major question facing developmental cognitive neuroscientists is this: how do neural systems embedded within the other physical systems of the human organism, which is itself embedded within an external environment, grow and change over development to

accomplish perception and cognition? I have framed the question in this way to emphasize three key points: 1) cognition and behavior are the actions of neural systems that are embodied; 2) the action of the system—the fact that it is dynamic and that it is plastic or changeable—is a fundamental component of its function; 3) because the action of the system is a fundamental component, the nodes and connections of the system can generate properties of the system that are not inherent in the individual components.

The first point emphasizes that the human nervous system is a *system* that can be studied with respect to its contribution to behavior. I have been careful here to avoid saying that "the brain" accomplishes this in isolation—it does not. In fact, the nervous system is itself embedded within, and interacts with, other biological systems of the human organism. The central nervous system (including the brain) is constantly receiving and processing information from multiple systems in the body that directly impact its functioning. This happens through direct connections, through hormones circulating in the blood, and through the manufacture of neuromodulatory molecules in the peripheral organ systems that affect functioning in the brain. Thus, a complete understanding of human cognition requires the acknowledgement that developing humans are *embodied*.

Marshall (Chapter 3 of this volume) discusses this concept at length, but briefly the notion of embodiment takes seriously the fact that the developing organism has a particular body, and is embedded in a particular context, which plays a *constitutive* rather than enabling role in the function of the organism. The fact that the body is not simply a vessel to hold a brain can be appreciated when one acknowledges that billions of neurons in the human peripheral and central nervous system, many of them physically embedded within the body's organ systems outside the brain, are dedicated to processing vital information about the organism's functioning and position in the environment. Many of these processes take place outside of conscious awareness, which may explain why the contribution of the body to developing cognition is often dismissed. However, the lack of awareness of these functions does not diminish their importance. The developing brain is situated within a developing body which is situated within an environment (Byrge, Sporns, & Smith, 2014).

The notion that complex behaviors and cognitive operations result from the action of multiple interacting neural systems is not novel. However, it seems that with every new publication from research groups claiming to have localized a particular complex function in a neuroimaging experiment, there is an opportunity for a reminder. In the twentieth century Luria (Luria, 1973a) presented both a historical and comprehensive treatment of how to think about neural systems, and his work remains recommended reading for any student interested in cognition or cognitive neuroscience. Thus, for Luria (1973a, p. 28), "the brain functions as a series of systems." These systems are also *dynamic*. They have a temporal character such that the preceding state of the system is an acute determiner of present and future states. This is critically important for function in the present state of the organism, but it also has far-reaching implications for development. Dynamic also means that the *action* of the system, with all of its constituent interconnected parts, determines behavior. Thus,

> individual areas of the cerebral cortex *cannot be regarded as fixed centers* but, rather, that they are "staging posts" or "junctions" in the dynamic systems of excitation in the brain and that these systems have an extremely complex and variable structure.
>
> (Luria 1973a, p. 29; italics added)

What Luria calls "junctions" modern network theorists would call "nodes." This notion will be important when we turn to a discussion of network science in the next section. However, it is notable that the concept of nodes is not fundamentally different from what Luria proposed. What has been added in recent years is a way to qualitatively and quantitatively study the action of neural networks.

The second point regarding our framing question is that the action of the system—the fact that it is dynamic and that it is plastic or changeable—is a fundamental component of its function. For developmental scientists, this means that as the organism changes over the course of ontogeny, the various systems implementing cognition also change in particular ways, and this changes the way systems interact with each other. In other words, no brain region develops in isolation from the regions to which it is connected. To borrow a term from Overton (2015), brain regions within a network are *interpenetrating* and co-acting, which implies a nonlinear function, rather than simply interacting, which implies a linear, additive function. A brain region's function is defined by its connection with other regions—the region would function differently if it were separated from the network, or embedded in a different network. This property of the system is an explanatory contributor to changing behavioral and cognitive profiles over development. For Luria, this was a key feature of complex functional systems: "the . . . distinguishing feature of 'localization' of higher mental processes in the human cortex is that it is never static or constant, but *moves about essentially during development of the child and at subsequent stages of training*" (Luria, 1973a, p. 31; italics in original).

Relatedly, and our final point established by our framing question, is that because the action of the system is a fundamental component, the nodes and connections of the system can generate properties of the system that are not inherent in the individual components. These systems properties are often described as "emergent properties" of the system, but I will try to not use this term because I believe it implies an additional property that is unwarranted. That is, system properties do not emerge like steam emerges off a boiling pot—steam is fundamentally different from the boiling water and can be separated from it. In the implementation of cognition, there is nothing in addition to the biological system (embedded within an environment). Emergent properties of biological systems are often called upon by cognitive scientists who argue that the mind is an emergent property of the brain, or, in other words, that the mind is something different from the brain. But this is the Cartesian dualism that Overton (2015) has explicitly rejected and tried to overcome. There is no mind that is "over and above" the neurobiological state (Searle, 2002). To emphasize the embodied context of the system, there is no mind that is not also the brain/body in context.

The importance of the action of any system in understanding that system is the reason Overton has attempted to bring to prominence, over the years, the notion of "process" in his metatheoretical writing. This applies to the study of the ontogeny of neural networks. The process—the dynamic action of the system—is the reason the system functions in a particular way. For this reason, I will refer to *generative properties* of the neural system (which emphasizes the process of generating) rather than emergent properties (which implies a passive emergence that is "over and above" the neurobiological system).

It should be clear at this point that what I have presented above is firmly planted within the Process-Relational and Relational-Developmental Systems paradigm. Nodes of a particular network—whether defined as neurons within a neural assembly, or neural assemblies within a broader system of neural assemblies—are situated within a *relational* network. Thus, the action of one brain region determines and is determined by the action of the region (or regions) to which it is connected. The notion of process—the fact that the system functions in a particular way because of its action, and that this changes over the course of ontogeny—is, as I have described above, also a key feature of the system.

Application of Network Science to Studying Neural Systems

When Luria wrote about complex functional systems, he was working from an intuitive understanding based on his knowledge of anatomy and on the careful study of lesions in his patients. His clarity and prescient conceptual insight on the topic of functional systems is even more remarkable considering the fact that studies of brain lesions, because they can seem to "knock

out" a particular function isolated from other functions, might lead one in the opposite direction to view the function as localized to that particular region. This was indeed the phrenological notion endorsed by a number of Luria's contemporaries, and it is even a concept stubbornly endorsed by some modern researchers who claim that particular functions are localized to specific regions (e.g., face processing in the "fusiform face area"; word processing in the "visual word form area"). It was only by careful study that Luria (and many historically important neurologists such as Wernicke, Hughlings Jackson, and others) realized that complex function is not localized to a particular brain region, and that the connections among the regions matter for understanding function. Thus, "the higher mental functions may be disturbed by a lesion of one of the many different links of the functional system; nevertheless, they will be disturbed differently by lesions of different links" (Luria, 1973b, p. 71).

The notion that the links are as important as the nodes is a fundamental aspect of modern network science. Luria and many of his contemporaries understood this, but were profoundly limited by available methods to study networks, their nodes, and the links between the nodes. What was missing was a conceptual and analytic approach to qualitatively and quantitatively define the networks, study their structure and characteristics, and study how these characteristics change in response to injury, lesion, degeneration, or typical ontogenetic processes. Network science, which provides these tools, has emerged over the last century as an important methodology in a variety of fields, from the study of chemical interactions, economic market behavior, and computer circuit architecture, to ecosystem dynamics, power station organization, transportation systems, genetic interactions, and interpersonal communications. Interest in applying this method to studying the brain has been growing steadily over the last decade. The most accessible and comprehensive text on this application is written by Sporns (2011) and covers in depth a number of the concepts we introduce below.

Much of contemporary network science is anchored in a branch of mathematics called "graph theory." Within graph theory, a basic "graph"—or mathematical representation of a network—is a set of *nodes* and a set of connections, called *edges*. This simple organization can be applied to a number of different complex systems. For example, in a social network, the nodes can be defined as people, and the edges defined as relationships between people. In neurobiological systems, nodes can be defined as neurons, neural assemblies, or brain regions. Connections are defined as structural connections (e.g., by axonal or dendritic connection for neuronal microlevel analysis, or by fiber pathway connections for investigations at a macro level of analysis) or as functional connections (e.g., for brain regions that meet a statistical threshold for correlation of their measured activity). For example, the somatic nervous system of the *C. elegans* worm has been completely mapped and graphed, and contains 282 neurons (nodes) and 2268 synaptic connections (edges; Morita et al., 2001).

Graph theory allows the researcher to quantify the *topology* of the network (i.e., the arrangement of the connections of the network invariant of its spatial organization). Thus, for example, edges can be linked across sequences of intermediate nodes and edges to form *paths*, which define the routes of information transfer in a network. As a concrete example, in a social network, a friendship between two people (A and B) is formed by two nodes and one edge (a connection). Adding a friend C defines a path from A—B—C. The definition of paths in a network allows the measurement of a number of properties, including topological distance and shortest path length. These path measures are used to determine the functional integration of neural networks. Shorter paths imply stronger potential for functional integration between nodes. The average of the shortest path length provides information about the network function as a whole, and is known as the characteristic path length (Watts & Strogatz, 1998). *Global efficiency*, defined as the average inverse shortest path length, is a related measure that is more influenced by the presence of short paths (Achard & Bullmore, 2007).

Nodes can also be quantified in terms of their *degree*, which defines the number of links connected to that node. Not all nodes have equal degree, which means not all nodes are equal in their influence on the network. Some nodes are *hubs*—nodes with very high degree, and thus high connectivity with many other nodes. Hubness is quantified by measures of *centrality*. For example, a person in a social network who has lots of friends (edges) will have higher influence in the network than a person who has few friends. The former person is a hub. Neurons and neural assemblies or brain regions also differ in terms of their degree, and thus some neurons or brain regions can act as hubs within the network. Hubness, though, is a double-edged sword. The hub can have high influence on the network, but this means that if it is knocked out it will have a significant effect on the network. Anyone who has ever had a flight delay or cancelation understands this intuitively. Many more delays and cancelations occur when airport hubs (such as London, Heathrow, Atlanta International, or Beijing Capital International) are knocked out, compared to smaller regional airports.

Hubs can form *rich clubs*, sets of highly connected nodes that are mutually densely connected, and are also more densely connected than would be expected based on the individual degree of each node (Senden, Deco, de Reus, Goebel, & Van den Heuvel, 2014; Van den Heuvel & Sporns, 2011). Nodes can also *cluster*, which describes the tendency of nodes to form closed triangles, such that nearest neighbors of a node are also directly connected to each other. The tendency to cluster represents a network's ability to form topologically local circuits, or to allow for information *segregation* within a network. A network can form *modules*[1] or *communities*, which are simultaneously densely connected to each other, and sparsely connected to other nodes in other modules. Such modules may be *motifs*, which are repeating patterns of connectivity that occur more frequently in real networks than in an ensemble of random networks (Milo et al., 2002). The organization of such modules, clusters, and motifs can define the *community structure* of the network, which shows the degree to which the network has meaningful divisions within it.

Network analysis has revolutionized how scientists understand the intrinsic organization of networks, and what makes them efficient in terms of information transfer (Tononi, Sporns, & Edelman, 1994). In a now classic paper, Watts and Strogatz (1998) showed that, using network analysis, biological networks can be shown to exhibit a "small-world" architecture. That is, biological networks exhibit functional architectures that are neither completely random nor completely regular. Instead, they appear to exhibit "small-world" properties with a small number of paths between any two nodes coupled with highly clustered connections (Bassett & Bullmore, 2006). This insight is functionally significant because such architecture is shown to enhance the efficiency of signal propagation, computational power, and synchronizability of the network (Watts & Strogatz, 1998).

This network structure turns out to be both immensely important to the network function and quantifiable (Humphries & Gurney, 2008). Small-world networks also exhibit both high global and high local efficiency (Latora & Marchiori, 2001). High global efficiency means that information is transferred efficiently across the whole network—the network supports wide-scale interactions. High local efficiency means that the network has high *fault tolerance*. That is, knocking out one node of the network will not cripple the entire network, which is an obvious benefit to a neural system, and would be favored during evolution of that system. Indeed, the human central nervous system is very resilient and resistant to damage to individual nodes (especially early in development; Dick, Raja Beharelle, Solodkin, & Small, 2013; Raja Beharelle et al., 2010). It has good fault tolerance. In contrast, other complex systems that are human-made can have poor fault tolerance. For example, the Boston MBTA subway system was built to maximize global efficiency, and has very low local efficiency and thus very low fault tolerance. Damage to one subway station can cripple the network because it destroys the connection between the previous and the next station (Latora & Marchiori, 2002).

Table 6.1 Complex network measures and their mathematical definition and meaning

Measure	*Meaning*	*Mathematical definition*
Connectivity		
Connection status (a_{ij})	A statistically significant functional connection exists between regions. Defines an edge.	$a_{ij} = \begin{cases} 1 \text{ if } \lvert z(i,j) \rvert \geq T \\ 0 \text{ otherwise} \end{cases}$
Degree (k_i)	Number of links connected to a node. High degree = high interaction with other nodes.	$k_i = \sum_{j \in N} a_{ij}$
Integration		
Shortest path (d_{ij})	Amount of functional connectedness of nodes. High d = high local integration.	$d_{ij} = \sum_{a_{uv} \in gi \leftrightarrow j} a_{uv}$
Global efficiency (E_{glob})	Measure of general integration of a network. High E = high global integration.	$E_{glob} = \frac{1}{n} \sum_{i \in N} \frac{\sum_{j \in N, j \neq i} d_{ij}^{-1}}{n-1}$
Segregation		
Local efficiency (E_{loc})	Defines nodes strongly associated with a particular node.	$E_{loc} = \frac{1}{n} \sum_{i \in N} \frac{\sum_{j,h \in N, j \neq i} a_{ij} a_{ih} \left[d_{jh} \left(N_i \right) \right]^{-1}}{k_i \left(k_i - 1 \right)}$ where d_{jh} (N_i) = length shortest jh path containing only neighbors of i.
Number of triangles	Defines nodes strongly associated with a particular node. t defines clustered nodes.	$t_i = \frac{1}{2} \sum_{j,h \in N} a_{ij} a_{ih} a_{jh}$
Clustering coefficient (C)	Measure of local density or "cliquishness" of the network. High C defines higher local density.	$C = \frac{1}{n} \sum_{i \in N} \frac{2 \left[\frac{1}{2} \sum_{j,h \in N} \left(a_{ij} a_{ih} a_{jh} \right) \right]}{k_i \left(k_i - 1 \right)}$
Community structure		
Modularity	Definition of size and composition of densely connected groups of regions.	$Q = \sum_{u \in M} \left[e_{uu} - \left(\sum_{v \in M} e_{uv} \right)^2 \right]$ where the network is fully subdivided into a set of nonoverlapping modules M, and e_{uv} is the proportion of all links that connect nodes in module u with nodes in module v.
Influence		
Betweenness centrality (b_i)	Defines "bridging nodes" that connect disparate parts of a network. High b = high likelihood that a node is a "hub" node.	$b_i = \frac{1}{\left(n-1 \right)\left(n-2 \right)} \sum_{\substack{h,j \in N \\ h \neq j, h \neq i, j \neq i}} \frac{\rho_{hj}(i)}{\rho_{hj}}$ ρ_{hj} = # of shortest paths between h and j; ρ_{hj} (i) = # of hj paths that go through i.
Small worldness		
Small worldness (S)	Measure of the degree to which the network exhibits small-world characteristics. Small-world networks often have $S >> 1$.	$S = \frac{C / C_{rand}}{L / L_{rand}}$ where C and C_{rand} are the clustering coefficients, and L and L_{rand} are the characteristic path lengths of the respective tested network and a random network.

Note. Modified, with permission, from Rubinov, M. & Sporns, O. (2010). Complex network measures of brain connectivity: Uses and interpretations. *NeuroImage, 52*(3), 1059–1069.

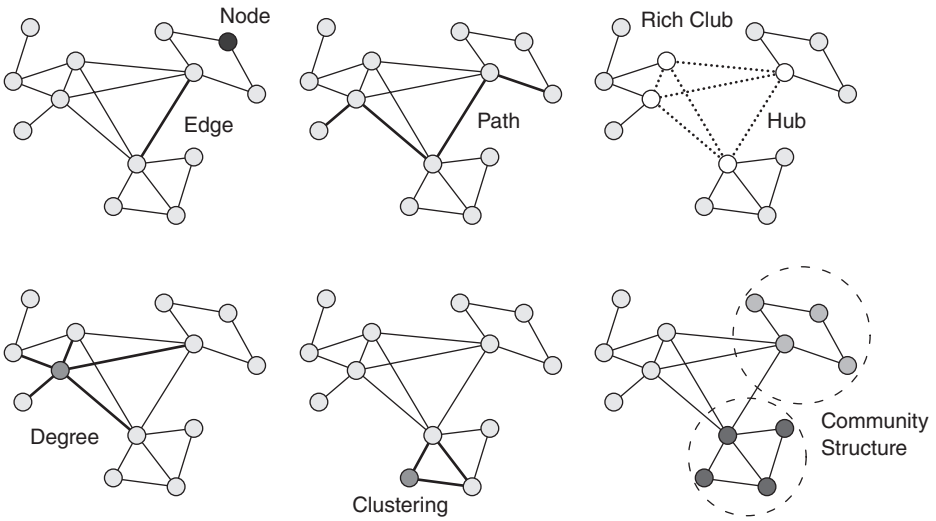

Figure 6.1 The figure provides a graphic illustration of a number of graph theoretic metrics. From left to right, the figure shows node and edge definition, path, rich club and hub, degree, clustering, and community structure, reflecting the formation of modules or subgraphs within the network.

Modified with permission from Van den Heuvel, M. P., Bullmore, E. T., & Sporns, O. (2016). Comparative connectomics. *Trends in Cognitive Sciences, 20*(5), 345–361.

Several of the metrics we reviewed above are summarized in Table 6.1 (based on a more comprehensive table in Rubinov and Sporns (2010) and shown graphically in Figure 6.1). This is by no means an exhaustive listing of all possible network metrics. New metrics continue to be developed, and the utility of available metrics continues to be debated. But regardless of what metrics are chosen, it is undeniable that the framework of network science provides developmental cognitive neuroscientists (and, with application to questions outside of neuroscience, developmental scientists more broadly) with a previously unavailable toolkit for qualitatively and quantitatively characterizing neural networks. The framework allows for novel ways of addressing old questions and applies new concepts, such as "small worldness," to understanding neural network organization. The acceptability of this conceptual framing is important when one considers that this allows developmental scientist the latitude to discuss and investigate changes in *pattern* organization. As Overton (2015) has noted, *patterns* are themselves a viable unit of analysis and explanation in the field of developmental science. Thus, one can ask, in the network science framework, whether the pattern of neural system organization changes over development, and whether this has a relation to behavioral changes. Note that one is not asking whether, for example, small worldness *causes*, in a mechanistic way, the behavioral change. It simply allows the researcher to investigate whether certain network organizations are associated with particular behaviors. Investigators can also ask more specific questions. For example, they can ask whether particular features of the network organization (e.g., rich club organization, global efficiency, local efficiency) are associated with particular behaviors. In short, investigators can ask how networks are formed—i.e., how nodes and edges are added or removed by ontogenetic processes, or rewired by experience, and how this affects various metrics of network organization.

The brief introduction given so far provides a vocabulary with which to discuss more recent investigations of the development of neural networks in humans using neuroimaging techniques. These investigations address two primary aspects of brain networks that are highly

interrelated—structural connectivity (defined by axonal and dendritic connections, the neural processes that make physical connections with other neurons) and functional connectivity (defined by the functional interactions of nodes in the network). Structural and functional connectivity are interpenetrating factors in the network, especially during development as the human brain maintains a high degree of plasticity. The topology of structural connections shapes neuronal activity, and in turn structural connections change in response to that activity (Sporns, 2011). Changes in both systems can be quantified and studied within a network science framework, from the prenatal period until old age, and the two levels of analysis can be combined to investigate their mutual influence on behavior.

Application of Network Science to Understanding the Development of Structural and Functional Connectivity Networks in "The Connectome"

Network science, as we reviewed above, provides us with a suite of conceptual and methodological tools to examine network behavior and how it develops. Whether this can be applied in the context of the available methods for studying brain and central nervous system development is another matter. It turns out, however, that the tools used in cognitive neuroscience—neuroimaging methods such as magnetic resonance imaging (MRI), electroencephalography (EEG), magnetoencephalography (MEG), and functional near-infrared spectroscopy (fNIRS)—are well suited to the use of network science concepts and methods. These tools can be employed to look at how developing networks establish both *structural* and *functional* connections.

Understanding how a neural network is *structurally* connected provides a wealth of information about how it might function (Dick & Tremblay, 2012; Dick, Bernal, & Tremblay, 2014). Diffusion-weighted MRI is a method that measures these connections *in vivo*. It does this by measuring water diffusion along axons, which are the long-range neural processes that cord together in the nervous system to form nerves (in the peripheral nervous system) and fasciculi (in the central nervous system; also called fiber pathways or tracts). These short- and long-range connections support direct communication among brain regions, which together form cortical and subcortical neural networks. Furthermore, the MRI metrics are sensitive to various microstructural properties of the axonal tracts, such as myelination (the "insulation" of the axon with a lipid substance, which gives the brain's white matter its color, and which improves the efficiency and precision of information transfer) and axonal diameter and packing density. Thus, one can address how the microstructure of these tracts changes over development. Studying these connections and how they develop is fundamental to understanding the network's function, as these form the *physical edges* between nodes of the network.

In addition to understanding *structural connectivity*, neuroimaging methods can quantify *functional connectivity* by taking the time series (sequence of temporally connected data points) of the neural response as the unit of analysis. These time series can be collected within spatial regions of interest (for example, specific brain regions), and the time series in one region can be correlated with the time series in another region. If the correlation between the two regions meets a statistical threshold, this defines a functional *edge* between two network *nodes*, and network science metrics can be applied.

The ability to study the brain's structural and functional connectivity—defined as the brain's *connectome* or *connectomics* (Van den Heuvel, Bullmore, & Sporns, 2016)—is important to understanding how networks mature in their organization across ontogeny. Furthermore, maturational processes which occur in the context of response to experience form an interdependent developmental process in laying down the structural support for the network.

With diffusion-weighted MRI and functional imaging methods, both maturational and experiential effects can be studied and related to changes in behavior.

In the developing organism, the foundation of this connectivity begins in the prenatal period. As the proliferation of neurons explodes during the first two trimesters, so too does the establishment of the connections between neurons. Axonal proliferation occurs once the neuroblasts (later neurons) have reached their final positions, after migrating from various neural proliferation zones in the fetal brain. Axons from projecting neurons follow chemical signals to find their target neurons, and this complicated process takes place over several weeks during the prenatal period. The proliferation of synapses (neural connection points), by both axons and dendrites (projections from neurons that facilitate the receipt of information from other neurons), also occurs during this phase, but in this case it continues much later into the postnatal period; sometimes, in certain brain regions, into late adolescence. Myelination (insulation) of axons also continues for quite some time postnatally, and again this is dependent on what parts of the white matter are measured (see Figure 6.2. For review, see de Graaf-Peters & Hadders-Algra, 2006). Thus, it has been known for over a century that primary sensory (e.g., visual, auditory) and motor pathways myelinate earlier in development than secondary association cortical pathways (Flechsig, 1896). Modern diffusion-weighted imaging has provided even more evidence of these regionally specific age-related differences in white matter microstructure (Broce, Bernal, Altman, Tremblay, & Dick, 2015; Kunz et al., 2014; Sadeghi et al., 2013).

It is important to remember, though, that development of the structural connections of the nervous system does not occur in a vacuum. Environmental factors have enormous influences on brain development. To give one example of many, early iron deficiency disrupts the process of myelination (Amin, Orlando, & Wang, 2013) and has long-term negative effects on cognitive development (Lozoff, Jimenez, Hagen, Mollen, & Wolf, 2000). Iron deficiency can occur as a product of poor nutrition, and can occur in developed countries, as a result of poor access to nutrition (due to low socioeconomic status) or due to cultural norms that influence nutritional choices (Brotanek, Halterman, Auinger, Flores, & Weitzman, 2005). The immediate and cultural environment matter for brain development.

The child's more direct experiences in their environment also have a direct impact on brain development. The axiom "neurons that fire together wire together" describes the process of connectivity establishment in response to experience. The developing brain is designed to work within this framework—it massively overproduces synaptic connections early in development, and then prunes these connections over a prolonged developmental timeline in response to experience (Huttenlocher & Dabholkar, 1997; Petanjek et al., 2011). In other words, connections are retained if they are used, and pruned if they are not. Such a process might seem wasteful in terms of resource expenditure for the organism, but it makes adaptive sense if one sees the organism as functionally situated within an environmental context, with the goal of maximizing its fitness within that context. An organism without such a propensity for plasticity in response to experience would not be able to accommodate to different environments, or changes in those environments.

The interplay of the structural and functional changes taking place during development can be measured with network science metrics. Thus, graph theoretic metrics have been applied to the study of brain development in infancy after preterm birth (Ball et al., 2014), developing visual spatial ability (Kim et al., 2016), developing language (Xiao, Friederici, Margulies, & Brauer, 2016), sensorimotor development (Khundrakpam et al., 2013), and developing cognitive control (Hwang, Hallquist, & Luna, 2013), to name a few research areas. According to the picture emerging from network science, the human brain is organized in terms of densely connected communities supported by anatomically long-distance fiber pathways, which themselves support topologically short-distance communication paths.

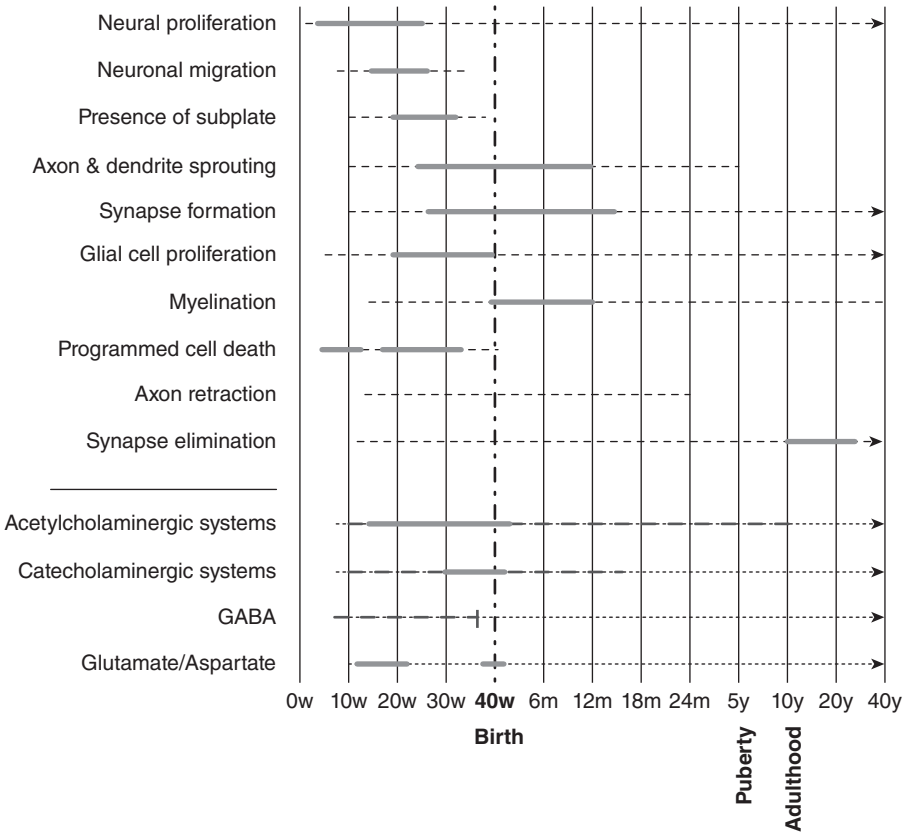

Figure 6.2 The figure summarizes the timing of several neurobiological processes in the developing brain. W = Weeks. M = Postnatal months. Y = Years. In the upper part of the figure, the dashed line means the process is active. A bold line means the process is very active. In the lower part, representing development of select neurotransmitter systems, a thin dotted line means that the transmitter is present, while the bold line indicates a period of overexpression of the transmitter. Increasing dot density in the catecholaminergic system means that there is a gradual increase in dopaminergic activity. The bold dashed line for the GABAergic systems indicates that the neurotransmitter GABA is excitatory in the prenatal period, and inhibitory in the postnatal period.

Modified with permission from de Graaf-Peters, V. B., & Hadders-Algra, M. (2006). Ontogeny of the human central nervous system: What is happening when? *Early Human Development, 82*, 257–266.

This is combined with densely connected and topologically central communication hubs that form a central rich club organization, a cluster of convergence zones that integrate different functional networks (Van den Heuvel et al., 2016). Such an organization develops over the course of the organism's lifetime, informed by both maturational and experiential factors that affect the anatomical and functional connectivity of the network.

Application of Network Science to Theory Development

Understanding and quantifying the properties of developing networks has significant ramifications for testing theories of central nervous system development and its relation to cognition. For example, as broad theoretical outlines, Johnson's (2011; Johnson, Grossmann, & Kadosh, 2009)

interactive specialization theory, and the neuroconstructivist framework advocated by researchers such as Karmiloff-Smith and others (Farran & Karmiloff-Smith, 2012), can be assessed with network metrics. A key feature of these theories is that the brain cultivates domain-specific functioning with development, which could be tested by examining the development of modules, communities, and motifs in subnetworks over time.

More focused domains of inquiry can also be investigated. Thus, examining developing self-control in adolescence, Casey and colleagues (Casey, Galván, & Somerville, 2016) and Luna and colleagues (Luna, Marek, Larsen, Tervo-Clemmens, & Chahal, 2015) advocate a "circuit-based," as opposed to region-based, view. For example, in Casey's model, "changes in self-control during adolescence coincide with a series of developmental cascades in the regional fine-tuning of connections within complex subcortical and cortical prefrontal and limbic circuits" (Casey et al., 2016, p. 128). Such changes, though, are difficult to define using traditional metrics, but fall under the purview of network science. For example, changes in segregation and integration (measured by global and local efficiency, or by clustering coefficient) could be investigated longitudinally and related to specific behaviors. Network metrics can thus be applied to examine how the strength of the connections between regions, rather than activity in individual regions, shifts during development. The success of this approach, which is just beginning to gain the notice of investigators in developmental cognitive neuroscience, will hopefully engender a process of theory development using concepts from the network science framework.

In this respect, the future looks promising. In a recent article, Byrge, Sporns, and Smith (Byrge et al., 2014) take a network science perspective for studying how the nervous system, across overlapping timescales, develops in the context of a body and an environment. Thus, they note three major ramifications of this approach for studying brain development: 1) rather than simply "channeling" functional connectivity in a network, the architecture of the network allows the generation of complex system-wide dynamics that enable the various nodes of the network to contribute across a variety of cognitive and behavioral tasks; 2) the role of external inputs is not simply a "triggering" event activating specific sub-routines, but rather these inputs act to cause widespread effects on the system that depend on how the inputs become integrated with the system; and 3) the cumulative history of these generative inputs is recorded in changing patterns of connectivity (both functional and structural), which defines the system's changing capacity to respond to input and to produce new internal dynamics. The network science approach provides a theoretical grounding and analytic method to study these systems-level dynamics of the developing organism.

Summary and Conclusions

The brain and body share a common evolutionary and developmental history, and their dynamic association is fundamental to understanding behavior and cognition. Furthermore, it is the actions of the organism within an environment that shape the continuously evolving organization of neural interactions that contribute to behavior and cognition. These points, raised by Sporns (2011) to conclude his comprehensive text on network science for the study of the brain, embody the perspective by Luria regarding the notion of functional neural systems. They also embody the Process-Relational paradigm and Relational-Developmental Systems metatheory endorsed by Overton. Thus, for Overton (2015, p. 12; italics in original), the developing organism is an

> *inherently active, self-creating (autopoetic, enactive), self-organizing, and self-regulating, relatively plastic, nonlinear complex adaptive system*. The system's development takes place through its own *embodied activities and actions* operating *coactively* in a lived world of physical and

sociocultural objects, according to the principle of *probabilistic epigenesis*. This development leads, through positive and negative feedback loops created by the system's organized action, to increasing system differentiation, integration, and complexity, directed towards adaptive ends.

As Overton (2015) suggests, the growing popularity of such a framework, in developmental cognitive neuroscience and in many other disciplines, reflects a "relational turn" in many areas of science, emphasizing the notion of "process." This is a promising development that will hopefully gain traction and popularity in future research endeavors.

Note

1 This characterization of modularity is unrelated to cognitive modularity, which was a popular cognitive science model of the mind in the 1980s and 1990s.

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7 The Contribution of Statistical Modeling to Developmental Theory

Alexander von Eye

The "quiet methodological revolution" (Rodgers, 2010, p. 1) is coming to a happy end: statistical modeling is *de rigueur*. Reasons for this are evident. First, instead of performing large numbers of significance tests that may be dependent upon each other and for which the protection for multiple comparisons can be problematic (von Eye, 2002), models are estimated that can be subjected to goodness-of-fit testing as complete models, not individual tests. Only when a model describes data satisfactorily—that is, when there are no significant model–data discrepancies—are the specific parameters inspected. These parameters represent individual hypotheses. In contrast, the model represents an entire theory, or part of one. Modeling thus links theory and hypotheses in a straightforward way.

Second, models can be specified such that latent or underlying variables represent behavior domains. When more than one indicator of a behavior domain is observed, and when the indicators are highly correlated, these indicators can prevent each other from becoming significant when they are entered together into, for example, a regression model. This is one of the most important indications of multicollinearity (Kutner, Nachtsheim, Neter, & Li, 2013), and has the potential of biasing the evaluation of this behavior domain as predictor of some outcome. Latent variables, in contrast, are not only error-free, but they function as powerful aggregates of multiple indicators of the same behavior domain. This applies even when indicators come with low intercorrelations or, when only two indicators are considered, when the correlation between two indicators is zero (Cattell & Tsujioka, 1964). These aggregates allow the researcher to estimate the weight of a group of indicators in a recursive (i.e., regression-type) model.

Third, modeling has changed the way statistical hypotheses are tested (see Rodgers, 2010). Many view classical null hypothesis testing as inconclusive, because the rejection of the null hypothesis does not necessarily support the alternative. Conversely, retaining the null hypothesis simply means that it was not rejected. This does not imply formal support for the null hypothesis. Consider, for example, the hypothesis that physical aggression decreases over the course of adolescent development. The corresponding null hypothesis is that this is not the case. Now, rejecting the null hypothesis in, for example, an analysis of variance simply suggests that this null hypothesis does not hold. The number of alternative hypotheses is infinite. There is no explicit support for any of the infinite number of alternative hypotheses. If, on the other hand, the null hypothesis prevails, this simply means that it was not rejected, given the data at hand.

In contrast, modeling places hypothesis testing in a different context. The hypothesis tested is that there are no significant discrepancies between model and data. If this null hypothesis is rejected, the model will not be retained. If, however, this hypothesis survives, the model is close enough to the data and can be considered supported. Goodness-of-fit testing now replaces null hypothesis testing, and large p values are good. The modeler is, therefore, in a more comfortable situation than the classical null hypothesis tester.

In this chapter, we use all of these reasons for favoring a modeling approach—statistical parsimony of models, aggregation of indicators using latent variables, and goodness-of-fit testing—but we focus on the first. We discuss the contributions of theories of development to modeling, and the reciprocal contribution made by formal models in the construction of theories of development. The chapter is structured as follows. First, there will be an overview of statistical and mathematical modeling. Second, there will be a general description of developmental theories. Third, the role of theory in the development of models is reviewed. Finally, the role of modeling in the development of theories is explored. Throughout, empirical data examples are provided to illustrate the concepts that are reviewed.

Mathematical and Statistical Modeling

Mathematical and statistical modeling is simply the description of relationships between variables using mathematical concepts. To the uninitiated, this can seem daunting. However, working through an example will hopefully provide clarity. To begin the discussion of mathematical and statistical modeling, consider the following formal definition of a *statistical model* (Pfister, 2012). A statistical model can be defined as the quadruple $(\Omega, F, P_\Theta, \Theta)$, where

Ω is the set of all possible observed measures;

F are the functions used in a model (as in, e.g., the Generalized Linear Model (GLM));

P_Θ comprises the rules of probability theory; and

Θ is the set of all possible values of parameter Θ.

For all Θ out of Θ, (Ω, F, P_Θ) constitutes a probability space. In application to real-world data, researchers are interested in estimating the unknown value of parameter Θ for this probability space, given the observed measures.

In other words, modeling involves estimating parameters for given observations when mathematical functions are used that relate the observed measures to each other. This estimation is statistical and is performed with respect to known loss functions (e.g., the standard loss functions used in regression such as least squares, maximum likelihood, and others).

We now ask how the researchers can arrive at the situation in which the parameters Θ out of Θ are to be estimated, given Ω. We assume that a decision concerning the functions to be used, F, has been made. To answer this question, we use the two-step sequence outlined by Cavagnaro, Myung, and Pitt (2013).

The first step of the sequence is that of *verbal modeling*, a qualitative step. To describe this step, we first assume that a theory exists. This theory may be coarse-grained, but should be specific enough that the derivation of testable hypotheses is possible. These hypotheses are formulated verbally or in the form of a graph. To give an example, let there be a theory about blood poisoning and the occurrence of ADHD. A testable hypothesis could then be that "increased blood lead content in children leads to increased occurrence of ADHD" (cf. Nigg et al., 2008; von Eye & DeShon, 2012). In the simplest case, the data needed to statistically test this hypothesis include just two measures: blood lead level and ADHD diagnosis.

Statistically, the hypothesis can be tested using GLM methods such as regression or analysis of variance (ANOVA). Multiple indicators and multiple outcome variables typically pose no problems, and even curvilinear relations can be examined. Using the new methods of direction dependence, the hypothesis that blood lead level is the cause and ADHD is the effect can be contrasted with the hypothesis that the status of the two variables is reversed (see Nigg et al., 2008; von Eye & DeShon, 2012; Wiedermann, Hagmann, & von Eye, 2014). Directed mediation hypotheses can be tested as well (Wiedermann & von Eye, 2015). Hypotheses of

direction dependence can be tested based on the distribution of residuals (errors). When such a regression model uses the correct variable as independent and the correct variable as the dependent, residuals are normally distributed. When these variables are used the wrong way around, residuals are skewed. Based on this result (Wiedermann et al., 2014), the direction of effect can be identified. This is of importance in particular in non-experimental, observational studies. Extensions of direction dependence hypotheses, for example, by considering such moderators as age, gender, or living condition, can also easily be accommodated. However, there will be a juncture at which all plausible hypotheses have been tested, and the theory is either considered confirmed, or it must be further developed.

The second step involves *shifting the scientific reasoning process* (Cavagnaro et al., 2013). The shift occurs in two domains. The first involves the role played by statistical significance tests. Classical null hypothesis testing will certainly not be abandoned. Parameters and specific hypotheses are still tested with reference to the null hypothesis. However, goodness-of-fit tests now enrich the decision-making process. As was indicated above, when a goodness-of-fit test suggests that the discrepancies between parameters that are estimated by a model and the observed data are no greater than random, one is in a situation of retaining a model. Indeed, one can accept a model as describing the data, and even the data-generating process, which is a stronger statement than simply stating that a classical null hypothesis is retained.

Specifying a model, though, is far more complex than specifying a null hypothesis. The model is a device that uses a mathematical structure, applies this structure to describe and explain data, and then allows one to test model–data fit using the tools of statistics. As has been discussed, each model possesses certain mathematical characteristics that allow the researcher to map certain processes. For example, the GLM allows one to test hypotheses that differ from the ones that can be tested based on differential equations. Other processes need to be mapped using models with different characteristics. In other words, a different set of functions, F, is used. For example, standard regression models do allow one to predict one variable from some other variable. However, the reverse prediction yields the same (standardized) parameter estimates. Therefore, direction dependence cannot be established using standard regression models (see Dodge & Rousson, 2000, 2001; von Eye & DeShon, 2012). Similarly, standard, manifest variable regression models do not allow one to estimate the strength of effects that go from A to B simultaneously with those that go from B to A (i.e., reciprocal effects). Structural models, in contrast, do allow one to test hypotheses about reciprocal effects. However, structural models do have shortcomings. For example, they lack elements of systems theory methodology (Molenaar, Lerner, & Newell, 2014). These issues, and others, are taken up again in the data example section below.

These examples illustrate two important roles that models play when it comes to establishing empirical footing for theories. The first role is that of translation. Relations verbally proposed by a theory are translated into testable hypotheses. The second role goes in the opposite direction. A theory may be, as was stated above, coarsely outlined, and open to input from modelers. In these instances, mathematical forms can be used to think about types of relations that, otherwise, are not part of a model. In other words, the mathematical properties of a model can guide theory building.

Theories of Human Development

Theories can be defined as structured sets of statements about a domain of reality. Theories of human development can, then, be defined as structured sets of statements about constancy and change in human behavior, and such theories are legion (see, e.g., Bergman, Cairns, Nilsson, & Nystedt, 2000; Lerner, 1986; Overton & Molenaar, 2015). Metatheories target characteristics

of theories. Accordingly, metatheories of human development target characteristics of theories of human development (Overton, 2014; Overton & Lerner, 2012).

Theories of human development structure their statements with respect to a number of factors, the most prominent of which include 1) age, 2) the particular behavioral domain of inquiry, 3) the type and form of change, and 4) the "reach" or scope of explanation of the particular theory. With respect to age, theories are either life-span, thus covering the development of humans from conception to death, or they cover specific periods of development. An example of the latter is Piaget's (1964) theory of cognitive development, which considers the development of this domain of behavior concluded in adolescence, or theories of wisdom (see Sternberg, 1985), which may focus on adulthood. In addition to age, theories are often focused on particular behavioral domains such as learning, thinking, perception, personality, or psychopathology. An example of a modern developmental theory that focuses on a particular behavior domain is that of positive youth development (see Lerner, Lerner, Bowers, & Geldhof, 2015). Other theories intend to capture all behavior, as is the case in Haeckel's (1866) theory of biogenetic recapitulation.

Theories are also concerned with type and form of change. Classical theories of human development discuss, for example, stagewise development. In these theories, stages are characterized by relatively stable behavior. Phases of rapid transitions lead the individual from one stage to the next. Empirical evidence for Piaget's stage theory of cognitive development was provided by van der Maas and Molenaar (1992; see also, in the same article, the transition forms that are accessible when catastrophe theory is used). More recently, dynamic systems approaches have been propagated (see Molenaar et al., 2014). These approaches became possible because new modeling methods, for example dynamical systems methodology or differential equation modeling, have been developed so that they can be applied to real-world data.

The end-goal of theories of human development is to combine the first three factors, and examine the "reach" or scope of such an explanation. Thus, specific behavior domains (e.g., mental health) may be studied over an a priori determined age range (e.g., young adulthood), and this is done under the assumption that particular trajectories are valid descriptors of developmental change (see, e.g., Bogat, Levendosky, De Jonghe, Davidson, & von Eye, 2004). But the outcomes of such investigations must generalize to particular populations. For example, person-oriented (von Eye & Bergman, 2003) as well as idiographic (Molenaar, 2004) approaches to development posit that development can be specific to the individual. This tenet, plus the fact that statements at the aggregate level instead of the person level rarely describe a substantial portion of the population (for examples, see Molenaar & Nesselroade, 2014; von Eye & Bergman, 2003), leads to the conclusion that theories of development that cover all humans are unlikely to be specific enough for the description of individuals. The "reach" or "scope" of the theory becomes important: to whom does a particular theory apply (cf. von Eye, 2015)? Naturally, this argument can be applied to behavior domains as well. For example, one can ask whether stage transitions are useful for the description of cognitive development alone, or whether they also validly describe such domains as emotional development or personality development.

The Contribution of Theory to Modeling

Theory is the basis of model specification. Models are translations of theories into a language that allows researchers to empirically test the specifications and hypotheses proposed in a theory. The two elements included in this process are the test of a theory as a whole and the test of individual statistical parameters. The former can be performed using overall goodness-of-fit tests. The latter can be performed using tests of individual parameters or groups of parameters

(von Eye, Widermann, & Mun, 2013). It is important to note that unlike standard regression and ANOVA approaches, modeling follows the routine such that a model must fit before individual parameter tests are interpreted.

Hypotheses are usually formulated with specific forms of relations in mind. Simple forms include correlation, regression, and reciprocal relation. Hypotheses concerning the shape of trajectories are formulated as well. For example, in growth curve modeling, a technique often applied to longitudinal data, non-linear growth trajectories can be examined. More complex forms of hypotheses concern interaction, mediation, moderation, or direction dependence. All these can be specified as contemporaneous, but also as lagged effects, and they can be specified for individual variables, groups of variables, and series of observations. Hypotheses can be specified for manifest as well as latent variables, various distributional assumptions can be made, and dynamic models can be tested (see Molenaar et al., 2014; Molenaar & Newell, 2010). Hypotheses can also be specified for characteristics of variables such as differences between ordered observations, and for segments of data spaces (von Eye & Gutiérrez Peña, 2004; von Eye, Mair, & Mun, 2010). Many more options exist. They are all used after hypotheses are derived that are compatible with a theory.

The contribution that theory makes to modeling is particularly evident in the context of person-oriented or idiographic research. Person-oriented theories are based on the tenet that development can be specific to individuals or small groups of individuals. Models that are formulated at the aggregate level, after aggregating data (in the form of variances or covariances), will, therefore, fail to describe these cases. It has been shown that estimating parameters at the level of the individual, before aggregation, and then aggregating parameters often does a much better job describing development than aggregating data first and then estimating parameters (for examples, see von Eye & Bergman, 2003). Here, the problem is that most modeling methods, e.g., structural modeling, do not allow the researcher to routinely specify models at the level of the individual. Such methods are being developed. Here, the impetus came from substantive modeling and is leading to the development of new classes of statistical and mathematical models.

However, hypotheses must sometimes also meet conditions that are not derived from a theory, and this is where feedback from model to theory must occur. This important contribution of modeling to theory is discussed in the next section.

The Contribution of Modeling to Theory

As was discussed above, the mathematical properties of models both define and constrain the type of relations that can be modeled. Consider, for example, a regression-type relation in which the relation between two variables can be described by a straight line. This can be modeled easily using a GLM. In contrast, other models (e.g., a cusp catastrophe[1]) cannot be modeled by a GLM.

The contribution of modeling to theory can be illustrated by the development of methods of dynamic systems modeling. Dynamic system models focus on developmental change and on regulation (as in, e.g., equilibrium hypotheses). The construction of such models must, according to Boker, Neale, and Kump (2014, p. 379), be "placed under constraints that are not merely data driven." These constraints are theoretical in the sense that substantive theory dictates them. However, they are also model-driven in the sense that the functions that a model uses must correspond to the hypothesized developmental processes. Now, new modeling approaches such as dynamic systems modeling provide the researcher with new options. Researchers can, therefore, ask and test the question whether these new options enrich the pool of substantive theories. Here, at least part of the impetus comes from those who develop statistical and mathematical models.

In this section, we discuss simple and complex relations that can be of interest in developmental theories. We also illustrate these relations using real-world data, and we discuss characteristics of these relations. Specifically, we discuss *regression-type and correlational relations*, *reciprocal relations*, and *trajectories*.

Regression-Type and Correlational Relations

Regression analysis in its various forms is, by far, the most frequently applied statistical method. Simply put, consider the two variables, X and Y, and the GLM regression of Y on X, $X \rightarrow Y$, or $Y = \beta_{0Y} + \beta_{1Y}X + \epsilon$, where β_{0Y} is the intercept, also known as he regression constant, β_{1Y} is the slope parameter, also known as the regression weight, and ϵ is the error term.

To illustrate, we use a data set from Finkelstein, von Eye, and Preece's (1994) study on the development of aggressive behavior in adolescence. The authors asked 67 adolescent girls and 47 adolescent boys to rate their own aggressive behavior at three points in time, two years apart. The questionnaire included items for the four dimensions Aggressive Impulse (AI), Aggression- Inhibitory Response (AIR), Verbal Aggression against Adults (VAAA), and Physical Aggression against Peers (PAAP). In addition, physical pubertal development was assessed using Tanner scores. In the following analyses, we use the self-ratings of verbal aggression against adults and physical aggression against peers, from 1983, 1985, and 1987. At these points in time, the respondents were, on average, 11, 13, and 15 years of age, respectively.

We test the hypothesis that verbal aggression against adults is predictive of physical aggression against peers, or VAAA $\rightarrow$ PAAP. Specifically, we assume that this relation does not change over time. The three observations are, therefore, instantiations of the same behavior, unchanged over the course of four years. Based on these assumptions, we define a structural model with two latent variables. The first, PAAP, uses the three ratings of physical aggression against peers as indicators (i.e., observed variables). The second, VAAA, uses the three ratings of verbal aggression against adults as indicators. Estimation is performed using maximum likelihood.

In this form, the model does converge, but the goodness-of-fit indicators suggest rejecting it ($X^2 = 34.46$, $df = 8$, $p < 0.01$, RMSEA = 0.17). That is, the significant X^2 suggests that the model is not a good description of the data. We therefore inspected the modification indices and noted that, at the first and third points in time, there is a relation between verbal and physical aggression that is not captured by the model. Freeing the corresponding residual covariances results in a fitting model ($X^2 = 10.83$, $df = 6$, $p = 0.09$, RMSEA = 0.08 with CI: $0 \leq$ RMSEA ≤ 0.16; CFI = 0.98; GFI = 0.97). This model is depicted in Figure 7.1 (standardized solution given).

Each of the estimated path coefficients in Figure 7.1 is significantly greater than zero. In addition, each of the coefficients has the expected sign. The residual distribution is close to the normal, and there is no large modification index. We therefore retain this model. When the question is asked what modeling could possibly contribute to theory building in developmental (or other) research, there are three points that can be illustrated with the present example: 1) The hypothesis was derived from theory. In this case, the theory posits that verbal aggression of adults is predictive (or a precursor) of physical aggression against peers, and this theory can be retained. Even stronger, based on the differences between goodness-of-fit testing and null hypothesis testing, this hypothesis can be considered confirmed. 2) The results of the development of the model in Figure 7.1 show, however, that this hypothesis can be considered confirmed only if the two covariances between indicators of verbal and physical aggression at ages 11 and 15 are estimated as well. In other words, there is more to the hypothesized regression relation than can be captured with a simple regression model. 3) The relations depicted in Figure 7.1 are all linear. This is most important in the discussion

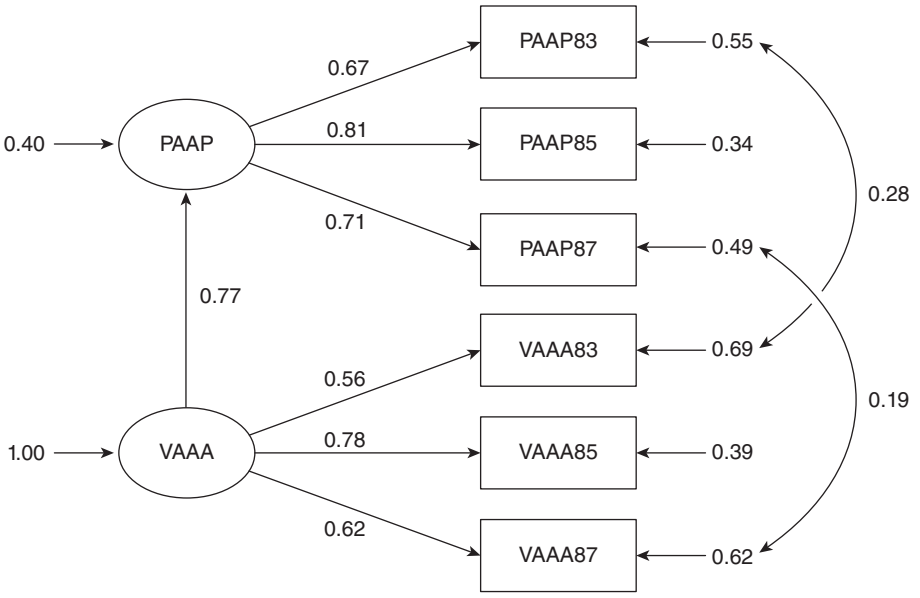

Figure 7.1 Model for the regression of Physical Aggression against Peers (PAAP) onto Verbal Aggression against Adults (VAAA).

of the path from VAAA to PAAP. If this type of regression relation is not the intended one, the structural model must be specified differently, and the result in Figure 7.1 is, at the least, biased. More generally, proper modeling requires that it is not sufficient to simply include relations in a model in the form of, for example, correlations or paths. In addition, researchers need to derive from theory and then make explicit the hypothesized form of a relation when specifying the model.

In addition to these points, the link between a model and theory is even stronger. Suppose that a researcher hypothesizes that there is a causal relation between VAAA and PAAP such that VAAA is (logically or temporally) prior to PAAP. This hypothesis cannot be considered confirmed by a model as the one in Figure 7.1. The reason for this disappointing fact is that the regression model in Figure 7.1 cannot be distinguished from a regression model in which the path is reversed. In addition, these two models cannot be distinguished from a model in which the two latent aggression variables are simply correlated (see the discussion of equivalent models in, e.g., Jöreskog & Sörbom, 1996). Model fit for all three models is exactly the same, and the two standardized path coefficients and the correlation coefficient are exactly the same as well. This applies accordingly to the corresponding significance tests.

We conclude from this first example that every model has its limits in the sense that it can be used to describe some types of relations, but not others. The example given in Figure 7.1 shows that the aggression model can be used to describe regression-type relations between latent variables. Therefore, this model can be interpreted as support for a causal hypothesis that links VAAA and PAAP. However, as noted above, this interpretation is weak because the model is indistinguishable from models in which just the opposite direction of causal effect, or indeed just a correlational relation, is proposed. Direction dependence methodology needs to be employed to arrive at a decision about direction of effect (von Eye & Wiedermann, 2013).

Reciprocal Relations

Reciprocal interactions are among the important relations that can be modeled using structural equations modeling, but not with standard manifest variable regression models (see, e.g., Jöreskog & Sörbom, 1996). Reciprocal interactions are defined by effects that two agents have upon each other. The important difference to standard interactions is that these effects can differ in magnitude. Depending on theoretical background, several forms of reciprocal interaction can be considered and modeled.

In the Humean tradition (Hume, 1777), causes precede effects in time. Therefore, simultaneous reciprocal interactions cannot be considered. The observations used to model reciprocal interactions in the Humean sense must, therefore, be temporally ordered. It is important to note that, when the goal of analysis is to just establish that temporally ordered reciprocal interaction exist, the origin of the interaction process does not need to be part of the model. However, if one agent is considered the cause or origin of an interaction, the beginning of an interaction must be part of the observation chain. In the first case, Granger causality models (i.e., mathematical techniques developed to establish temporal precedence in one data set in predicting another) can be estimated (for examples, see von Eye & Wiedermann, 2015; von Eye, Wiedermann, & Mun, 2013; see also Example 6.5 in Jöreskog & Sörbom, 1996). In the second case, the same models can be estimated, but the designers of the study must make sure that the beginning of an interaction is observed. When, however, counterfactual (Paul, 1998) or mechanistic (Williamson, 2011) theories constitute the basis of a study, contemporaneous reciprocal effects can be considered as well (for an illustration, see, e.g., Example 5.5 in Jöreskog & Sörbom, 1996).

A third class of models concerns the status of variables. In many models, the status of variables is defined as dependent vs. independent, external vs. internal, or temporally prior vs. temporally posterior, and the variables themselves can be classified based on scale levels. In the process-relational framework, individual-level variables are related to aggregate-level variables, i.e. to variables that describe the physical or societal environment of individuals (Overton, 2014; Overton & Lerner, 2012). For example, the performance of high school students can be related to the poverty level in a school district, or the probability of falling victim to a crime can be related to characteristics of boroughs. The status of variables in this approach can be seen as parallel to the one discussed in hierarchical linear modeling. In process-relational theories, however, reciprocal relations are part of the set of hypotheses that are entertained. This includes contemporaneous reciprocal relations. In other words, reciprocal relations are assumed to exist between aggregate-level variables (poverty level, crime rate) and individual-level variables (performance in high school, victimization rate).

The three types of models just discussed share in common that two (or more) agents have effects on each other. This concept is certainly closer to reality than the one in which one agent has effects on another without feedback or without contemporaneous effects in the opposite direction.

In the following data example, we illustrate reciprocal relations. We use data from the Finkelstein et al. (1994) study again. Specifically, we ask whether Aggressive Impulses (AI) and Physical Aggression against Peers (PAAP) are in a temporally ordered reciprocal relation to each other such that AI leads to increases in PAAP, and PAAP leads to increases in AI. A Granger causality model will be estimated. We use the observations from all three points in time. Manifest variable models are estimated using maximum likelihood.

In the development of this model, we begin with a model in which the two series of measures are unrelated to each other. We treat this model as the null model, with which we compare later models. As expected, the significant X^2 shows that the model is a poor fit to the

data ($X^2 = 52.76$, $df = 9$, $p < 0.01$, RMSEA = 0.21 with CI: $0.16 \leq$ RMSEA ≤ 0.27; CFI = 0.81; GFI = 0.86). None of the statistics support the null model. We conclude that cross-series relations or even reciprocal relations may have to be considered to explain these data.

In a first attempt at modeling the reciprocal relation between AI and PAAP, we include two sets of parameters. In the first, PAAP measures at later points in time are predicted from AI measures at earlier points in time; that is, AI83 → PAAP85 and AI85 → PAAP87, where the numbers behind the variable names indicate the observation years. In the second set of parameters, AI measures at later points in time are predicted from PAAP measures at earlier points in time; that is, PAAP83 → AI85, and PAAP85 → AI87. Goodness-of-fit of this model is deplorable as well ($X^2 = 48.55$, $df = 7$, $p < 0.01$, RMSEA = 0.22 with CI: $0.16 \leq$ RMSEA ≤ 0.28; CFI = 0.86; GFI = 0.89). Therefore, and because this model is not better than the null model ($\Delta X^2 = 4.21$, $\Delta df = 2$, $p = 0.06$), it cannot be retained. We conclude that, if reciprocal relations allow one to explain the data at hand, Humean causality cannot be used as a theoretical background. The hypothesis that contemporary relations are needed must be tested.

To test this contemporary relations hypothesis, we insert two additional effects into the model. Specifically, we make the decision that, at the level of contemporary relations, causal effects originate in AI, and we insert the paths AI83 → PAAP83, AI85 → PAAP85, and AI87 → PAAP874. This model describes the data very well ($X^2 = 3.55$, $df = 2$, $p = 0.17$, RMSEA = 0.08 with CI: $0.00 \leq$ RMSEA ≤ 0.22; CFI = 0.99; GFI = 0.99), and the residual distribution contains no outliers. We therefore retain this model and interpret the parameters of interest. Table 7.1 displays the parameter estimates and the corresponding significance information (significance tests where intercepts or residual variances differ from zero are neither reported nor interpreted).

Table 7.1 Parameter estimates and significance statistics for Granger-type causality model of the relation between Aggressive Impulses (AI) and Physical Aggression against Peers (PAAP) during adolescence

	Sending Variables					
	AI83	*AI85*	*AI87*	*PAAP83*	*PAAP85*	*PAAP87*
Receiving Variables						
AI83						
AI85	0.45				0.00	
	(0.08)				(0.05)	
	5.73				0.05	
AI87	0.12	0.42			0.24	
	(0.08)	(0.09)			(0.06)	
	1.45	4.96			4.09	
PAAP83	0.57					
	(0.13)					
	4.26					
PAAP85	0.18	0.13		0.36		
	(0.11)	(0.12)		(0.07)		
	1.61	1.06		5.53		
PAAP87		–0.10	0.43	0.14	0.25	
		(0.09)	(0.09)	(0.05)	(0.07)	
		–1.17	4.67	2.67	3.57	

Note. AI83/AA85/AA87 = Aggressive Impulse 1983/1985/1987; PAAP83/PAAP85/PAAP87 = Physical Aggression against Peers 1983/1985/1987. Parameter estimates, standard error (in parentheses), and z scores are reported for each path in the model.

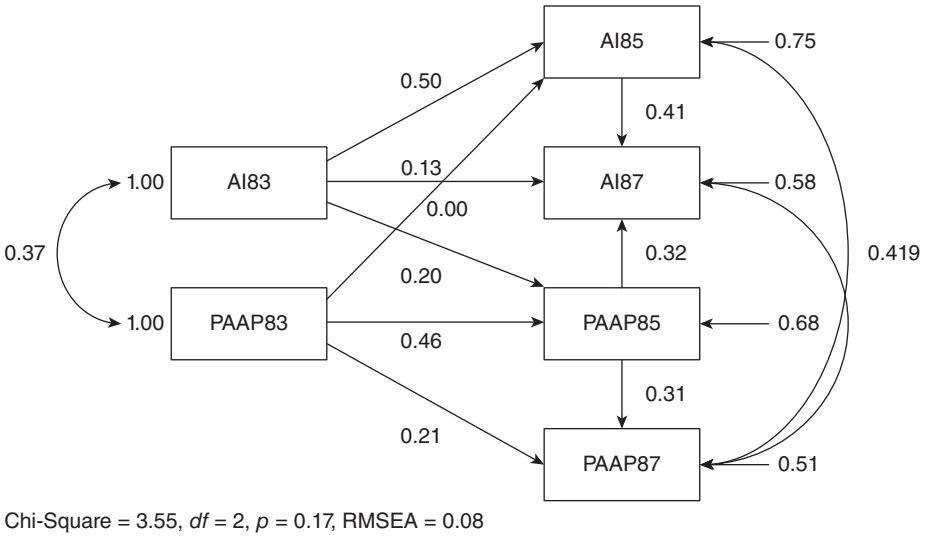

Figure 7.2 Model for the temporal ←→ relation between Aggressive Impulses (AI) and Physical Aggression against Peers (PAAP).

Figure 7.2 displays the final model (standardized estimates given). Table 7.1 contains the β estimates of the model (and associated standard errors and z scores). The table can be read as follows. The rows represent the variables that are positioned at the end of a path. The columns represent the variables from which a path originates. For example, Cell AI85–AI83 (rows are listed first) displays a parameter estimate of 0.45, with standard error = 0.08 and z = 5.73. These numbers indicate that, at age 13, Aggressive Impulses are higher by about half a scale point for those adolescents who, at age 11, score higher in Aggressive Impulses by a full scale point. This estimate comes with a standard error of 0.08 and is, therefore, significant. Note that the links between AI83 and PAAP87 as well as PAAP83 and AI87 are not included in the model. These links are compatible with the proposed theory. However, neither are significant, nor do they improve model fit.

As Table 7.1 and Figure 7.2 suggest, we find, over the course of four adolescent years, an interesting reciprocally predictive pattern for Aggressive Impulses and physical aggression against peers. Each of the two behaviors predicts itself from one observation point to the next; that is, over spans of two years. PAAP predicts itself even over a span of four years. AI at age 11 predicts PAAP contemporaneously and over a span of two years. At age 13, AI seems unrelated to PAAP. However, at age 15, AI predicts PAAP again. PAAP feeds back to AI by predicting AI at age 15 from age 13.

We also find that the relation between AI and PAAP is not time-stable. Specifically, at age 13, the two behaviors seem to be unrelated. At ages 11 and 15, there are contemporaneous relations, and at ages 13 and 15, there exist lagged relations, in both directions. In passing, we note that this result can be used to justify longitudinal studies. Had the relation between AI and PAAP been examined only once, at any of the three ages, the result would have been that either AI is predictive of PAAP (ages 11 and 15) or there is no relation at all (age 13). Neither would be reflective of developmental reality. We conclude that a ←→ relation between AI and PAAP exists in adolescence, and that, in the present example, longitudinal information is needed to unearth this relation.

Developmental Trajectories

In the following example, we model trajectories by specifying path models. These could, in principle, also be estimated using regression models. This even includes the quadratic components of the trajectories. However, we also propose that elements of the trajectories are related to each other. Structural models must be used for these estimations.

We use the same data as in the first two examples. The model we propose has two main properties: 1) both verbal aggression against adults and physical aggression against peers exhibit curvilinear trajectories that can be described by second-order (i.e., quadratic) orthogonal polynomials and 2) the constant, the linear component, and the quadratic components of verbal aggression against adults are predictive of the corresponding components of physical aggression against peers.

We estimate the model using maximum likelihood, and we estimate the constants for the two trajectories.[2] The parameters of the first and second-order orthogonal polynomials are fixed. Figure 7.3 displays the resulting model (raw estimates given).

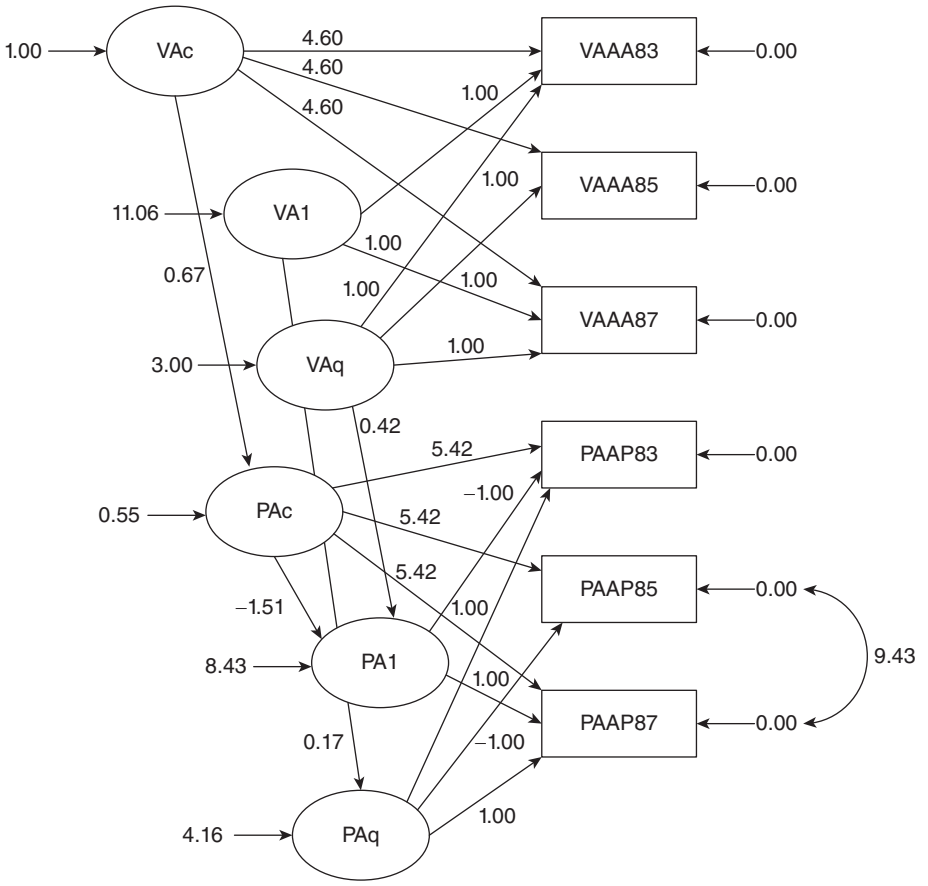

Figure 7.3 Model for the trajectories of Verbal Aggression against Adults (VAAA) and Physical Aggression against Peers (PAAP) and their relation.

For this model, we obtain an excellent model fit ($X^2 = 12.53$, $df = 10$, $p = 0.25$, RMSEA = 0.05 with CI: $0.00 \leq \text{RMSEA} \leq 0.12$; CFI = 0.99; GFI = 0.96). All of these statistics support the model. In addition, none of the residuals are extreme. Each of the estimated parameters is significant.

To obtain this model, only two additions to the originally proposed model were needed. First, there is an element in the development of Physical Aggression against Peers that is not captured by the model. Specifically, the residual covariance between PAAP85 and PAAP87 was large. The second addition is the path from the constant to the linear element of the trajectory of Physical Aggression against Peers. The linear slope is predictable from the constant.

Without going into any speculation concerning these two add-ons to the model, we highlight that the relations among the elements of the polynomials that constitute the developmental trajectories of verbal aggression against adults and physical aggression against peers can be estimated only in structural models, not in manifest variable regression models. In the present example, these elements indicate that the average level and the linear and quadratic elements element of the trajectory of Physical Aggression against Peers can be predicted from the corresponding elements of the trajectory of Verbal Aggression against Adults. The signs of the paths are positive. This indicates that as the average, the linear and the quadratic slopes of Verbal Aggression against Adults increase in value, as do the values of the corresponding elements of the trajectory of Physical Aggression against Peers.

Summary

Statistical modeling has become a method of choice in modern developmental science. Models are both solidly grounded in theories, and by design are also used to modify theories in specific ways by refining model assumptions based on statistical tests of the model parameters. Thus, modeling is both guided by theory and guides theory development. Statistical modeling also allows more flexibility in testing a variety of relations inherent in developmental data, including reciprocal relations, temporal relations, and linear and non-linear developmental trajectories. These relations are not so easily established in the context of traditional regression and ANOVA models. It is for these reasons that statistical modeling will continue to play a substantial role in the advancement of developmental science.

Notes

1 A catastrophe event is one in which large and rapid change in a system occurs, even though the inputs may be smooth and continuous. A cusp catastrophe is a type of transition that can be observed when there are two independent variables, X_1 and X_2, and one dependent variable, Y. The cusp catastrophe can be described as the universal unfolding of $f(x) = x^4$, and has the equation $F(Y, X_1, X_2) = Y^4 + X_1Y^2 + X_2Y$. Other equations can also evince cusp catastrophes, e.g. $Y = X^{2/3}$.

2 The LISREL command files for this and the first two models can be requested from the author at voneye@msu.edu.

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Part II

The Relational Perspective

Cognitive and Social-Emotional Development in Context

8 Moral Development in Context

Elliot Turiel and Larry Nucci

We are very pleased to be given the opportunity to participate in the current volume dedicated to the excellent contributions of Willis "Bill" Overton to our fields of study. In particular, we wish to acknowledge his important contributions through the paradigm of a Relational-Developmental Systems approach to lifespan development. That approach is premised on propositions that avoid mechanistically framed binary oppositions predicated on mechanistic additivity, aiming at an explanation of the whole by taking some of this (e.g., environment) and adding it with some of that (e.g., biology). Overton clearly articulated his relational position in a presentation in 2012 at the meeting of the Jean Piaget Society, arguing that:

1) the fact that a feature is mental does not imply it is not physical, and vice-versa (from Searle, 1992, p. 15);
2) the fact that a feature is biological does not suggest it is not cultural, and vice-versa;
3) the fact that an act is cognitive does not suggest it is not emotional, and vice-versa (Turiel, 2010).

His three points indicate that the Relational-Developmental Systems metamodel incorporates an understanding that environment and biology—like cognition and emotion, like intrapersonal and interpersonal, like self and other, like mind and body etc.—are separable only for analytic purposes. They constitute a *relational bidirectionality*, and, hence, an understanding that each part is composed of and composed by the other; an *epigenetic* model of lifespan development, and, hence, an understanding that development is sequential, ordered, directional, relatively permanent, and emergent; and a *temporal plasticity*, and hence an understanding that there can be multiple individual trajectories toward the same end. Within this broad Relational-Developmental Systems understanding there are specific theories that further articulate the alternatives to split off environmentalism, split off nativism, and split off additive conceptions. A major feature of an integrated developmental systems perspective on human functioning and development differs from positions of split-off biological and environmental determinisms by taking seriously the relational interweaving of thought, emotions, and actions. Actions constitute the foundation of thought and the development of thought, and thought in turn feeds back on actions.

Like Bill Overton, we have been influenced by the work of pioneering developmentalists like Baldwin (1906), Piaget (1970), and Werner (1957), each of whom conceptualize development as entailing mental constructions arising from the person's relational bidirectional interactions with the physical and social environment. The formulations of Baldwin, Piaget, and Werner take the relational character of mind and the person seriously in that human beings are, indeed, seen as thinking beings and development is viewed as a function of their relational bidirectional interactions with complex and multifaceted environments that continue throughout the lifespan. In these views, thought and emotions are not

independent pieces of a puzzle. Thought and emotions are interdependent parts of a whole (Kohlberg, 1969; Piaget, 1981; Turiel, 2006). Emotions are not so powerful, and thinking so weak, that emotions dominate reasoning. Emotions do not drive thought and behavior and individuals do not simply act non-rationally or irrationally because of unconscious or unreflective emotional reactions. Emotional appraisals are part of reasoning that involves taking into account the reactions of others and self (Nussbaum, 1999).

In this chapter we illustrate the relevance of the relational approach for moral development. We emphasize our approach, which has been labeled social domain theory, because we have proposed, as documented by numerous studies in a variety of laboratories, that at young ages children begin to form moral judgments that are different in form from other social judgments. In particular, systems of moral thought differ even in children as young as 4 or 5 years (if not earlier) from systems of thought about the conventions, rules, and roles of authorities in social systems, as well as from systems of thought about arenas of personal choice and jurisdiction. We have theorized about and researched the moral, social-conventional, and personal domains. As distinct domains of thought, these constitute different developmental pathways, each with its own sequence.

The domain approach is congruent with the Relational-Developmental Systems paradigm in that in the context of distinctions among domains, there are relational systems within each domain among reasoning, emotions, actions, and social interactions. Whereas the domains constitute different systems of thought, emotions, and social interactions, they do inform each other in decisions about multifaceted social situations by virtue of processes of coordination (which we describe in more detail later in this chapter). In line with the propositions put forth by Overton, we do not regard the usual suspects in the field of psychology and other disciplines—e.g., biology, environment, the physical, culture, thought, emotions—as separate variables to be contrasted with each other or simply added together to ascertain influences on development.

In many instances, explanations of moral development focus on the influences of the environment either in the form of the teaching of adults leading to the incorporation of society's standards, rules, or values by children (Aronfreed, 1968; Mischel & Mischel, 1976; Grusec, in press), or in the form of acceptance of cultural practices by virtue of participation in a culture (Shweder, Mahapatra, & Miller, 1987). In other instances, the focus is on the manifestation of morality through biological or genetically based behaviors, sometimes evolutionarily determined (Hauser, 2006). Additive models view morality as due to a combination (not relational) of some of this—biology—and some of that—adult teaching or cultural practices (Freud, 1930; Haidt, 2001). Often, it is emotions derived either from learning or genetics that determine moral attitudes and actions. Since in these views emotions are split off from reasoning, moral decisions are seen as either non-rational or irrational.

Our approach to the development of morality has also been influenced by the work of Piaget (1932) and Kohlberg (1963, 1971), each of whom provided important and lasting contributions regarding central aspects of morality. In the first place, they treated the topic of morality as a substantive realm requiring careful epistemological analysis aimed at providing sound philosophical-definitional parameters (see especially Kohlberg, 1971). To put it briefly, they defined the substance of morality as entailing considerations of welfare, justice, and rights. They demonstrated how definitional-philosophical considerations about morality map onto psychological analyses of the ways people make moral judgments. In demonstrating that people do indeed think and reason about moral issues, Piaget and Kohlberg provided evidence that morality is not adequately defined, as a realm of endeavor or in the ways individuals function, as the acceptance of specific standards and rules, or as the formation of habits of action or traits of character. Equally importantly, they demonstrated that morality involves thought connected with emotions. In particular, Piaget focused on connections between welfare or justice and emotions of affection, sympathy, and respect.

Another significant contribution by Kohlberg and Piaget stemmed from their recognition that individuals' judgments about moral goals can be in conflict with the dictates of those in authority and with power, and that moral decisions can involve opposition to established practices of injustices. In Piaget's most advanced level of autonomous morality and in Kohlberg's highest stages (stages 5 and 6 of "principled morality"), moral judgments can include opposition to the existing power structure.

However, there is a sense in which the domain approach differs in important particulars regarding development from the formulations of Piaget and Kohlberg. They each proposed sequences of the development of moral judgments from childhood to adolescence or adulthood that entail processes of differentiation of morality from other types of judgments—including judgments about prudence (e.g., punishment, obedience), self-interest, rules as fixed entities, the perceived necessity to unilaterally respect authority, and the conventions of the social system. Another way of putting this is that they proposed, within their respective sequences, that moral development progresses from confusions of what exists (is) with oughts (i.e., what people "ought" to do in a particular situation), to distinct understandings of "ought." By contrast, the research on domains shows that children distinguish is from ought. Young children differentiate morality from those other types of social and pragmatic judgments—hence the idea of distinct developmental pathways within domains.

Kohlberg's research, for example, was premised on the proposition that moral judgments could best be studied by presenting research participants with multifaceted situations entailing conflicts that would require them to resolve the conflicting considerations. For instance, one of the situations created by Kohlberg involves a man's decision as to whether to steal an exorbitantly priced drug to save the life of his cancer-stricken wife (Kohlberg, 1963). As detailed elsewhere (Turiel, 2008a), the problem in starting with such multifaceted situations (in this case, considerations of life, property, rights, legality, and unfairness) is that they make for complexities that fail to uncover how children make straightforward moral judgments about harm, fairness, and legal considerations. As considered in the next section, by separating variables in less complex situations, we are able to show that children possess understandings of harm and fairness.

Research on Moral Development

The research findings of judgments in the moral, social-conventional, and personal domains, therefore, are not consistent with the differentiation models of moral development put forth by both Piaget (1932) and Kohlberg (1963). A large and extensive program of research shows that understandings and judgments of morality, the conventions of society, and personal matters of individual discretion and privacy are structured within distinct conceptual frameworks. Children understand this—they are able to differentiate morality from prudence, the perspectives of persons (self or others), or self-interest (Nucci, 1981). It is important to note that the research on domains was initially conducted by disentangling and thereby separating different components in the complex types of situations that had often been used in prior research. For example, participants were presented descriptions of moral transgressions or of positive actions that were straightforward and not juxtaposed with other considerations (e.g., inflicting harm, theft, helping, sharing, violation of rights, unequal treatment).

As we review in this section, it has been well documented through studies conducted in several cultures that children as young as 4–6 years of age have formed patterns of thinking about morality that are differentiated from patterns of thinking about the conventional and personal domains. Each of the domains of thought constitutes different developmental pathways, each with its own sequence. Judgments applied within complex social contexts may draw from knowledge across domains, requiring the coordination of elements and considerations from more than one conceptual framework. Thus, from our vantage point, situated

moral judgments are not fully accounted for by changes solely within the moral domain. Instead, moral decision-making in complex social situations entails contextualized weighing and balancing of competing elements—what we refer to as *coordination*—to arrive at a given action choice. Our view does not treat context simply as the content subsumed within a given stage or framework of moral judgment (e.g., conventional at one level or principled at another), but rather as an integral aspect of situated moral reasoning.

Research on the domains has provided evidence for age-related developmental shifts in the conventional (Geiger & Turiel, 1983; Midgette, Noh, Lee, & Nucci, 2016; Turiel, 1983) and personal domains (Nucci, 2001). However, identifying a sequence of development of moral judgments has proven to be more complex because of significant continuities and discontinuities in relation to age and because of the role of contextual features associated with morally relevant decisions. We have begun to focus upon broad age-related changes in the moral domain in work that we summarize in the next section. That research was preceded by a number of studies providing evidence that moral reasoning undergoes development. Importantly, that prior work signaled that elements of moral reasoning emerge at different times in early childhood, and that context interacts with developmental factors in the generation of moral decisions.

The Emergence of Morality in Early Childhood

An initial investigation of the moral judgments of children indicated that the development of moral judgments in early childhood is grounded in understandings of harm and welfare and that concepts of fairness and justice emerge in later years (Davidson, Turiel, & Black, 1983). A number of subsequent studies have obtained similar findings indicating that younger children's moral judgments are based on concepts of concrete harm and welfare of others, whereas at older ages there is a greater emphasis on fairness, involving equality and equal treatment between persons (Kahn, 1992; Nucci, 2001; Tisak & Turiel, 1988). However, it is not sufficient to characterize the development of moral reasoning as entailing a shift from concepts of harm and welfare to fairness and equal treatment. It appears that there are emerging concepts of fairness among young children and that older children's judgments are based on both welfare (which are still maintained at older ages) and fairness. Therefore, there are both continuities and discontinuities in development that need to be taken into account.

With respect to judgments about harm, the most consistent finding has been that very young children evaluate unprovoked harm as wrong, and that judgments about unprovoked harm do not vary with age (Smetana, Jambon, & Ball, 2014). It should be noted, though, that there are age-related differences in young children's application of the criteria for treating harm as a moral transgression (Smetana et al., 2012). Children below the age of 4 years do not view acts such as hitting and teasing as wrong independent of the dictates of authority.

The form of harm also bears on the ages at which children fully apply moral judgments. Acts of inflicting physical harm were judged to be wrong more consistently than acts inflicting psychological or emotional harm (Helwig, Hildebrandt, & Turiel, 1995). It appears that young children are not able to interpret situations of psychological harm to entail welfare as readily as they can interpret the welfare involved in acts of physical harm (Helwig, Zelazo, & Wilson, 2001; Jambon & Smetana, 2013). Thus, even in the case of unprovoked harm, we see evidence of development in children's moral understandings.

Development of Moral Judgments in Context

These findings of age-related shifts in moral thinking, however, need to be couched within other findings evidencing the role of context in moral judgments. In addition to weighing

the moral purposes of harm, research has uncovered developmental effects on children's and adolescents' evaluations of harm as a function of the relationship to the person being harmed. Posada and Wainryb (2008) reported that Colombian children and adolescents from age 7–15 years evaluated engaging in unprovoked harm (hitting, kicking, and hurting someone) as wrong, and most of them maintained these same judgments in cases where harm would aid in their own personal welfare (hitting another child and stealing his bike to use for transportation to a job). However, these judgments shifted when the person who would be the target of the harm was someone who had previously harmed a family member. In this "revenge" condition the study participants were more likely to accept harm, with adolescents twice as likely as children to endorse harm in the revenge condition.

The importance of relationships has been demonstrated in children's judgments about harm to friends and siblings (Wainryb et al., 2005). Through narrative accounts of children's own transgressions with subjects at 7, 11, and 16 years of age, researchers have determined that instances of harm between friends were "unusual, unforeseeable, and circumstantial" (Recchia, Wainryb, & Pasupathi, 2013, p. 1459) while instances of harm to siblings were not uncommon. Children and adolescents described their own actions entailing harm to siblings as more ruthless than the harm caused to friends. Harm against friends was relationship oriented, whereas harm toward siblings was more explicitly offensive and property oriented. With age the form of harm across relationships shifted from damage to property to psychological insensitivity (Recchia et al., 2013).

Harm and helping both involve moral judgments about human welfare (Turiel, 2015b). However, harm and helping are not simply two sides of the same coin. Narrative accounts of children and adolescents differ in the salience of the impact of helpful and harmful acts directed at peers (Recchia, Wainryb, Bourne, & Pasupathi, 2015). Children at age 7 years were more likely to refer to the consequences of harm than of helping, and by age 16 referred to the consequences of helping and harmful actions equally. This indicates that the positive effects of helping are less salient to younger children, and that the negative effects of harm are identified (Recchia et al., 2015). These researchers also reported that adolescents were more likely than children to consider the costs of helping to the self. This latter finding is consistent with outcomes from studies of prosocial reasoning indicating that concerns for the costs of helping and expressions of self-interest as a factor in weighing whether to help show an increase in adolescence (Eisenberg, Carlo, Murphy, & Court, 1995). Instead of a linear progression of moral development with age, the picture that emerges with regard to judgments about whether to engage in helping shows a non-linear pattern with an apparent phase of "less" moral "hedonistic" reasoning in early adolescence. A similar quadratic U-shaped function in the priority given to self-interest rather than prosocial factors in decisions about whether to help appears in early adulthood (Eisenberg et al., 2002).

Further Evidence of Coordination in Social Contexts

Contextual variations are evident in judgments about several moral constructs, including equality (Elenbaas, Cooley, Rizzo, & Killen, 2015), rights (Helwig, 1995), social inclusion (Cooley, Elenbaas, & Killen, 2016), and trust (Gingo, 2012; Perkins & Turiel, 2007). In many situations decisions involve coordination of different moral goals and of moral and non-moral social goals that do not show a straightforward relation to age. For example, age-related changes in children's judgments about fair distribution of goods vary according to whether the goods to be distributed are necessities. When asked to distribute goods that are nice and fun to play with, children below the age of 10 years tend to employ principles of equality, not equity. However, when the goods are described as necessary (e.g., school supplies, medical equipment), children aged 5–6 years employ principles of equity to insure that disadvantaged

children have access to needed goods (Elenbaas, Rizzo, Cooley, & Killen, 2015; Rizzo, Elenbaas, Cooley, & Killen, 2016).

Consider as another example of analogous findings the non-linear age-related changes in decisions regarding honesty or trust, and deception when in conflict with other moral and non-moral goals. Two studies, one with children from 7–12 years (Gingo, 2012) and the other with adolescents from 12–17 years (Perkins & Turiel, 2007), yielded findings demonstrating age-related differences in judgments about deception and variations by situational contexts. In these studies participants were presented with hypothetical situations depicting parents directing their children to engage in acts considered morally wrong (e.g., cutting in line, racial discrimination for adolescents), acts in the personal domain (e.g., pertaining to choice of friends), and prudential acts (e.g., climbing a wall at a park, riding a motorcycle). The children and adolescents evaluated the legitimacy of the directives of parents and the acts of deception. The age-related findings suggest that whereas the children and adolescents negatively evaluated the directives from parents regarding the acts in the moral domain, most of the younger children (7–10 years) did not judge deception of parents positively. By contrast, most adolescents judged deception of parents regarding the moral (and personal) acts as acceptable. The relevant contextual variations are that children and adolescents positively judged directives from parents regarding the prudential acts and deception with regard to those acts as unacceptable. Therefore, adolescents give priority to achieving moral and personal goals over honesty. Children and adolescents give priority to honesty in the context of prudential directives and acts.

Continuities and Discontinuities in Moral Development

The current evidence points toward age-related continuities and discontinuities in moral decision-making. Across ages, for example, we see continuity in moral judgments about unprovoked harm. Young children and adults judge unprovoked physical harm of another person to be wrong. We also see evidence of positive age-related shifts in moral reasoning about issues of fairness. Findings regarding the distribution of goods indicate that considerations about equity appear later in childhood than distributions based on strict equality. Meanwhile, research has also uncovered discontinuities in children's judgments about the fair distribution of goods as a function of the types of good under consideration (necessary or discretionary). Finally, in other areas, such as judgments about helping, there is evidence of U-shaped patterns in the development of moral judgments with younger children and older adolescents providing judgments that are more alike than those produced by children and early adolescents. All of this prior work points toward the need to further examine the potential broad age-related trends in moral thinking, while exploring the role of context in moral decision-making. That has been the focus of our most recent work and the topic we turn to next. Aspects of this study as it was being completed have been discussed in previous publications (Nucci, 2014; Nucci & Turiel, 2009; Turiel, 2015a).

In this study we explored age-related changes in reasoning about three basic moral issues: direct harm in the form of hitting; indirect harm stemming from whether to return money lost by someone the story protagonist sees; and helping. Each of these three situations was presented within three conditions. In the *unconflicted* situations the protagonist must make a moral decision without any obvious personal needs or the needs of any third party coming into play. There were two conflict conditions. In the *conflicted-self* condition the story protagonist has personal needs or wants that are in conflict with causing harm or providing help to another person. In the *conflicted-other* condition the moral choice of whether to cause harm or help someone is in conflict with the needs of a third party. Finally, these situations were varied in terms of the characteristics of the person who is the object of the moral decision: a generic

other, a vulnerable other, or an antagonistic other. The other child was described simply as a "girl" or "boy," or as someone who had antagonized the child the previous day by teasing and making fun of him/her, or as a vulnerable child who falls or drops money because of a handicapping condition or engages in hitting because of an inability to control emotions.

Participants in the study were asked to make two kinds of judgments: 1) whether the act was right or wrong, and 2) whether the protagonist in the situation would have a right to engage in the action if that is what s/he chose to do. This second question was primarily designed to be an indicator of whether the participants maintained that the protagonist would be bound by a judgment that engaging in a given non-moral choice would be wrong. The participants were 167 children and adolescents (82 males; 85 females) distributed across four age groups: 8, 11, 14, and 16/17 years of age. This was an ethnically diverse sample drawn from schools in urban and suburban settings in two areas of the United States: the upper midwest and the San Francisco Bay Area of California.

Our analyses included the judgments made as well as the supporting justifications offered for judgments of whether an act would be right or wrong, and whether the actor in a given scenario had a right to make the non-moral choice. A detailed presentation of these findings is beyond the scope of this chapter. In summary, the analyses indicated that there are age-related differences in the decisions made, and in the use of moral and personal justifications, as well as correspondences between justifications and the contexts and issues evaluated. With regard to age effects, we found a general tendency for moral action choices of the youngest (8-year-old) and oldest (16-year-old) participants to be more alike and in the positive moral direction than were the decisions of the early adolescent participants (11–14 years). This resulted in an overall U-shaped function in moral decision-making by age. This age effect was most pronounced in the case of judgments of whether the protagonist would have a right to engage in the non-moral action choice (e.g., keep the money). This is presented in Figure 8.1. This broad developmental finding, however, did not hold up across all contexts. For example, there were no age effects in judgments of unprovoked harm of a child in general. In keeping with long-standing findings from prior research, the great majority of our participants across ages judged the act of unprovoked hitting as wrong.

In addition to straightforward analyses of judgments and their supporting justifications, we were interested in how the different considerations brought to bear in generating moral judgments were weighed and balanced, involving processes of coordination (Turiel, 2008b).

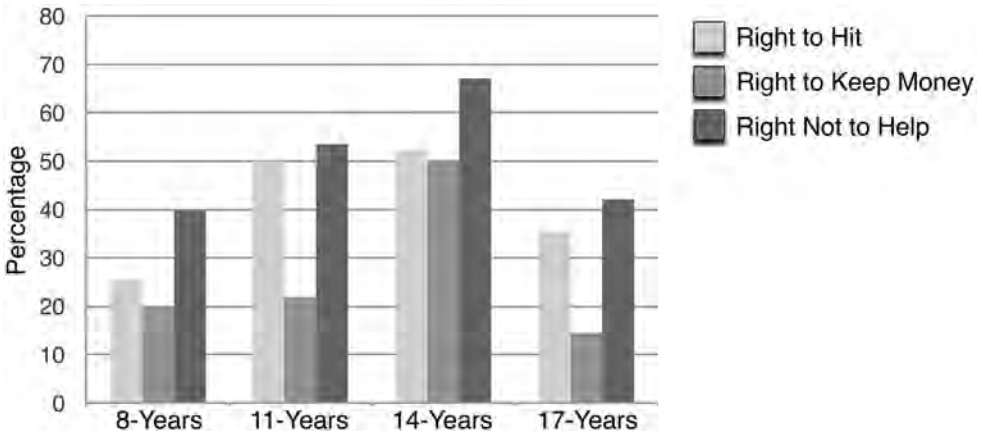

Figure 8.1 Percentage of participants by age judging that the protagonist would have a Right to Hit; Right to Keep the Money; and Right Not to Help.

For example, in reasoning about the indirect stealing situations, some participants referred to questions about whether the dropped money was still the property of the person who had dropped the money. In other cases, participants offered reasons affirming continued ownership of the money. Others brought in both considerations of possible loss of ownership and continued ownership. Understanding how different considerations about ownership were dealt with, and whether or how they were connected with other aspects of a person's reasoning, are *not* part of the coding of justifications. We identified three broad patterns in the coordination of justifications.

As we outline in the rest of this section, these patterns were associated with age and we refer to them as levels of coordination. The first level (Level I) describes moral judgments in which evaluation of the right or wrong of an action is based on the most salient moral elements of harm or welfare presented in the situation and not other features. The decisions made using this pattern appear non-wavering and unambiguous. Individuals may recognize or mention other elements, or can recognize other elements if they are brought to the person's attention, but these are not integrated within the person's reasoning; they are merely noted.

The second level (Level II), referred to as multi-dimensional uncoordinated, is characterized by attention to different features of a situation, and a recognition of ambiguity, but without resolution or evidence of coordinating the moral and non-moral concerns in a systematic way. This process is manifested by inconsistency and ambivalence that sometimes results in a reading of moral ambiguity as allowing for selection of an action that fits the needs and desires of the actor. At this level, judgments about whether an act is right or wrong are not coordinated with judgments about whether one would have a right to engage in a given action. Thus, it is frequently maintained that one would have a right to engage in an action even though the act could be considered wrong.

At the third level (Level III), labeled as multi-dimensional coordinated, there is evidence of consideration and weighing of multiple (moral and non-moral) aspects with a resolution. Individuals who engage in a *coordinated* process demonstrate an awareness of moral ambiguity and the arguments that can be made for acting in self-interest in such situations. However, they engage in reasoning that leads to resolution of the elements that generate that moral ambiguity with the integration of non-moral concerns in a consistent and systematic way.

The levels represent degrees of complexity and comprehensiveness in the coordination of elements in the reasoning of participants. Although our expectation was that these levels would be associated with increased age, we did not view these levels as consistent with criteria posed in previous analyses of developmental "stage" (e.g., Kohlberg 1969). Stages refer to patterns of thought in which the same form of reasoning is employed independent of the particular elements contained in a given situation. By contrast, our expectation was that the complexity of the situation would affect the types of processes brought to bear in evaluations of a given situation. For example, based on many studies (e.g. Smetana, Jambon, & Ball, 2014), we did not expect complex coordination to be used in evaluations of the prototypical situation of unprovoked harm of a child in general. This is because that situation does not involve competing or conflicting considerations. We also expected that particular features of a situation, such as whether it involved a vulnerable child, would highlight the salience of the moral components of a given situation, and thus "simplify" the reasoning brought to bear on how one should act. We expected that more complex reasoning would be elicited by contexts that included competing considerations such as self-interest.

Therefore, whether a decision involves processes of coordination would depend on the situational context that will in some respects not be related to age. We anticipated that situations involving hitting an *antagonistic* target and those involving provocations in the *conflict-self* and *conflict-other* (i.e., hitting in self-defense or to protect another) might involve considerations of different elements in coming to a decision. We expected that in most of the situations

involving the issues of helping and indirect stealing, there might be decisions involving coordination. Prosocial behaviors, such as in our helping situations, are not straightforward in that they include discretionary choices with personal considerations. We also viewed decisions about indirect stealing as likely to include an element of personal discretion (and moral complexity) associated with the ambiguity and differing interpretations of ownership of the money. Although electing to keep the money that someone else unknowingly drops could be considered stealing, there are aspects to this situation that differ from a direct and purposeful attempt to take another's property. First, the situation presents itself by chance. The protagonist in these situations did not set out to take another person's money, and did not actively cause it to leave the other person's possession. In the situations that we employed, the money falls to the ground in a public space (a bus or a park), and not in an area such as a house owned by the person who loses the money. In sum, we expected there would be age differences in levels of coordination about the situations involving more than one component.

Coordination Levels: Age and Context Effects

Our initial exploratory analysis for age effects revealed an overall linear main effect for age. The youngest children were most likely to make Level I (straightforward, one-dimensional decisions), with Level II (multi-dimensional uncoordinated) and eventually Level III (multi-dimensional coordinated) decisions more likely with increasing age. The overall distribution of participants at each level by age and issue is summarized in Table 8.1. This initial analysis was done with the unprovoked hitting scenarios excluded. This initial analysis, however, also revealed complex interaction effects with age among the context and relationship variables for each issue. We therefore summarize the outcomes for each issue separately.

Situations Involving Hitting

As expected, there were no age effects for level of coordination about unprovoked hitting. The overall patterns for the relationship between age and coordination level are presented in Table 8.2. Across ages, all of the participants provided Level I one-dimensional coordination in their reasoning about situations involving the child in general and nearly all of them employed Level I in situations involving the vulnerable child. In these contexts, *welfare* and *fairness* were the most frequently used justifications. We saw evidence of more age-related variability in levels of moral thinking when the question of unprovoked hitting involved the *antagonist*. In addition to appeals to welfare and fairness, the situations involving the antagonist included personal choice and reciprocity justifications. It appears that to some extent unprovoked hitting of an *antagonist* was seen as involving provocation.

The two contexts involving conflicts of *self* or *other* with respect to decisions about hitting generated the expected linear age-related trend for levels of coordination. The youngest

Table 8.1 Proportions of participants at each age employing Level I, Level II, or Level III reasoning overall (unprovoked hitting excluded)

Age and Relationship	*Level I*	*Level II*	*Level III*
Age in Years			
7–8	91	09	00
10–11	73	23	04
13–14	45	45	10
16–17	35	18	47

Table 8.2 Proportions of participants at each age employing Level I, Level II, or Level III reasoning for hitting (conflicted situations), indirect stealing, and helping

Age and Relationship	*Level I*	*Level II*	*Level III*
Hitting			
Age in Years			
7–8	91	09	00
10–11	75	25	00
13–14	58	58	11
16–17	27	26	47
Indirect Stealing			
Age in Years			
7–8	93	07	00
10–11	71	22	07
13–14	58	35	07
16–17	35	09	46
Helping			
Age in Years			
7–8	88	12	00
10–11	73	20	07
13–14	42	37	11
16–17	28	24	48

children primarily used Level I coordination. Level II appeared at age 13–14 years, and Level III was most prevalent in the oldest (16–17-year-old) participants. This would indicate that the older participants took more features into account than younger ones in these more complex situations. The conflict-self situations, for example, were ones that involved the use of hitting to fend off an aggressor. References to self-defense as a justification were greater between Level II and Level III participants than among those at Level I. Level I participants mainly referred to welfare considerations that focused on the one dimension of the protagonist inflicting harm on the child being hit. By contrast, participants at Levels II and III using *welfare* and *fairness* justifications also took into account the welfare and fairness of the person under attack (including that the protagonist would have a right to protect him or herself).

Situations Involving Indirect Stealing

As shown in Table 8.2, age-related effects were observed in levels of coordination across each of the situations involving judgments about whether to return the money to the person who dropped it. The most frequent justifications used by those at Level I were affirmation of ownership and the related welfare category (for judgments of right and wrong and the right to keep the money). There was little use of personal choice at the first level for judgments of right and wrong. At Level II there was greater use of the following categories: defining ownership, reciprocity, negation of harm (keeping the money caused no harm), and personal choice. These patterns reflect the Level II coordination of attempts to take into account various considerations without clear-cut priorities. At Level II the questioning of ownership of dropped money (as reflected in the defining ownership category) reflected the interpretation of the situation as an ambiguous case of loss or theft. This questioning of the continued ownership of the dropped money was associated with a corresponding justification that keeping the money would not cause harm since it was essentially no longer the property of the person who had dropped it. For participants at Level III the consideration of defining ownership was offset by arguments affirming ownership, along with welfare justifications, as was the case at

Level I. At Level III the ambiguities taken into account at Level II were resolved within a coordinated integration of the components contained within this indirect stealing scenario.

As was the case with hitting, however, the age effects associated with indirect stealing situations generated significant interactions with context and relationship. The interaction observed between age and context was accounted for by the tendency among 16–17-year-olds to use higher levels in the *conflict-self* and *conflict-other* situations than in the *unconflicted* contexts. This suggests that in the absence of the added complexity of a conflict involving a personal need for the money, or in considering whether to keep the money to help a friend, the issue of returning money dropped by another was straightforward for the majority of the oldest adolescents. Participants also tended to use less complex forms of coordination when making decisions about whether to keep the money dropped by the *vulnerable* other child. This was most noticeable for the two oldest age groups. Meanwhile, decisions about whether to return the money to the *antagonist* generated higher levels among the participants from 9–14 years. Thus, the situation with the antagonist would appear to hold more ambiguity than whether to keep the money dropped by a vulnerable child for participants above the age of 8.

Situations Involving Helping

As with hitting and indirect stealing, we observed an overall age effect for levels of coordination for the helping situations. This is summarized in Table 8.2. As expected (and as with hitting and indirect stealing), decisions about whether to help tended to involve less complex coordination in the unconflicted contexts than in the two conflict situations. For example, the proportion of 16–17-year-olds displaying Level III coordination when judging helping in the unconflicted context occurred less frequently (27 percent) than when they were evaluating whether to help in the *conflict* situations (52 percent and 65 percent, respectively). Decisions about helping the *antagonist* tended to elicit higher levels than judgments about whether to help the *vulnerable* child or a child in *general*. The elements involved in processes of coordination in the helping situations are different from those in the indirect stealing and hitting situations. In particular, situations calling for helping present considerations of potential conflicts between obligations and personal choices. Accordingly, categories of personal choice and reciprocity were used with some frequency for the helping situations across levels. At Levels I and III, however, there was greater use of welfare and fairness categories, and less emphasis on personal choice and reciprocity than was the case at Level II. The differences between Levels I and III lie not in the justification categories that were employed, but in how different considerations were weighed in arriving at decisions. The greater use of *reciprocity* at Level II than Levels I and III was mainly due to their use in judgments about helping the antagonist.

Coordination Levels and Action Choices

One question we had was whether the developmental patterns we observed on levels of moral reasoning were associated with judgments of right and wrong, and whether the protagonist would have a right to engage in the non-moral action choice. As we reported in the previous section, we observed a curvilinear pattern in action choices, with the youngest and oldest participants providing action choices that were more similar than the older children and early adolescents. We found that the level of coordination significantly predicted whether participants would judge that the protagonist's action was acceptable. This held even when controlling for age and contextual variables. That is to say, coordination levels predicted judgments of the acts independent of age. While the overwhelming majority

of participants employing Level I or Level III coordination judged the acts as wrong, the likelihood of a participant employing Level II coordination judging a given act as wrong was basically at chance levels (54 percent). The level of coordination also predicted whether participants judged that the protagonist had a right to do the described action. Looking at all the situations combined, 13 percent of Level I participants judged that the protagonist had a right to engage in the non-moral action choice. In contrast, 36 percent of participants who showed Level III coordination and 70 percent of participants at Level II judged that the protagonist had a right to engage in the actions.

Conclusion

The results of the research on the development of moral judgments we detailed in this chapter confirmed what prior research has suggested: that it defies a straightforward characterization of moral development as a linear progression. It used to be thought—not unreasonably—that the development of moral judgments progresses through a series of levels or stages leading to "true" moral understandings only at relatively late ages. Those formulations did not account for two important features: that moral understandings begin to be formed in early childhood and that people, including children, think systematically about other aspects of social relationships and systems of social organization. It is now an old but still relevant story that children form judgments distinctly different from the moral domain about conventions in the social system and arenas of personal jurisdiction. It is also the case that many social situations pose multiple considerations and goals, sometimes with conflicting considerations within the moral domain and at other times with conflicts between moral and other social considerations.

It is these multiple features that do not allow for an adequate depiction of development in the moral domain to be rendered in terms of a straightforward, linear progression of ways of thinking. In the first place, the study we have considered in the final portions of this chapter clearly confirmed that children make judgments that inflicting harm intentionally in unprovoked situations is morally wrong. As suggested by previous research, it was also determined that with regard to harm in unprovoked situations, for example, there is continuity across ages. Those in all the age groups judging that such unprovoked harm is wrong used similar reasoning. The research also produced findings regarding decisions in other contexts demonstrating that changes in reasoning and decision-making occur with increasing age. However, the developmental road in this regard is not without twists and turns.

Twists and turns are connected with the ways social situations can be multifaceted, requiring coordination of different considerations and goals. In the situations we discussed, the coordination process results in ambiguities and problems for adolescents' emerging understandings of the role of individual or personal considerations in some moral decisions. In attempting to account for personal prerogatives, it appears that decisions at the different ages reveal a U-shaped curve—with younger children making decisions that appear more akin to older than younger adolescents. However, the decision markers do not reflect a less developmentally advanced process of moral judgment on the part of those at mid-adolescence than the younger children. Rather, they reflect efforts on the part of adolescents to account for significant aspects of personal jurisdiction in the choices people make and for how to coordinate those aspects with the legitimate claims of others. In turn, the similarities of decision markers between the oldest (16-year-olds) and youngest (7–11-year-olds) do not represent similar processes of thinking: the Level III forms of coordination are different from and more complex than the Level I forms.

In sum, the observed twists and turns in moral development reflect the ways that individuals attend to varying features of social interactions and to their attempts to make sense of the social world. These age-related twists and turns in reasoning about conflicts embedded within

the varying contextual aspects of situations should be seen as attempts by the adolescents to come to more comprehensive and adequate solutions to complex problems requiring that they account for multiple considerations. This points to another binary opposition avoided in Bill Overton's Relational-Developmental Systems approach, namely that a feature being contextual does not imply it is not judged, and a feature being judged does not imply it is not contextual. A more general formulation of these points can be seen in the following statement by Overton (2010, p. 20):

> An open system takes inputs from the environment, transforms them, and releases the transformations as outputs. At the same time in this coaction of system and environment, there are reciprocal effects on the system itself (change of organization) and on the environment (transformed environment).

In keeping with what we refer to as twists and turns in processes of development, Overton (2010, p. 6) has stated that "in open self-organizing systems, nonlinearity (nonaddivity; discontinuity) is frequently the rule"; and that "[a]lthough each level of organization of the system is a part of the normative sequence moving toward a normative end, there are multiple means or action paths to each system level."

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9 Embracing Complexity in the Study of Executive Function and its Development

Philip David Zelazo and Stephanie M. Carlson

Bill Overton's groundbreaking contributions to developmental theory and research have long been an inspiration to us both, and in this chapter, we briefly describe Bill's influence on our work on cognitive development, including our research on pretend play and executive function. We also address what we believe may be Bill's most profound contribution to the field of developmental psychology, his articulation of a meta-theoretical framework for understanding developmental systems, relational meta-theory. His meta-theoretical view has evolved over the years (Overton, 2010, 2013), but the seeds of this relational, contextualist approach were sown as early as the 1970s (e.g., Overton, 1973; Overton & Reese, 1973), and his writing has always been at the forefront of emerging developmental systems views (e.g., see Bronfenbrenner, 1979; Gottlieb, 1992; Lerner, 1991; Oyama et al., 2001; Sameroff & Chandler, 1975).

Our current, complex characterizations of human development (e.g., see the 16 articles in the recent Special Issue of *Development and Psychopathology*, titled *Longitudinal Transactional Models of Development and Psychopathology*) have been deeply influenced by developmental systems views, which have gained traction in part because of rapid technological advances. These advances have allowed us to observe psychologically relevant processes at multiple levels of analysis, and then to model this developmental system over time, capturing reciprocal causal influences across levels (e.g., allowing us to observe brain–behavior relations, as well as interactions among genes, the environment, and the epigenome). Indeed, Zelazo (2013) suggested that the current state of developmental science is characterized by the following assumptions: 1) psychological phenomena are usefully studied at multiple levels of analysis; 2) psychological development depends on neural plasticity, which extends across the lifespan; 3) the effect of any particular influence on psychological development will depend on the context in which it occurs; 4) psychological phenomena, and developmental changes in psychological phenomena, typically reflect multiple, simultaneous causal influences; and 5) these causal influences are often reciprocal. Together, these assumptions suggest that the field has now moved away from what Overton (2010) calls a "split metatheory," with its emphasis on traditional dualisms (e.g., mind/brain, cognition/emotion, individual/society, nature/nurture), and instead moved toward a more holistic, developmental systems view of human beings as dynamic, multidimensional phenomena that are simultaneously behavioral and neural, cognitive and emotional, individual and social. This systems view aims to understand the way in which processes operating at many levels of analysis (cultural, social, cognitive, neural, and molecular) work together to generate human behavior and changes in human behavior. Consideration of multiple levels of analysis highlights the extent to which the effect of any particular influence on psychological development depends on the context in which it occurs, and it reveals the need to capture multiple, simultaneous, and interacting causal influences on behavior and development that are often bidirectional in nature.

Bill's theoretical work on cognitive development, in particular, combines a systems view with a hierarchical approach to the development of representations. From the perspective of his developmental relational systems approach, action in the world drives the development (via differentiation and integration) of competence toward "increasingly complex and abstract higher orders of reflection" (Overton & Ricco, 2011, p. 234). As he puts it,

> Beginning in infancy, where a primitive form emerges in the coordination of action, this system progresses at around 18–24 months to a level entailing symbolization processes, and the consequent *emergence* of language (i.e., a system of symbols) and thinking (i.e., symbol creation and symbol manipulation), thus establishing a first order of self-conscious reflection. From this base level of first order symbolic reflection, higher orders of reflection emerge during childhood and adolescence. Thus, in adulthood, second, third, and even higher order judgments are possible.

In what follows, we outline the ways in which Bill's thinking has influenced our own theoretical and empirical work integrating the development of executive function, pretend play, rule use, and creativity, through the prism of self-conscious reflection.

Executive Function

Executive Function (EF) refers to a specific set of attention-regulation skills involved in conscious goal-directed problem solving, including *cognitive flexibility* (thinking about something in multiple ways), *working memory* (keeping information in mind and manipulating it), and *inhibitory control* (deliberately suppressing attention (and subsequent responding) to something (e.g., Blair & Diamond, 2008; Carlson, Zelazo, & Faja, 2013; Diamond, 2012; Garon, Bryson, & Smith, 2008). In our work on EF, we have focused on the role of reflection in the development of hierarchical rule-based representations that support EF skills, deliberate reasoning, and intentional action. Reflection is the deliberate consideration (and re-consideration) of something in the context of goal-directed problem solving. Reflection occurs when one interrupts an ongoing stream of consciousness or action, and actively considers one's situation, or construes it in a way that is experienced as "stepping back" and achieving some degree of *psychological distance* on one's experiences (Carlson & White, 2013; Dewey, 1931/85; Werner & Kaplan, 1963; Sigel, 1993).

Consistent with Bill's approach, our research explicitly addresses multiple levels of analysis (e.g., brain, cognition, behavior). The Iterative Reprocessing (IR) model (e.g., Cunningham & Zelazo, 2007; Zelazo, 2015), which builds in part on the Levels-of-Consciousness model (Zelazo, 2004), the Cognitive Complexity and Control theory-Revised (Zelazo et al., 2003), and related theoretical models of EF (e.g., Bunge & Zelazo, 2006; Carlson & Zelazo, 2008; Marcovitch & Zelazo, 2009), describes both the cognitive and the neural processes associated with reflection and how these then lead to specific EF skills and to consciously controlled behavior. According to this model, the development of EF is made possible, in part, by increases in the efficiency of reflection, which then allow for increases in the hierarchical complexity of the rules that can be used to characterize problems and select context-appropriate rules for responding. Having reflected on their situation, children are then in a position to initiate and exercise their EF skills (i.e., cognitive flexibility, working memory, and inhibitory control), often using self-directed speech as they do so. When children respond to situations reactively, without much reflection upon what they are doing, they are more likely to show classic EF failures, such as assuming they know what to do, and treating a new situation as if it were an old, familiar one. Like other skills, reflection is acquired largely as a function of experience, or practice: the repeated engagement and use of reflection in the context of problem

solving strengthens these skills, increases the efficiency of the corresponding neural circuitry, and increases the likelihood that the skills will be activated in the future. The model illustrates how reflection allows EF skills to modulate attention and consequently control behavior in corresponding ways, allowing behavior to be more adaptive, planful, and focused when necessary. This process is recursive, such that increases in reflection lead to increases in EF and behavioral control, which in turn support subsequent reflection.

Pretend Play

One area in which developing reflection and EF skills play a key role is pretend play, where one stipulates either overtly or mentally that something (a real object, setting, or role) is something else (a pretend object, setting, or role; Harris, 2000). Over the course of the second year, children become more likely to perform pretend actions (e.g., talking on the telephone) with pretense objects (e.g., a spoon) that bear little physical resemblance to the real objects, and they also become more likely to perform pretend actions without objects altogether (e.g., Ungerer, Zelazo, Kearsley, & O'Leary, 1981). Moreover, there are proportional (complementary) age differences in children's ability to resist responding on the basis of the actions suggested by the real objects, such as placing the spoon in their mouth in the previous example (Elder & Pederson, 1978; Pederson, Rook-Green, & Elder, 1981).

Piaget (1976) observed his daughter Jacqueline at 15 months place her head on a pillow and close her eyes, thus simulating the gestures of sleep using the real props associated with sleeping. Only later in development did she substitute a symbol for the pillow—resting her head on her bear and a plush dog. As Vygotsky (1978, p. 103) put it: "It is remarkable that the child starts with an imaginary situation that initially is so very close to the real one. A reproduction of the real situation takes place."

A well-known study by Overton and Jackson (1973) documented this important developmental progression in children's symbolic play during the preschool years and beyond: at first, children substituted their own body parts for an object to perform imaginary actions, rather than representing the object symbolically. For example, when asked to pretend to brush their teeth, they might do so using their finger as a toothbrush. Older children, however, grasped an imaginary toothbrush. Overall, in the context of symbolic play, one sees increasing independence from the literal context, an increasing reliance on imagination, and an interaction between more top-down symbolic processes and more bottom-up perceptual or procedural influences.

A central theme in our work has been to understand the mechanisms whereby children acquire the skills needed to reflect upon their own actions and create psychological distance from stimuli. Consistent with the IR model, we have suggested that symbolic thought, including imaginative or pretend play, progresses through a series of levels corresponding to increasing degrees of reflection on the nature of the symbol–referent relation (Carlson & Zelazo, 2008). During the second year of life, children begin to treat symbols *as* symbols, as when they engage in pretend play. This developmental advance marks the beginning of genuine symbolic thought insofar as there is, for the first time, reflection on the fact that there is a relation between symbol and referent. Children's symbolic thought is still limited, however, and they generally fail to consider the nature or quality of the symbol–referent relation. Further increases in children's reflection during the preschool years allow children to consider the quality of the symbol–referent relation (e.g., detecting ambiguity in which referent is being symbolized), and eventually to consider multiple symbol–referent relations in contradistinction (e.g., allowing them to appreciate irony).

Although symbolic thought figures prominently in play, it may also be initiated by recognition of a discrepancy or a problem to be solved; it may be elicited by a sense of novelty,

surprise, complexity, incongruity, or ambiguity. Once initiated, however, how might symbolic thought contribute to success in problem solving? One possibility is suggested by Werner and Kaplan (1963), and more recently by Sigel (1993). By way of the substitution of symbols for stimuli themselves, one's attention is moved away from the concrete and motivating (e.g., appetitive) properties of the stimuli and toward a more abstract characterization. The dimension in which this movement is hypothesized to occur is referred to as psychological distance.

Psychological distancing may facilitate problem solving in several ways. First, simply by decreasing the salience of certain aspects of a stimulus or problem, psychological distancing may help children to resist a temptation to respond impulsively—to select prepotent but inappropriate responses. Second, symbols may permit one to notice alternative angles or implications of a problem that were not initially obvious. This, in turn, may allow a wider range of possible responses to be entertained and executed (Carlson & Beck, 2009; Carlson & White, 2013).

Research has indeed shown that symbols can provide degrees of distance from reality, which then might make it possible to reflect on the self and govern one's responses more effectively. For example, in Walter Mischel's delay-of-gratification task, children need to wait alone in the presence of food rewards if they want to receive the larger reward; otherwise, if they do not wait until the experimenter returns, they can take only the smaller reward. A symbolic strategy that was highly effective in extending preschoolers' delay times involved a cognitive transformation in which children were asked to pretend that the marshmallows in the experiment were "white fluffy clouds" (Mischel & Baker, 1975). Presumably this symbolic ideation decreased the salience of the food reward, thus enabling children to delay gratification.

A more direct demonstration of the role of symbols in psychological distancing comes from the Less is More task (Carlson, Davis, & Leach, 2005). In the Less is More task, children are presented with two piles of candy, one large and one small, and must point to the small pile to obtain the large pile. Three-year-olds, compared to 4-year-olds, have difficulty inhibiting their tendency to point to the preferred, larger reward. In one study, 3-year-olds were trained on symbolic representations for the quantities of treats, in increasing degrees of separation from reality, before being given the task (e.g., one-to-one correspondence with rocks versus a mouse and elephant to stand for small and large amounts, respectively). Children in the symbol conditions performed better than children presented with real treats, and improved as a function of the degree of symbolic distance from the real rewards.

Subsequent studies by Carlson and colleagues have shown that, with older children, it is not even necessary to use symbolic stimuli in the experiment to improve performance: changing their mindset alone will suffice. In challenging novel tasks requiring EF skills, such as persisting at a boring task while faced with a tempting video game, 3- to 6-year-old children were assigned to complete the task as usual (as themselves) or to a condition in which they were psychologically distanced from the self, either by thinking of themselves in the third person or, even more distant, imagining they were someone else who is really good at games like these, someone like Batman. The researchers found that 5- and 6-year-old children significantly benefitted from this simple suggestion, and more so as distance from the self increased (White & Carlson, 2016; White, Prager, Schaefer, Kross, Duckworth, & Carlson, in press). In the studies described, in the most distant condition (using pretend animals to represent the quantities of treats; pretending to be Batman while enduring a boring task), children performed as if they were a full year older, echoing Vygotsky's (1978) proposal that, in play, children are "a head taller." We argue that this more mature display of EF skills is made possible by increases in reflection on the problem at hand, and hence on one's options for responding. Chosen responses are, by definition, more controlled.

Rule Use and Executive Function

Bill Overton's work on decision-making has been conducted within a relational framework that emphasizes the hierarchical nature of representational structures, and this fits well with our own research on rule use. Our research illustrates the simultaneous consideration of multiple levels of analysis, distinguishing among levels of hierarchically arranged cognitive control processes, and we examine these processes, and changes in these processes, in relation to multiple levels of function (e.g., behavior and brain).

A widely used measure of EF is the Dimensional Change Card Sort (DCCS) task (Doebel & Zelazo, 2015). The Minnesota Executive Function Scale (MEFS; Carlson & Zelazo, 2014) is a brief (4-min) computer-adaptive measure of EF that is based on the DCCS and that involves a series of developmentally ordered rule use tasks that vary in hierarchical complexity and the extent to which they require EF skills. The MEFS is suitable for ages 2–85 years; has been used with over 10,000 children; has been validated in typical and atypical populations (e.g., Beck, Schaefer, Pang, & Carlson, 2011; Chu, VanMarle, & Geary, 2013; Doom et al., 2014; Fuglestad et al., 2014; Hostinar et al., 2012); and predicts kindergarten readiness and first-grade math achievement over and above IQ (Carlson & Harrod, 2013; Hassinger-Das, Jordan, Glutting, Irwin, & Dyson, 2014).

In one level of the MEFS, corresponding to the "standard DCCS" (Doebel & Zelazo, 2015), children are shown a display with two boxes, one with a green rabbit on it and one with a purple pig (Figure 9.1). They are then shown test cards with either green pigs or purple rabbits. Children are first instructed to sort by color: *All the green ones go in the green box, and all the purple ones go in the purple box*. They sort a few test cards in this way by dragging the virtual test cards across the touch screen, and are then told to stop sorting by color and start sorting by shape: *All the rabbits go here, and all the pigs go here*. Many typically developing preschoolers fail to keep up with these demands and instead rigidly continue to sort the cards by the first dimension, in this case by color. They do this despite knowing the current rules and telling them to the experimenter, and this gap between knowing and being able to act on that knowledge is a classic sign of difficulty with EF.

Research suggests that the formulation and use of more complex rules that control the application of simpler rules (e.g., if color game, then if green, then it goes here) involve the recruitment of increasingly anterior regions of lateral prefrontal cortex (PFC) into an increasingly complex, hierarchically arranged network of PFC regions. Higher levels in the hierarchy operate on the products of lower levels (see also Badre & D'Esposito, 2007; Botvinick, 2008; Christoff & Gabrieli, 2000; Koechlin et al., 2003). As rules become more complex, they also become more abstract (i.e., abstracted away from the exigencies of a situation), and this can

Figure 9.1 Example of the Minnesota Executive Function Scale (MEFS).

also be viewed as a shift from hotter to cooler aspects of EF (see also Munakata, Snyder, & Chatham, 2012). In general, on this view, the development of prefrontal cortical circuitry proceeds in a bottom-up fashion that parallels well-documented age-related changes in the complexity of the rules that children can formulate, maintain in working memory, and use when solving problems. For example, research has found that even 2.5-year-olds successfully use a single arbitrary rule to sort pictures (e.g., Zelazo & Reznick, 1991), 3-year-olds can use a pair of rules, and 5-year-olds can use a hierarchical set of rules, including a higher-order rule for switching between rule pairs (e.g., Zelazo et al., 2003). Throughout this process, children increasingly are coming to use rules as abstract structures and to recognize them as such: No longer lured by the "green-ness" of the pig, they can see it also as an animal, and flexibly shift their responses to the stimulus according to currently active and appropriate rules. Once rules are reflected upon, they cease to be a script for behavior, but rather an open invitation to consider alternatives.

Agency and Creativity: Inherent in Reflection and Executive Function

Indeed, there is a developmental association between these higher-order constructs and the generation of new ideas or inventions. This is at first blush a paradoxical relation, between meta-cognition (over-thinking) and creativity (under-thinking). However, the paradox is resolved when we consider the Levels-of-Consciousness model, wherein a reflective agent will reach a peak level of conscious awareness on a problem or situation, which then becomes a tipping point for descending back down the ladder of consciousness and freeing up resources for associations (choices) to be revealed and reprocessed in a creative way. This is reportedly how Einstein came up with the theory of relativity; he thought about the problem at age 16, shifted his attention to new things, and came back to it with a more explicit formulation 10 years later. This process feels subjectively unconscious, intuitive, and even derived from an external source, such as a child's imaginary companion, a fiction writer's main character, or Kant's "guardian spirit," until it, too, is held up for conscious inspection, and the cycle continues, but now from a more advanced starting point in a developmental system (Carlson, 2010).

Recently, Pascual-Leone and Johnson (in press) argued that problem solving ("invention") is the real driver of cognitive development—the active synthesis of new schemes out of old schemes, resulting in novel cognition or behavior. In their organismic causal modeling of problem solving, Pascual-Leone and Johnson show how new schemes emerge from an individual's cognitive processes, such as the executive processes (organismic schemes) that vary in (metasubjective) complexity because they are self-constructed hierarchical coordinations of existing schemes. We would add that the levels of problem solving children are capable of are dependent on both age and experience, and that just as expertise varies within an individual according to different interests and opportunities for learning, so too might meta-cognitive development proceed in an uneven fashion across domains (e.g., Karmiloff-Smith, 1995).

Conclusion

Developmental psychology has changed considerably since Bill Overton began constructing his relational meta-theory, and for the most part, it has embraced key features of Bill's theoretical approach. Indeed, our own work examines psychological phenomena at multiple, interacting levels of analysis and seeks to explain processes of reorganization as they unfold on various time scales. Given the now widespread acceptance of a developmental systems approach, many researchers today view the developing human being as a complex, multidimensional, and

dynamic process, and aim to comprehend how aspects of the environment, including social relationships and culture, interact with genes and everything in-between to yield a developing person. We owe this, in large part, to Bill's life work and legacy.

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10 A Contextually and Developmentally Sensitive View of Children's Memory Development

Between the Laboratory and the Field

Deirdre A. Brown and Michael E. Lamb

Children's memories of their experiences make an important contribution to how they come to develop social bonds, develop their identity and life story, and learn about the world. In this chapter, we briefly review the lessons learned from research examining the development of memory and consider their relevance to an applied context—when children provide eyewitness testimony about maltreatment. Deficiencies in what children produce in conversations or interviews are often readily attributed exclusively to children's limited or developing capacities, even though their performance is in fact affected by the behaviour and capacities of both the children and the adult interlocutors. We therefore take a dynamic and relational approach (Overton, 2015) to understanding children's memory which acknowledges that children's narratives about their experience are influenced by a variety of factors that must be acknowledged and managed by the adults questioning them. The characteristics of the interaction, the event being described, and of the adult and child participants all affect the nature of the children's accounts.

The study of memory development has a long history, and is rife with examples of how an exclusive focus on discrete abilities, narrow conceptualisations of memory, differing methodological paradigms, and/or the focus on specific contexts can produce results that underestimate the capacities of children. In this chapter, we examine lessons learned from the study of memory development in the context of a real-world setting—forensic interviews with children—the understanding of which has been informed by laboratory-based experimental studies examining the various aspects of cognitive and social processes that contribute to eyewitness testimony as well as field-based studies examining how these processes unfold during investigative interviews. Together, a large body of research has informed expert consensus statements regarding best-practice and evidence-based guidelines for interviewing children about their experiences in forensic contexts.

The chapter begins by reviewing diverse views about children's episodic memory capacities before noting how widespread hysterical panic about the wholesale abuse of young children in childcare settings prompted efforts to better understand the development of memory in childhood. We then describe how the resulting research transformed our collective understanding of children's testimonial capacities, and especially their abilities to provide useful information about their victimisation. This knowledge in turn allowed researchers to develop guidance for practitioners seeking to elicit testimony of the highest quality from young alleged victims. Further refinement of that guidance depends on the ability to conduct ecologically valid research on children's testimony, as we note in the final substantive section of the chapter.

Contrasting Views of Children's Memories

From the late nineteenth century, psychologists began to document what came to be known as 'infantile amnesia' (IA)—the inability of adults to recall early childhood experiences

(i.e., events they experienced before their third birthdays). These observations prompted researchers to ask whether and when infants and young children became able to form durable memories of their experiences, and what might account for the apparent absence of long-term memory prior to the IA boundary. From the subsequent decades of research, a substantial body of evidence was amassed showing that very young infants clearly remember their experiences, sometimes over long time periods, if appropriate non-verbal measures of memory are used (Hildreth, Sweeney, & Rovee-Collier, 2003; Rovee-Collier, Hartshorn, & DiRubbo, 1999; see Rovee-Collier & Hayne, 2000, for review). Additionally, researchers demonstrated that young children are capable of forming autobiographical memories that are retained for days, months or even longer, from a much younger age than the typical boundary of infantile amnesia (Baker-Ward, Gordon, Ornstein, Larus, & Clubb, 1993; Cassel & Bjorklund, 1995; Fivush & Hamond, 1990; Fivush & Schwarzmueller, 1998; Hamond & Fivush, 1991). Importantly, however, researchers also showed how fragile early memory formation is; it can be dramatically compromised by variations in learning and test conditions (e.g., Hayne, Boniface, & Barr, 2000; Hayne, MacDonald, & Barr, 1997; see Hayne, 2004, for review). The impact of context similarity on learning and memory retrieval is not limited to infants, however. Instead contextually bound learning is evident across the lifespan, with successful memory retrieval at all stages of development being better when the overlap between conditions at the times of learning and recall is maximised (e.g., Godden & Baddeley, 1975).

Because babies and young children clearly can form and maintain episodic memories, the inability of adults to remember earlier experiences (i.e., IA) could not be attributed to a mere failure to form memories early in life, but instead called for a less adult-centric and more prospective view of memory that recognised the distinctive possible characteristics of early memory processes. Research from this perspective yielded a clearer understanding of both the formation and the likely fate of earlier memories. For example, recent research has shown that the age of our earliest memories is influenced by how old we are when asked to recall them. Although adults typically cannot recall events that happened before they were three years of age, children and adolescents can do so (Jack, MacDonald, Reese, & Hayne, 2009; Peterson, Warren, & Short, 2011; Tustin & Hayne, 2010). However, some early experiences are not accessible even to young people, and start to become unrecoverable after about 7 years of age. After this point, children's recall of early experiences begins to fade and become less detailed, thus resembling adults' recall of events from this period (Bauer & Larkina, 2014).

Many theories have been advanced to explain the inaccessibility of early memories in later life. Some of the most compelling evidence is associated with positions that emphasise the dynamic and social nature of autobiographical memory, and the influence of language, culture and adult–child interactions on remembering. For example, the social-cultural developmental theory (Nelson & Fivush, 2004) asserts that children develop the skills to narrate past events, and learn what they should include in their narratives, from experiences of conversing about past events with significant adults in their lives. Specifically, adults help children to understand experiences, relate their characteristics to past events and cultural norms, and model how to construct effective narratives by employing elaborative and child-sensitive styles of engaging with children. Such a style may include building upon the children's contribution, prompting for further information and directing the focus of the conversation towards details or aspects of the experience that are salient and meaningful to the children. Many studies have shown how the style of conversational exchange between children and their parents has far-reaching influences beyond the development and longevity of memory, contributing to children's emotion knowledge and regulation skills, development of identity and formation of coherent life stories (see Salmon & Reese, 2015).

The Wave of Child Abuse Hysteria

Over the last 35 years, interest in children's early memory skills has not solely been driven by theoretical questions, however. In the wake of a multitude of complaints made by adults that they had been sexually abused as children, and in conjunction with a series of investigations of alleged abuse of multiple victims in day-care centres, it became extremely important to determine whether and how well children could recall and report their experiences. Such issues spurred an enormous wave of research on children's eyewitness testimony and this has greatly enhanced our understanding of children's memory development (see Lamb, Malloy, Hershkowitz, & La Rooy, 2015, for a review).

Initial examinations of children's testimonial ability pointed to two apparently contradictory conclusions. Some studies obtained findings underlining children's reliability (the extent to which they could provide accurate accounts of their experiences) while others yielded findings pointing towards their suggestibility (underlining the extent to which they could be influenced to make inaccurate or wholly false reports about their experiences). The findings were derived from studies adopting contrasting methodologies, with the first group of studies examining how children responded to unbiased interviewing whereas the others focused on their responses to highly suggestive questioning. As the field evolved, the two bodies of research became more integrated, resulting in a more holistic understanding of both the optimal conditions that help children describe their experiences in a complete, organised and accurate manner, and risky practices likely to compromise the validity of children's accounts.

Through this process, scholars in the field have come to recognise 'standpoints of synthesis'—reflecting the interview, child and event—that help to resolve problems of opposites and provide an integrated perspective on children's capacities (strengths) and weaknesses as witnesses. An important consequence of this evolution is the recognition that children can simultaneously demonstrate both competency and vulnerability, and can report both accurate and inaccurate information within the same interview, thereby making a dichotomous view of eyewitness testimonial capacity inadequate. The answer to the question 'Can children be reliable witnesses?' cannot be a simple 'yes' or 'no', and instead becomes 'It depends upon. . .', with the remainder of the rejoinder reflecting the confluence of event, child, interview, family, community and systemic factors.

Additionally, many strands of research have informed a set of guiding principles that can assist in evaluating the quality of children's testimony. One of the most important aspects of such an evaluation is to examine the context in which disclosures are elicited, and the interactions that shaped such disclosures. One cannot conceptualise children's testimonial abilities without considering the nature of the event under investigation, the nature of the investigative process itself and the many layers of influence (child, family, systems) that are involved when children are interviewed about alleged maltreatment. Children are embedded within interactions that occur prior to, during and after forensic interviews, and they both influence and are influenced by what unfolds during the child–interviewer exchanges. Participants in forensic interviews are interdependent and so too, therefore, is the information such interviews produce. That is, the testimony elicited is the product of the joint and dynamic interaction, not one-dimensional.

Are Descriptions of Abuse Unique?

When children are asked about experiences of maltreatment, some characteristics of the events themselves may influence how well they can describe what occurred. An important question for researchers has been whether the way in which children recall traumatic experiences is fundamentally different from the ways in which they remember and recount more mundane,

neutral or positively valenced events. In the past, forensic professionals often dismissed the relevance of experimental research on children's memory by arguing that the stressful nature of sexual abuse made memories thereof distinctly different. In fact, considerable controversy persists in the experimental literature concerning the effects of increased arousal or stress on the accuracy of children's memory. The entire range of possible associations between stress and memory have been reported in research studies—enhanced memory for stressful events (Goodman, Hirschman, Hepps, & Rudy, 1991), degraded memory as a result of stress (Bahrick, Parker, Fivush, & Levitt, 1998) and no impact at all of stress (Howe et al., 1994). Clearly the relationship between stress and recall is complex and is likely the product of factors relating to the child (e.g., how distressed they were; Peterson & Noel, 2012), the event (e.g., how long ago the event occurred; Peterson, 2015) and how the child is interviewed. In general, it appears that there is an inverted U-shaped association between stress and memory: when stress is very low, the event may seem too mundane to be memorable, whereas very high levels of stress divert psychological resources to the management of affective responses and reduce the cognitive resources available to appraise and encode details about the events. However, when the level of stress is moderate, it serves to attract attention and make the event salient, thus ensuring good encoding. Importantly, even when stress enhances recall, memories are still susceptible to the same deleterious effects of suggestion and delay as memories of more mundane events (Cordon, Pipe, Sayfan, Melinder, & Goodman, 2004; Fivush, 1998; Howe, 1997).

Real-world events such as child abuse may not necessarily be better or worse remembered than memories of events or stimuli studied in the laboratory for many reasons. First of all, incidents of sexual abuse may vary in their level of trauma, and thus potentially facilitative effects of arousal and salience cannot be assumed. Relatedly, children's ignorance or misunderstanding of sexual events may make some abusive experiences even less memorable.

Second, stress may affect different types of memory processes (e.g., recall, recognition and reconstructive memory) in different ways. The context in which children are asked to retrieve information about the experienced event—during interviews with child protection service workers, police officers, attorneys or judges—may be stressful regardless of whether the target events were (Goodman et al., 1992). Researchers have not yet studied the effects of stress at the time of recall, although some have studied the effects of social support and of supportive interviewer practices which presumably reduce stress (Carter, Bottoms, & Levine, 1996; Davis & Bottoms, 2002; but cf. Imhoff & Baker-Ward, 1999) and it seems reasonable to expect that stress at the time of recall may hinder retrieval (Nathanson & Saywitz, 2003).

Third, whether the event involves shame, perceived responsibility, embarrassment or guilt, and whether it is talked about, reflected on, kept secret or even negated, may all affect how experiences of abuse or trauma are remembered and recalled over time (Salmon & Reese, 2015). Studies have shown that how parents or significant adults respond to children's disclosure can influence whether children elaborate upon their early accounts, as well as whether they recant or retract those reports subsequently (e.g., Malloy, Brubacher, & Lamb, 2013; Malloy & Mugno, 2016).

Fourth, a report of maltreatment may bring about significant consequences for children and those around them. Concern about the possible consequences of disclosure (e.g., harm to the children or siblings, removal of loved ones from the home) may influence how likely children are to report maltreatment (Goodman-Brown et al., 2003; Malloy, Lyon, & Quas, 2007).

Fifth, children may have had multiple opportunities for their memories to become distorted. For example, they may have been informally interviewed by a number of people (e.g., parents, teachers, social workers, healthcare providers) prior to formal investigative interviews, and these people may have employed questioning strategies known to produce errors in children's accounts (Korkman, Juusola, & Santtila, 2014).

Sixth, children may have been exposed to other sources of information about the alleged events (e.g., conversations between adults, rumours within a school or childcare centre, media reports) that could lead to incorporation of non-experienced information into children's reports (Principe & Schindewolf, 2012).

Finally, it is not uncommon for children to delay reporting maltreatment for considerable periods of time (London et al., 2008); extensive evidence, along with everyday experience, makes clear that memories routinely decay over time.

Furthermore, for many children, maltreatment may have been chronic, meaning that it is difficult if not impossible to distinguish between specific individual episodes of abuse (Brubacher, Powell, & Roberts, 2014). It is unknown whether the distinctiveness of specific traumatic events is retained when multiple instances of abuse are experienced and the stress becomes chronic rather than acute (Peterson & Warren, 2009). Following repeated traumatic experiences, generic memory retrieval may occur, with several episodes summarised by reference to some broad common characteristics even when children are asked to describe specific events, characterised by distinctive information about particular events, times, locations, people, places or activities (McNally, 2005; Williams, 1996; Williams & Dritschel, 1992).

Overall, although salience generally affects the memorability of experienced events, we cannot presume that specific instances of abuse will always be salient and thus easy to remember, and nor should we presume that children will be supported and encouraged to talk freely about their experiences, coming to forensic interviews free of the influence of others. In assessing the likely reliability of children's reports or denials of alleged maltreatment, therefore, we cannot examine their testimonies or accounts in isolation from the context of the events, their disclosure and others' attitudes to the forensic interview process.

What is Distinctive About the Forensic Interview?

When children are questioned about alleged maltreatment in formal interviews, the conversational exchange will have distinctive characteristics and will thus differ from most other adult–child interactions in a number of important ways (Lamb & Brown, 2006). As discussed in the previous section, the topic of the exchange may pose cognitive (e.g., retrieving specific details about discrete episodes of a recurring event; retrieving information about an event that occurred days, weeks or even years earlier; separating out what children recall themselves from what they have learned from other sources) and socio-emotional (e.g., managing distress; limited motivation to engage in the investigation) challenges. Additionally, the forensic interview places the child in the unfamiliar role of expert with the adult interviewer generally naive about the events under discussion.

Whereas typical conversations involve brief summaries of the main aspects of experiences that are the focus of discussion, successful forensic interviewers should seek elaborative descriptions of anything the child can remember about the focal incidents. Thus children must not only recognise that they possess information about which the adult is ignorant, but also provide unabridged accounts of what they know. Other challenges may arise because adults are perceived as authority figures, and the forensic interviewers are unfamiliar to the children. These factors may create anxiety or reticence and foster efforts to appear compliant, perhaps by answering questions in the absence of memory.

Adults usually question children to determine what they know, provide corrective feedback or identify opportunities to teach. As a result, a number of behaviours may be encouraged in typical interactions with adults that are actively discouraged during forensic interviews. For example, outside investigative interviews, good (i.e., interesting or entertaining) stories may be more valued than accurate ones, and this may encourage children to sacrifice precision for impact. Kulkofsky, Wang, and Ceci (2008) showed that children who told better-organised stories or narratives about events were often less accurate about the

specific details than children who provided briefer accounts. Children may also not recognise that 'I don't know' is a valued and appropriate response in a forensic setting (Scoboria & Fisico, 2013), because they are often encouraged to answer challenging questions in other settings by guessing (e.g., in conversations with parents, or in tests of knowledge by teachers). Perhaps not surprisingly, a recent evaluation of forensic interviews about alleged abuse showed that children said 'I don't know' rarely—they responded in this way to less than 6 per cent of all prompts (Earhart, La Rooy, Brubacher, & Lamb, 2014). In an attempt to highlight the unique goals of the information exchange in forensic interviews, many interview protocols thus encourage interviewers to describe and practice 'ground rules' that emphasise the particular expectations of the interview (i.e., to talk only about things that really happened, to say 'I don't know/remember/understand' when appropriate, and to correct interviewers if they say something incorrect).

The type of question asked also exerts a powerful influence on what children say and how they structure their accounts of past experiences. Our understanding of how interviewer questioning strategies influence children's responding has been informed by research using a range of methodological approaches, including both tightly controlled laboratory-based experiments manipulating a range of factors thought to influence how and what children recall about events and field-based research examining forensic interviews conducted to determine whether children have been abused. Despite very different methodological approaches, remarkably consistent conclusions have emerged from both field and laboratory-based research. Across a range of indices of children's memory competence—amount of detail, accuracy, relevance and narrative coherence—very broad open-ended prompts (e.g., 'tell me everything you remember about that') reliably and consistently elicit better information from children than closed-ended questions (e.g., those that require a yes or no answer, or are posed using a multiple-choice format; see Brown & Lamb, 2015, for a brief review).

A common finding in studies exploring children's memories of their experiences is that, as children get older, they report more details in response to open questions, but the overall accuracy (the ratio of correct to incorrect statements) remains relatively stable (Schneider & Bjorklund, 2003). Very young (e.g., 3- to 4-year-old) children can report useful information when given very broad open-ended prompts (e.g., 'tell me everything you can remember about that'), but they tend to be more responsive to more focused open-ended questions (e.g., 'What colour was that car?'), demonstrating that younger children seem to be more reliant than older children on the increased structure and more concrete retrieval cues that signal the category of information on which questioners would like them to focus (Korkman et al., 2006; Melinder & Gilstrap, 2009). For example, Hershkowitz, Lamb, Orbach, Katz, and Horowitz (2012) showed that 3- to 4-year-old children provided more information in response to focused ('Wh-') prompts than more broadly open ones, whereas the reverse was true for 5- to 6-year-olds. From around 5 or 6 years of age, developmental differences in relation to the effectiveness of different prompts become less apparent than during the preschool years.

Differences in the effectiveness of distinct question types are also apparent when considering groups of children with varying degrees of developmental delay. Studies of children with intellectual disabilities have shown that, whereas children with mild levels of cognitive impairment are generally comparable to typically developing children matched for developmental level, children with more severe intellectual disabilities are less proficient than even very young typically developing children matched for developmental level (e.g., Brown, Lewis, Lamb, & Stephens, 2012). Importantly, such research has demonstrated that children with both mild and moderate levels of intellectual disability can respond informatively to very

open-ended prompts, challenging presumptions that such questions will be unproductive with these children. As with younger typically developing children, however, children with intellectual disabilities respond most informatively to more focused open-ended prompts.

Changing Typical Investigative Interview Practices

Despite the evidence that very open-ended questioning best elicits uncontaminated and reliable testimony from children, studies from around the world (e.g. Australia: Powell & Hughes-Scholes, 2009; Canada: Luther, Snook, Barron, & Lamb, 2014; Finland: Korkman, Santtila, & Sandnabba, 2006; Korea: Yi, Lamb, & Jo, 2015; New Zealand: Wolfman, Brown, & Jose, 2016a; Norway: Thoresen, Lonnum, Melinder, Stridbeck, & Magnussen, 2006; Sweden: Cederborg et al., 2000; United Kingdom: Sternberg et al., 2001; United States: Warren, Woodall, Hunt, & Perry, 1996) have consistently shown that interviewers tend not to ask such questions. Instead, at best interviewers employ narrowly focused open-ended questions (e.g., 'wh-' questions), with children offered few opportunities to provide uninterrupted narratives, and at worst, they are predominantly asked option-posing, closed or suggestive questions. On the one hand, the disproportionate use of narrowly focused questions documented in these studies may reflect the interviewers' use of alternative strategies when children are not forthcoming in response to more open prompts (Gilstrap & Ceci, 2005). Open prompts are strongly promoted as the ideal interview question type because they elicit more detailed and accurate responses, but they can also be associated with more non-responding, especially by very young children who are uncertain what additional information is being sought (e.g., Hershkowitz, Lamb, Orbach, Katz, & Horowitz, 2012; Korkman, Santtila, & Sandnabba, 2006; Korkman, Santtila, Westeråker, & Sandnabba, 2008; Melinder & Gilstrap, 2009; Wolfman, Brown, & Jose, 2016b). On the other hand, interviewers may persist with a narrowly focused style when questioning children (especially those with intellectual disabilities) because they assume the children are incapable of answering less structured questions (Aarons & Powell, 2003; Aarons et al., 2004; Ericson et al., 1994; Milne, 1999; Nathanson & Platt, 2005; Phillips et al., 2012; Sharp, 2001), and thus fall back on their usual styles of interacting with children in other contexts (Lamb & Brown, 2006). Indeed, several researchers have demonstrated that adults do not flexibly alter their questioning style depending on children's responses (e.g., Korkman et al., 2006, 2008; Klemfuss, Quas, & Lyon, 2014; Wolfman et al., 2016b). To understand better what leads children and/or interviewers to behave in particular ways during exchanges, we need to examine closely the dynamics at a turn-by-turn level, and the factors that affect adherence (or not) to recommended interviewing practices.

Because of the difficulty interviewers have following general recommendations about the ways in which they should strive to conduct their interviews, researchers at the National Institute of Child Health and Human Development (NICHD) developed an Investigative Interview Protocol that provided more explicit guidance about how to implement guidelines in practice (Lamb, Hershkowitz, Orbach, & Esplin, 2008). Importantly, the developers of the Protocol attempted to take into account children's innate and learned capacities and the distinctive characteristics of a unique conversational context where the content, outcome, conduct and roles are unlike those faced by children in typical memory tasks or when interacting with adults. Early studies showed that interviewers trained to follow the Protocol when interviewing children about alleged maltreatment used broad open prompts more often and problematic questions (option-posing and suggestive) less often. Children interviewed using the Protocol thus tended to provide more information in response to these broad open prompts (see Lamb, Orbach, Hershkowitz, Esplin, & Horowitz, 2007,

for a review). The Protocol provides both an ontological account of how children can be helped to provide reliable testimony, and an epistemological effort to use the knowledge gained from research to promote effective and skilled interviewing through training programmes, structured feedback and a protocol that translates research evidence to practice (Lamb, 2016).

Many laboratory-based studies of children's eyewitness testimony, and indeed general guidelines about interviewing (e.g., *Achieving Best Evidence*, Home Office, 2011), promote an additive and linear approach to questioning (aka the 'funnel' approach), with a minimal number of broad open-ended questions posed first, followed by some specific, albeit open-ended, questions, and finally a series of yes/no recognition questions. The Protocol has avoided the problem of this kind of split system by instead advocating a relational, flexible and child-led approach that emphasises the effectiveness of open-ended prompting throughout and provides examples and the meta-cognitive structures to make that possible. Generative rules are embedded in the Protocol to foster a child-centred and flexible approach to interacting with the child. For example, when interviewers ask a focused recall or recognition-based question, they are trained to follow the response with a broad open-ended prompt ('Tell me more about that')—a practice called 'pairing'. The Protocol thus allows interviewers to navigate the complex system that is the forensic interview in a holistic, open and adaptive way, guided by children's recall process and using the children's language to generate further cues for recall or elaboration.

Ecological Validity

One of the challenges faced by researchers studying children's eyewitness testimony has been to balance the tensions between establishing experimental control, thereby limiting potential confounds in the research, and creating sufficient ecological validity in the research paradigms so that the findings can be generalised to real-world settings outside the laboratory context. Making questioning strategy constant across groups is important when researchers seek to characterise memory and reporting processes in children of varying developmental and cognitive abilities, for example, but that approach precludes examination of the interviewers' contributions to the outcomes of the exchanges. Additionally, tightly constrained interviewing protocols may obscure children's competencies and lead to misleading conclusions. Stated differently, considering the relational aspects of how children and adults communicate and exchange knowledge is relevant whenever and wherever an interview or questioning method is the focus of study. As discussed earlier, forensic interviewers have difficulty adopting an open style of questioning children, despite evidence that such an approach is preferable, and researchers also often fail to adopt this approach, even when studying questions of forensic importance.

For example, many researchers have examined the effectiveness of using visual aids such as dolls, diagrams and drawings to facilitate children's recall (see Poole, Bruck, & Pipe, 2011, for a review). Typically, these studies have employed a funnel approach to interviewing, leaving it unclear whether the positive benefits of these supplementary techniques (e.g., drawing) are made possible by the poverty of recall achieved when verbal questioning provides a poor scaffold, and would thus not be beneficial when associated with more thorough, sensitive and exhaustive forensic interviewing of the type described above. Indeed, drawings and diagrams used in conjunction with an elaborative interviewing protocol such as the NICHD Protocol may not offer any additional benefits (Salmon, Pipe, Malloy, & Mackay, 2012, though see Aldridge, Lamb, Sternberg, Orbach, Esplin, & Bowler, 2004). Researchers who are designing and reviewing studies using different interview methods should take into account the potential impact of the types of questions when evaluating their findings and their implications.

Other important lessons from the field are also often overlooked by researchers designing studies of children's development. For example, many ignore the importance of preparing children for interviews by establishing ground rules for the interaction, building rapport using child-led questioning strategies and allowing children to practise being informants in response to the types of questions they will encounter in subsequent interviews before the substantive interviews commence (see Roberts, Brubacher, Powell, & Price, 2011, for a review). When this important preparation does not occur, children may not demonstrate the limits of their capabilities, and erroneous conclusions about their abilities may result.

There are many important challenges for researchers seeking to elaborate upon our understanding of children's memory development. Because context affects recall so profoundly, a close consideration of methodology and level of analysis is warranted. Thus, attention to interview preparation strategies is likely to offer benefits whenever interviewing is the mode of data collection, whatever the focus of the interview. Effects documented in laboratory-based studies should also be examined and replicated in diverse contexts. For example, many researchers adopt a pragmatic approach when testing episodic memory, examining recall of scenes shown in short video clips, thus limiting the time demands and the resources needed (e.g., additional research assistants to stage interactive events). However, children clearly recall more about events they have directly experienced than about those they have merely witnessed or been told about (e.g., Murachver, Pipe, Gordon, Owens, & Fivush, 1996), and so research questions addressed using restricted memory stimuli (e.g., videos, stories, brief witnessed interactions) should also be asked using procedures that use richer and more salient stimuli (distinctive experienced events). Similarly, many well-established memory phenomena may seem relevant to understanding the reliability of children's testimony, although we do not know how well laboratory studies reflect the way such phenomena and processes operate in real-world contexts. For example, laboratory research on the creation and reporting of false memories has challenged the widely held assumption that older children make better witnesses than younger. Instead, under certain conditions, older children and adults are more likely to make memory errors than younger children (see Brainerd & Reyna, 2012, for a review). However, the relevance of these findings for the courtroom is uncertain because they are based on 'artificial' memory tasks (e.g., remembering word lists) that are very different from the memories of experiences about which children are typically asked to give evidence. Only by considering together the results of field studies as well as tightly controlled laboratory experiments that use a range of stimulus experiences will the field be better placed to understand how and when children recall experiences well, and when their ability to do so might be compromised.

The level of analysis used in studies of memory development is also important. Traditionally, research on children's eyewitness testimony has primarily focused on assessing how much information children report (e.g., the number of details provided) and the accuracy of that information. One often-neglected dimension of testimony that has a significant influence on witness credibility is the narrative quality or coherence of the statement (Davis, Hoyano, Keenan, Maitland, & Morgan, 1999). Because children's accounts are often the most important forms of evidence in cases of maltreatment, listeners (including investigators and jury members) must be able to understand the evidence communicated by the children. If they are unable to make sense of children's accounts for any reason (i.e., they are ambiguous, unstructured, disorganised or incoherent), the credibility and impact of that evidence may be diminished (Davis et al., 1999; Westcott & Kynan, 2004). Stated differently, the number of details provided about an experience is only one, incomplete index of testimonial quality. We also need to consider how those details are put together, and the interplay between the nature of the questions posed and that of the responses, to gain a broader, holistic and relational perspective. Children's eyewitness testimony has hitherto been conceptualised largely from

an individualised perspective, albeit one that acknowledges the influence of the interviewers' questions on children's responses. The independent and mutually reciprocal influence of children on interviewers has seldom been considered.

Conclusion

Research examining children's memory development has identified a complex array of factors that can enhance or diminish children's ability to convey what they remember about events. When investigating child maltreatment, many of these factors cannot be ameliorated, but the ways in which investigative interviewers interact with children *can* be optimised. A variety of interviewing protocols and training programmes (e.g., Benson & Powell, 2015; Cederborg, Alm, Lima da Silva Nises, & Lamb, 2013; Lamb, 2016) have been developed to translate research findings into practice and help forensic interviewers to adopt evidence-based practices when they question children. In this way, the relational perspective leads us beyond considering what occurs between children and their interlocutors to consider the systems within which the children, the interviews and the interviewers are nested. By taking a dynamic perspective on these systems, meaningful research questions can be derived and tested, with basic science informing the field and, in turn, the field informing future research agendas.

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11 Language Development

Motion Verb and Spatial-Relational Term Acquisition from a Developmental Systems Perspective

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Introduction

This chapter honors the theoretical contributions Dr. Willis Overton has made to the field of developmental science with his reflection on a major framing meta-model, *Relational-Developmental-Systems*, and how his theoretical writings have influenced our thinking on language and cognitive development in the young child. At the heart of the *Relational-Developmental-Systems* meta-model is the critical importance of thinking about development from a systems perspective whereby development emerges from the complex co-acting relations among multiple interdependent systems operating at multiple levels of analysis (e.g., the psychological, cultural, and biological/neural levels; Overton, 2013, 2014, 2015).

This influence is reflected across multiple domains, including for the study of language development. It is beyond the scope of this chapter to explore the influence on the entire domain of "language," which is itself a broad domain studied at many levels of analysis. In this chapter, though, we show how this systems perspective can frame the investigation of one aspect of language development, the development of English motion verbs (e.g., *hop*, *run*, *skip*), and other spatial and relational terms (i.e., spatial prepositions such as *over*, *under*, *between*, dimensional adjectives such as *big*, *little*, *tall*, and shape terms such as *circle*, *square*, *octagon*). Motion verbs and spatial-relational terms are arguably a major pillar of human language; without them one would have great difficulty in describing an everyday event or in describing where objects are located in their environment. These words allow us not only to describe the relations between objects (e.g., "The Empire State Building is *taller* than the Chrysler Building" and "The gas station is *between* the grocery store and pet store"), but also everyday actions and events (e.g., "Adam *skipped* to the bathroom at intermission"). Critically, children's facility to use these kinds of spatial and relational words in their productive vocabularies by the age of 4 years has consequences for developing spatial ability (Pruden, Levine, & Huttenlocher, 2011). Given their linguistic importance and their significance for predicting future cognitive ability, a comprehensive examination of how these words are learned is needed. Here we provide an account of how these words are learned by examining multiple levels of analysis with a *Relational-Developmental-Systems* framework. We focus here on the relations between the psychological, cultural, and biological systems and motion verb and relational/spatial term development.

This chapter is organized into four sections. The first section reviews what we know about the developing psychological system, or what we refer to as the conceptual system, used to acquire motion verbs and relational terms. The second section discusses the impact of the developing cultural system on children's acquisition of motion verbs and relational terms with an emphasis on looking at how caregiver language input as well as which language is being acquired can affect the development of motion verbs and relational terms. The third section offers evidence on how the developing biological system impacts the acquisition of motion

verbs and relational terms. In this section, we examine the research on embodiment, and on how the child's biological sex, as well as the developing nervous system, impacts motion verb and relational term acquisition. In the final section, we propose that to fully understand how motion verbs and relational terms are acquired by the child, we need to adopt a systems perspective whereby we address and examine the roles of the psychological, cultural, and biological systems on language development. We offer a glimpse of the work we think needs to be carried out in the future to begin developing a comprehensive developmental systems theory of language development.

The Developing Conceptual System: Discrimination and Categorization of Semantic Concepts Encoded in Motion Verbs and Relational Terms and their Association with Verb Learning

There are a number of semantic concepts to which motion verbs or spatial-relational terms can be mapped. While linguists (Jackendoff, 1983; Langacker, 1987; Talmy, 1985, 2000) have identified several semantic concepts codified in motion verbs and spatial-relational terms, two semantic concepts, *path* and *manner*, have received the most attention as they appear to be universally encoded in languages across the world (Jackendoff, 1983). In all languages, *path* refers to the trajectory of a figure relative to a ground (e.g., in English spatial-relational terms *over*, *under* and in English motion verbs *come*, *approach*, *enter*), and *manner* refers to how an action or motion is performed (e.g., in English motion verbs *skipping*, *hopping*, *strolling*). However, cross-linguistically these concepts can be packaged in different syntactic word classes (e.g., path is codified in spatial prepositions in English and motion verbs in Spanish; manner is codified in motion verbs in English and adverbs in Spanish; Talmy, 1991, 2000; Slobin, 2004). These important features make these concepts ideal for understanding conceptual and language development more broadly, and have been the focus of some our own research, which we discuss further below (Pruden et al., 2012, 2013; Konishi, Pruden, Golinkoff, & Hirsh-Pasek, 2016; Song, Pruden, Golinkoff, & Hirsh-Pasek, 2016; Pulverman, Song, Hirsh-Pasek, Pruden, & Golinkoff, 2013).

Motion verbs and spatial-relational terms conflate only a subset of potential semantic concepts in their meaning. This requires that children learning their native language figure out which semantic concepts are conflated in their language and which concepts to pay attention to when perceiving an event. Before a child can begin to map motion verbs and spatial-relational terms to events, they must learn to pay attention to and discriminate between semantic concepts like *path* and *manner*. Furthermore, language would lose its utility and become cumbersome if labels referred to only one single action or object, as proper names do. Thus, children must figure out that labels refer to "categories" of actions and must be able to form categories of semantic concepts like path and manner. That is, the young language learner must learn that the motion verb "hopping" can apply not only to different agents (i.e., bunnies, people, etc.), but also across different paths (i.e., hopping over, hopping under) and across different grounds (i.e., bunnies hopping over a log; Jimmy hopping under a tent).

A decade of research on infants' ability to discriminate and categorize the semantic concepts of path and manner reveals that even the very young word learner is equipped with the semantic conceptual system needed to acquire motion verbs and spatial-relational terms (Pruden et al., 2012, 2013; Konishi et al., 2016; Song et al., 2016; Pulverman, Golinkoff, Hirsh-Pasek, & Sootsman Buresh, 2008; Pulverman et al., 2013). Research with 7- to 9-month-olds (Pulverman et al., 2013) and 14- to 17-month-olds (Pulverman et al., 2008) shows that infants have the ability to attend to and discriminate among changes in a figure's path and manner, even before they begin comprehending (and even later producing) their first motion verbs and spatial-relational terms. In these studies, infants are first habituated

to an animated character performing both a manner with a path (i.e., a starfish spinning past a ball). They are then tested on events that either change only the path (i.e., starfish spinning over a ball), only the manner (i.e., starfish bending past a ball), both the path and manner (i.e., starfish doing jumping jacks around a ball), or change nothing (a control trial). In these studies, infants as young as 7 months looked longer at those test trials where there was a change in path and/or manner relative to the control trial. This suggests that these infants detected the change in the paths and manners, and thus were able to attend to and *discriminate* changes in path and manner.

Discrimination of path and manner is only the first step, though, to mapping labels to concepts. Before children can map a motion verb or other relational term to the path or manner, they need to form *categories* of path and manner (Golinkoff & Hirsh-Pasek, 2008). In two separate papers, Pruden and colleagues examined infants' ability to form categories of path (Pruden et al., 2013) and manner (Pruden et al., 2012) under conditions in which no language was presented along with the stimuli. Using the same stimuli as those in the discrimination experiments (Pulverman et al., 2008, 2013), Pruden and colleagues (2013) first explored whether 7- to 9-month-old and 10- to 12-month-old infants could form categories of a figure's path (e.g., over) when across four trials the figure's manner changed (e.g., spinning over; twisting over; bending over; jumping jacks over). At test, infants were shown two test events, one in which the same path was paired with a new manner (e.g., toe touching over) and one in which a new path was paired with a new manner (e.g., toe touching under). Results revealed that infants as young as 10 to 12 months showed a significant looking preference for the familiar event at test, suggesting that they had formed a category of path. In a similarly designed study, Pruden and colleagues (2012), using the same stimuli, tested whether 10- to 12-month-olds and 13- to 15-month-olds can form categories of manner (e.g., spinning) when the figure's path changed over four familiarization trials (e.g., spinning around, spinning past, spinning in front of, and spinning under). During the test trials, infants viewed a test event in which the same manner was shown with a new path (e.g., spinning over) and a test event in which a different manner was shown with a new path (e.g., bending over). The group of 13- to 15-month-olds showed a significant preference for the test event containing the new manner, while the 10- to 12-month-olds showed no significant preference, suggesting that by 13 months infants form categories of manner. Follow-up studies using more naturalistic stimuli, such as human actors performing dynamic actions, found similar results with 10- to 12-month-olds, which showed evidence of discrimination and categorization of a figure's manner of motion (Song, Pruden, Golinkoff, & Hirsh-Pasek, 2016). Together these studies provide evidence that the ability to discriminate and form categories of paths and manners is in place by around the first birthday.

More recent research has turned to investigating how this conceptual system develops. That is, what mechanisms might explain the development of discrimination and categorization abilities? Two mechanisms in particular have been examined as potential mechanisms by which these abilities develop: language and comparison. For example, there is evidence that infants appear to use language input (or in this case labels) to aid in their ability to form categories, including a category of a figure's path (Pruden et al., 2013). Infants as young as 9 months can now form categories of path when a novel label (*javing*) accompanies the four familiarization trials used in the Pruden et al. (2013) experiment. With this label, pre-linguistic infants now show the ability to form categories of path.

Infants also appear to use comparison of relational information to aid in the formation of categories of path and manner. The idea that comparison promotes learning is rooted in research on analogy and similarity (Gentner, 1983; Gentner, Holyoak, & Kokinov, 2001; Gentner & Namy, 2004; Markman & Gentner, 1997). Gentner (1983) proposed that a process of structure mapping allows one to structurally align the properties of one object/event to another and

as a result notice the similarities and differences of these objects. It is thought that this process of comparison allows children to notice commonalities that were not noticed prior to alignment and comparison (Gentner, 1983, 2003; Wolff & Gentner, 2000). Indeed, comparison is already implicated as a potential mechanism for learning object names (Gentner & Namy, 1999; Namy & Gentner, 2002), and some relational terms, including verbs (Childers, 2008), and even adjectives (Klibanoff & Waxman, 2000; Waxman & Klibanoff, 2000). In Pruden and colleagues' previous categorization studies (2012, 2013), events presented during the familiarization phase were presented sequentially or one at a time. However, when infants aged 7 to 9 months are shown the familiarization events simultaneously or in pairs to allow infants to make comparisons between the two relational events, then these pre-linguistic infants can form categories of path (Pruden, Shallcross, Hirsh-Pasek, & Golinkoff, 2008). Thus, it appears that at least two mechanisms are at play in the developing conceptual system—both language and comparison allow infants who were at an age previously unable to categorize actions to now show the ability to form these categories.

Studies are now beginning to address the consequences of variability in this developing conceptual system and how this variability affects children's later verb learning (e.g., Konishi, Stahl, Golinkoff, & Hirsh-Pasek, 2016; Song, 2009). For example, Konishi and colleagues investigated variability in 13- to 15-month-olds' ability to form categories of path and manner and whether this variability was related to the very same children's comprehension of both transitive and intransitive verbs at 27 to 33 months of age. The authors followed 25 infants from just after their first birthdays until after their second birthdays and found that individual differences in infant ability to form categories of path and manner predicted their successful performance on a verb comprehension task where they were shown two different side-by-side actions performed by the same actor while hearing phrases like "where is she eating the cake?" Song (2009) found similar results showing that 10- to 12-month-old infants had wide individual differences in their ability to form categories of manner, which in turn, were correlated with their receptive relational vocabulary size. Twenty-seven 10- to 12-month-old monolingual, English-learning infants viewed human actors performing a hopping action (i.e., manner of motion) across five different paths and five different actors during the familiarization phase and were tested on whether they had formed categories of this human action during the test phase. Results revealed wide individual differences in infant ability to form these categories of human action with these individual differences correlated with infant receptive relational vocabulary size, as measured by using action words and spatial preposition and location words from the MacArthur-Bates Communicative Development Inventories (MCDI) long form (Fenson et al., 1994) to create the *Relational Vocabulary* infant checklist. This last set of findings suggest that the developing conceptual system—that is, infant ability to discriminate and form categories of path and manner or semantic concepts—has an impact on later motion verb and spatial-relational term acquisition.

The Developing Cultural System: How the Language We Speak and Hear Affects Our Motion Verb and Spatial-Relational Acquisition

The motion verb and spatial-relational lexicon does not develop in isolation. The child's culture and the social contexts in which the child lives play an influential role in the development of this lexicon. This idea is not new, as others have posited the important role that culture and social contexts play in language development (e.g., Hoff, 2003, 2006; also see Akhtar & Tomasello, 2000), even when discussing how children learn verbs (e.g., Tomasello, 1995). However, the investigation of motion verbs and spatial-relational terms provides a unique opportunity to specify more directly how this occurs.

Culture is very clearly implicated in the acquisition of motion verbs and spatial-relational terms. One of the largest cultural influences on the child's development of a motion verb and spatial-relational term lexicon is the language to which they are exposed. A child's native language not only affects the rate and timing with which verbs are acquired (e.g., Choi & Gopnik, 1995; Tardif, 1996; Tardif, Shatz, & Naigles, 1997), but also appears to affect what aspect of events and actions are attended to and labeled with motion verbs and spatial-relational terms (e.g., Maguire et al., 2010; Sethuraman & Smith, 2013; Slobin, 2004; Talmy, 1985, 1991). Talmy (1985) offered a classification of the world's languages based on whether path information, characterized as the core schema in events, was expressed by the main verb or by a satellite, such as in English verb particles or prepositions. Two language typologies were presented: verb-framed languages where *path* is expressed in the main verb and satellite-framed languages where *path* is expressed in a satellite. Take, for example, English and Spanish. English overwhelmingly expresses path information in satellites (e.g., "The bottle floated *out*"; note that *path* information is presented in a satellite preposition while a motion verb expresses the *manner* of motion) and thus is classified a satellite-framed language, while Spanish expresses *path* information in its main verb (e.g., "La botella *salió* flotando"; note that *path* information is presented in the main verb while the *manner* of motion is presented as an adverbial particle; roughly translated to English, this means "The bottle moved out in a floating way") and is classified as a verb-framed language. Though some have disagreed with this dichotomy and argued for a more relaxed classification whereby typology may be a continuum such that there may be languages which express *path* equally as often in the main verb and satellite (Naigles, Eisenberg, Kako, Highter, & McGraw, 1998; Slobin, 2006), research still finds that those languages that fit this dichotomous typology conceptualize motion events and map labels to motion events in very different ways (e.g., Allen et al., 2007; Berman & Slobin, 1994; Naigles et al., 1998; Naigles & Terrazas, 1998).

Developmental research shows that between 19 and 24 months of age, children are beginning to follow language-specific lexicalization patterns in their naturalistic production of language. Choi and Bowerman (1991) showed that English- and Korean-speaking toddlers' talk about motion events takes on language-specific patterns before children reach their second birthdays, and Berman and Slobin (1994) found that children used language-specific lexicalization patterns when narratives were elicited. Studies of children's construal of novel verbs while viewing motion events depicting path and manner also reveal language-specific lexicalization patterns (Hohenstein, 2005; Maguire et al., 2010). These studies suggest a role for the language one is learning on how they make sense of events in the world and how they ultimately learn motion verbs and spatial-relational terms.

Social contexts in which the child lives are also very important to the development of a child's lexicon (e.g., Hart & Risley, 1995; Hoff, 2006; Huttenlocher, Haight, Bryk, Seltzer, & Lyons, 1991). While social context can be parsed into a number of different factors, many researchers have focused on adult language input as one of the chief factors affecting children's development of motion verbs and spatial-relational terms (Choi, 1999; Longobardi, Rossi-Arnaud, Spataro, Putnick, & Bornstein, 2015; Naigles & Hoff-Ginsberg, 1998; Pruden, Levine, & Huttenlocher, 2011; Veneziano & Parisse, 2010). Naigles and Hoff-Ginsberg (1998) found in a sample of 57 English-speaking mother–child dyads that maternal verb frequency, as well as syntactic diversity of the mother's verb use, were significant predictors in children's verb frequency and syntactic diversity. These results held even when controlling for children's frequency and use of verbs in their own speech 10 weeks earlier. Choi (1999) found similar evidence in Korean-speaking parent–child dyads, with children's early emergence of verb semantics and structure facilitated by the caregiver input, particularly the caregiver's own verb usage. Finally, work by Pruden and colleagues (2011) specifically addresses the relation between adult language input and children's developing

spatial-relational lexicon, with their focus on the development of dimensional adjectives (e.g., *big*, *little*), shape terms (e.g., *circle*, *square*), and terms that encode spatial features (e.g., *curvy*, *bent*). In a longitudinal study design, they found that parent spatial language input, specifically the quantity of spatial language parents used in their child's first 4 years of life, predicted children's own spatial language use by 4 years of age.

Together, the findings from the research presented in this section on the developing cultural system suggest that both the specific language(s) to which the child is exposed (e.g., English, Spanish, etc.) and the social context in which this language is heard (e.g., quantity and quality of adult language input) play a role in the development of the motion verb and spatial-relational word lexicon.

The Developing Biological System: How the Body and Brain Impact Verb and Spatial-Relational Term Acquisition

Of the three levels of analysis discussed here, we probably know the least about the effects of biology on developing motion verb and spatial-relational term acquisition. In this section, we review three different strands of research on the developing biological system and the consequences this development has on children's acquisition of motion verbs and spatial-relational terms. Much of what we know about the developing biological system as it relates to language development pertains to the idea of embodiment, or the concept that cognition may be rooted in the interaction of the body with the world (Wilson, 2002; also see Marshall, Chapter 3 of this volume). We first briefly review the literature on embodiment, particularly how interactions of the body with the world impact children's development of a verb and spatial-relational term lexicon (e.g., Marcinowski & Campbell, 2016; Maouene, Hikada, & Smith, 2008; Maouene, Sethuraman, Laakso, & Maouene, 2011; Oudgenoeg-Paz, Leseman, & Volman, 2015). Second, research has begun to examine how the brain processes events and actions that are expressed by motion verbs and spatial-relational terms. We offer a very brief overview of the neurobiological mechanisms of motion verb and spatial-relational term processing in adult populations using fMRI (Quandt, Cardillo, Kranjec, & Chatterjee, 2015; Wu, Morganti, & Chatterjee, 2008). Lastly, we explore what impact the biological sex of the child may have on their learning of relational language (Pruden & Levine, 2016).

The concept of embodiment essentially takes seriously the notion that there is no mind without the body, and the body's interaction with the world is a constitutive process contributing to the developing mind. Embodiment has received quite a bit of attention in recent years as it pertains to the study of motion verbs and spatial-relational terms. Early studies of children's comprehension and production of verbs by Huttenlocher and colleagues (1983) suggests that children's first motion verbs are frequently used in contexts in which the child is participating in the action and are those that encode self-action as opposed to other-action. More recent work by Schwarz, Van Kleeck, Maguire, and Abdi (2016) also finds that children who act out a verb, as opposed to simply observing others acting it out, were better at comprehending newly learned verbs. In some of our own work, we found that gesture may play an important role in the development of children's spatial language, with parent use of gestures in the context of spatial language (e.g., pointing to the highest point on an object while using the word *tall*) is a significant predictor of children's later spatial language production (Cartmill, Pruden, Levine, & Goldin-Meadow, 2010). Maouene and colleagues (2008) report systematic and structured associations between body parts like the hands, legs, and mouth and use of early verbs that encode actions performed by these body parts. Notably there were some age of acquisition patterns showing that the earliest verbs encoded movement related to the mouth, hands, and legs, and later verbs were less bodily defined. More recent research suggests that verbs more highly associated with a single area of the body are

the ones acquired earliest (Maouene, Sethuraman, Laakso, & Maouene, 2011). Correlating body region with age of acquisition of motion verbs is not the only type of research supporting the concept of embodiment and its role in children's acquisition of motion verbs and spatial-relational terms. Other research has looked at how children's gross and fine motor skills are related to their developing lexicons. For example, Oudgenoeg-Paz and colleagues (2015) show in a longitudinal study that the age at which children sit and walk predicts their later spatial-relational object exploration, which in turn predicts their later productive spatial language use, including their knowledge of verbs describing motion. In a separate study examining infant construction ability, researchers found that those infants identified as high constructors (calculated based on number of constructed items) between the ages of 10 and 14 months comprehended significantly more spatial-relational words at 2 and 3 years of age (Marcinowski & Campbell, 2016). These studies examining the role of self-action, body parts, and motor ability in children's motion verb and spatial-relational term acquisition suggest a role for the concept of embodiment in children's language development.

With technological advances we are beginning to learn how the brain processes actions and events that are expressed in motion verbs and spatial-relational terms. Though research using fMRI is largely conducted using adult populations, we are learning what regions of the brain appear to process aspects of events, such as *path* and *manner*, expressed by motion verbs and spatial-relational terms (Quandt et al., 2015; Wu, Morganti, & Chatterjee, 2008). For example, Wu and colleagues examined whether the processing of path and manner information processing fits the expectations of the well-established two-stream "what-where" model of the visual system (Goodale & Milner, 1992). In this model, information about the shape, color, or size of objects ("what" information) is processed along a ventral stream in inferior and middle temporal cortical regions of the brain. "Where" information (i.e., information about where objects are located in space, as well as information about motion, i.e., "how" something is moving) is processed along a dorsal stream incorporating regions of the parietal cortex and the frontal eye fields. The authors reasoned that since manner is about "what" an object is doing—i.e., what kind of movement an object is able to accomplish—manner should be processed in more ventral regions. In contrast, "path" information, which encodes "where" a figure is going, should be processed in more dorsal regions of the brain. Using the same animated starfish as Pruden and colleagues (2012, 2013) used in their work on infant categorization of path and manner, adult participants who viewed a number of motion events containing either a path or manner while in an MRI scanner showed that the manner of an action was associated with bilateral posterior inferior/middle temporal cortex (i.e., a ventral region), and path was associated with right superior parietal lobule, left inferior parietal lobule, and bilateral frontal eye field (i.e., more dorsal stream regions). Similar results were obtained in a follow-up paper by Quandt and colleagues (2015) where they asked adult participants to read English prepositions and motion verbs while in an MRI scanner. Recall that English prepositions often encode path (e.g., *across*, *along*, *around*, *through*) and English motion verbs express manner of motion (e.g., *jump*, *hug*, *kick*, *pull*). Results revealed that the left posterior middle temporal gyrus (i.e., a ventral stream region) was more active when reading motion verbs (words expressing manner) than when reading prepositions (words expressing path). While these studies offer a glimpse into how the brain is processing motion events in the world, there is still much we do not know. No research to date has examined the developing brain and how it processes motion events with paths and manners. Future work will not only need to investigate how the developing brain processes events, but also how changes in the developing brain impact later verb and spatial-relational term development.

Investigations at the biological level are not just about the brain, but can also focus on other biological characteristics such as the sex of the child. Some of our own recent research suggests that the child's sex may play a role in the child's developing spatial-relational lexicon

(Pruden & Levine, under review). In a longitudinal study, we tracked spatial-relational language, specifically shape terms, dimensional adjectives, and words describing the spatial features of objects, used in the home setting by 58 parent–child dyads from when the children were 14 months to 46 months of age. Our results revealed that by the age of 46 months, boys produced significantly more of these types of spatial words (i.e., shape terms, dimensional adjectives, and spatial feature terms) than girls. However, it appears that it may not be the biology of the child that determines the size of one's spatial lexicon—further analyses revealed that this sex difference is mediated by parent spatial language input, suggesting that the cultural system is at work in explaining sex differences. Parents not only produced more spatial language when talking to boys than to girls, but this appears to mediate or explain the sex difference in children's own spatial language usage. This study serves as an example of how the cultural system may interact with biology to yield development in the spatial-relational lexicon. Future work will need to investigate these interactions further to understand what role biological sex may play in language learning, and more specifically, how culturally construed views of gender and gender roles may explain those sex differences we see in spatial language use by parent and child.

The studies reviewed in this section offer a glimpse into what we know about the biological system as it pertains to the development of motion verbs and spatial-relational terms. Together, the current literature suggests there is much to be done to understand how the biological system for the acquisition of motion verbs and spatial-relational terms develops and how this biological system interacts with both the conceptual and cultural systems to yield language acquisition. However, current research on the concept of embodiment and verb learning, on how the adult brain processes motion events, and on the sex differences in the development of the spatial-relational lexicon all points to promising research paths.

Future Work: Examining the Complex Relations Between the Conceptual, Cultural, and Biological Systems on the Development of Motion Verbs and Spatial-Relational Terms

The previous sections of this chapter highlighted the research that has been done on the developing conceptual, cultural, and biological systems as they pertain to motion verb and spatial-relational term development. In each section we have examined how each level of analysis contributes to an explanation of the development of the child's lexicon. However, the *Relational-Developmental-Systems* meta-model outlined by Overton in numerous writings (e.g., Overton, 2013, 2014, 2015) suggests that it is the co-acting influences of each level of analysis on others that will ultimately lead to the development of the motion verb and spatial-relational lexicon. A serious examination of these co-acting influences of the conceptual, cultural, and biological systems on motion verb and spatial-relational term acquisition has largely been ignored (though see some recent attempts by Golinkoff & Hirsh-Pasek, 2008 and Parish-Morris, Pruden, Ma, Hirsh-Pasek, & Golinkoff, 2010 using the Emergentist Coalition Model). As noted above, few of the studies we reviewed in this chapter made any attempt to explore how these systems interact with each other to produce language acquisition. It is our hope that this chapter invites other developmental scientists to consider approaching the development of motion verbs and spatial-relational terms from a *Relational Development Systems* framework. There is much work to be done and we propose that researchers begin by designing longitudinal studies where children's development of motion verbs and spatial-relational terms can be examined and the antecedents of language acquisition, including children's developing conceptual, cultural, and biological systems, can be investigated.

With respect to children's developing conceptual systems, we still know very little about how individual differences in children's discrimination and categorization of motion events

are linked to their later verb learning, and no research to date has examined how the cultural system, including parent language input and the language or languages to which the child is exposed, may mediate and/or moderate the relations between children's perception of motion events and their later verb learning. With respect to the cultural system, there is a dearth of research on how the languages the child is learning (e.g., English, Spanish, etc.) may affect the development of their conceptual system (i.e., discrimination and categorization of motion events), their biology, and, ultimately, their later motion verb and spatial-relational term acquisition. Finally, with respect to the biological system, while we know only a little about how this system itself develops in the context of motion verb and spatial-relational term acquisition, we know even less about how this system interacts with the conceptual and cultural levels to produce language development.

We believe a systematic study of the neurobiology of discriminating and categorizing path and manner in developmental populations is needed. This work could then be used to examine the complex relations between the child's event perception abilities, the language input they hear, and, ultimately, individual differences in their trajectories of acquiring motion verbs and spatial-relational terms. While there is still much research to be done to understand how children acquire language, particularly words that label events and relations in the world, studying the phenomena at multiple levels of analysis, as advocated by Overton, is becoming more attainable, and should be the long-term goal for research groups working in this area.

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12 Communication as the Coordination of Activity

The Implications of Philosophical Preconceptions for Theories of the Development of Communication

Jeremy I. M. Carpendale

Communication is ubiquitous in nature. It takes diverse forms, from flowers serving as signals for bees and the colors of poison dart frogs indicating their toxic nature, to bees communicating about new sources of nectar, and to the alarm calls of various species of monkeys, prairie dogs, and chickens. Human communication includes incidental forms of communication such as the crying of newborn babies as well as intentional forms based on anticipating others' responses, which begin to emerge before infants' first birthdays. It is the latter form of communication that language is based on and is usually considered communication. But to understand the development of human forms of communication, it is important to conceptualize communication broadly. Doing so requires being aware of the way in which preconceptions influence how this topic is approached and how evidence is interpreted. I articulate how communication can be viewed from the perspectives of two contrasting worldviews that can be characterized as conceiving of the individual as the starting point and source of social development or, in contrast, as the outcome of social development, in which case the starting point is the process of social interaction leading to increasingly complex forms of interaction.

It is important to frame the study of development of communication in the context of worldviews, which are essentially philosophical preconceptions that influence the theories and methods of developmental science. Although these assumptions influence theory as well as the design and interpretation of empirical research, they are not empirical and are rarely discussed. Therefore, before continuing it is important to analyze the coherence of these underlying worldviews. This has been the task taken on by Bill Overton throughout his extensive and influential career (e.g., Overton, 2015).

To examine the pervasive influence of preconceptions, it is essential to examine the assumptions on which the questions are based because otherwise the deck is already stacked against other approaches (Jopling, 1993). In this chapter I consider the development of communication, beginning with prelinguistic communication in infancy. Some approaches begin by presupposing minds as the starting point, and therefore they cannot explain the development of minds. I contrast such approaches with a relational-developmental-systems view beginning from the social process of interaction within which communication and minds emerge. Views of communication are also linked to assumptions about knowledge and understanding, and have implications for understanding the development of thinking and morality. This chapter focuses on explicating the nature and development of human communication, illustrated with observations from a diary study. I also note the implications of human communication for cognition and moral development.

Preconceptions and Communication

I consider two families of approaches to understanding communication—both based on systems of thought with long histories. One way to explicate the differences between the two families is to consider the question: For what is communication? It might appear that the obvious answer is that communication is for expressing ourselves (Clark, 1978). This way of conceptualizing the issue tends to be taken for granted within one worldview and body of research. The preconceptions on which this answer is based lead to presupposing what philosophers refer to as the problem of other minds (Overgaard, 2006). That is, the infant is assumed to have a mind and is trying to figure out if other people also have minds and how to communicate with them. This way of thinking was articulated by Descartes, although the assumption regarding the mind as pre-existing has a much longer history. Wittgenstein (2009) used Saint Augustine's *Confessions* as an example of this way of thinking. In writing about his life, Saint Augustine began by describing himself as an infant attempting to communicate his desires to the people around him. Since he could not have remembered his infancy, this description must be a manifestation of the preconceptions he brought to his attempt to re-construct his infancy. From this perspective, the infant is assumed to have beliefs, desires, and intentions, but she cannot yet express them—this is similar to thinking of the infant as starting off like a foreigner in a country in which she does not speak the local language and is attempting to communicate. This approach also assumes the code model or message model of language, according to which communicating involves one person encoding meaning in words that are then transmitted and decoded by another person (for criticism see Canfield, 2007; Wittgenstein, 2009).

To characterize this view of communication, George Herbert Mead (1934) used the analogy of prisoners isolated in their own separate cells attempting to figure out how to communicate with each other, perhaps by tapping on the bars. This "prisoners-in-cells" approach already presupposed individuals with minds who have something to communicate, and, therefore, this approach does not explain how such minds develop (Clark, 1978). It already presupposed what it is meant to explain, and this results in a puzzle: how does communication start? From this perspective, the question is: what must the child bring to the interaction to be able to communicate (e.g., Tomasello & Carpenter, 2013; Tomasello et al., 2005)? The problem of other minds arises due to assuming that what is primary is a first-person perspective of subjective experience and a third-person perspective of an external observer. Rather than assuming these perspectives as primary, they may both be derived developmentally from interpersonal experience that has been referred to as intersubjectivity (Jopling, 1993) or a second-person perspective (Fuchs, 2013). To explain communicative development it is necessary to start with a developmental approach beginning with such interpersonal experience.

The Process-Relational Worldview: Communication as Coordination

It is possible to start more broadly by thinking of communication as arising through a process of organisms learning about aspects of their world. This leads to re-conceptualizing communication as the coordination of activity between infants and caregivers, which can be observed developing from early forms of infant caregiver coordination of actions. This alternative approach sketched in here begins from a constructive view of knowledge, according to which infants learn about the action potential of their world (e.g., Chapman, 1991b; Piaget, 1936/63). That is, they learn what happens when they do things. This applies to the world of physical objects and also to other people, which are necessarily a large part of infants' world because they must be cared for. From this perspective, rather than the child needing

social skills to communicate, communication of various forms is present from early in infancy. Increasing coordination with others can be observed developing in infant–caregiver interaction. According to a broader definition of communication suggested by Clark,

> *communication is that which is involved in the co-ordination of the separate activities of two or more individuals into a single social activity*.
>
> (1978, p. 233, italics in original)

This definition fits with an approach to communication based on a process-relational worldview and a relational-developmental-systems meta-model (e.g., Overton, 2015). This approach has various roots, one of which is in biological approaches attempting to do biology without dichotomies between biological and social factors (e.g., Gottlieb, 2007; Griffiths & Tabery, 2013). That is, biological and social factors are so intertwined that they cannot be clearly separated, so they should not be treated as pre-existing and independent factors—nature and nurture—that interact. This is because they mutually create each other. This general way of thinking from a process perspective has a long tradition in philosophy, which Bernstein (2010) characterized as "the pragmatic turn." He documents how this way of thinking has been contributed to by diverse thinkers including Hegel, Peirce, Wittgenstein, Putnam, and Habermas, not always because they were building on each other's work, but also because they were working within the same framework on the same general approach.[1] Although much of psychology did not follow Mead's approach, a number of theorists did develop the idea that human minds have social origins (Baldwin, 1906; Kaye, 1982; Newson, 1974; Valsiner & van de Veer, 2000; Vygotsky, 1978; Winnicott, 1964). As mentioned, the worldview on which research is based sets up the problems addressed, and this brings with it possible answers and also influences the methodology employed. From a relational-developmental-systems approach to communication, an explanation is of a developmental or historical form, so the way to study such development is to document the increasing complexity of coordination between infants and caregivers.

Mead (1934) contrasts the prisoners-in-cells approach with his own approach, which begins from a radically different starting point. He did not presuppose minds, and instead began from interaction. Communication can be seen as emerging from the coordination of actions between two individuals. This coordination is at first neutral regarding intentions. For example, the crying of a newborn infant is not intentional, but it still results in the caregiver responding, and thus the crying *functions* to communicate the infant's distress to caregivers. Meaning for adults already exists in infants' actions and reactions before infants are aware that they are communicating.

Rather than starting from the mind as given, from a relational-developmental-systems perspective the starting point is interaction, and so the problem is to explain how the process of interaction begins and becomes progressively more complex. This requires explaining how infants are drawn into social interaction, and develop within this social and emotional cradle (Hobson, 2002). The starting point from this perspective is an acting, sensing organism, with the capacity to develop expectations based on prior experience. The process of social development is bidirectional because infants acquire skills, such as smiling, which result in eliciting more complex social interaction in which they develop further.

Starting the Social Process

A developmental systems approach is an attempt to do without a dichotomy between social and biological factors. Instead, on close examination, biological and social factors are intertwined and mutually create each other (e.g., Gottlieb, 2007; Griffiths & Tabery, 2013).

For example, human infants, like many other species, have an interest in biological motion, which may draw infants into paying attention to other people. To illustrate how the human developmental system gets off the ground, human infants develop within a social environment because they are born relatively helpless compared to other species, and thus must be cared for. This necessarily results in a social environment in which infants develop (Portmann, 1944/90). Various biological characteristics result in the infant being drawn into the social world. For example, characteristics of human infants' visual systems with a focal length of about 20 cm may result in often looking at caregivers' faces. Even newborn infants have a preference to look at eyes directed toward them (Farroni, Massaccesi, Pividori, & Johnson, 2004). Human eyes, unlike the eyes of other primates, are distinctive in having relatively darkly colored irises surrounded by white sclera (Kobayashi & Kohshima, 1997, 2001). This biological characteristic could support cooperative social interaction because it makes it easier to follow gaze direction, and thus to coordinate attention with others (Tomasello, Hare, Lehmann, & Call, 2007). The fact that human eyes are visually salient has the potential to draw typically developing infants into the social world because they pay attention to eyes and, thus, become experts on eyes and faces. The importance of attending to eyes is suggested by evidence that infants who are later diagnosed with autism decrease in their looking at others' eyes between 2 and 6 months of age (Jones & Klin, 2013). Clearly these examples are incomplete and additional factors can be present because blind infants also develop communication. These are just a few examples of possible biological characteristics that could result in the social developmental niche in which human infants develop. These examples illustrate a process through which biological characteristics result in a social environment that stimulates learning and neurological development. The social skills acquired can then elicit more complex social interaction, which supports further social development in a bidirectional manner. Thus, the biology creates the social factors that shape biology, which, in turn, supports social skills. And these further skills influence social experience, and so on.

Communication of various forms is present early in infant–caregiver interaction. An example of how infants develop social skills in dyadic interaction is that infants learn about face-to-face interaction between 4 and 6 months. If infants experience contingent interaction with their caregiver, they come to expect that their mother will respond to their smiles (Mcquaid, Bibok, & Carpendale, 2009). This form of interaction is *communion*, but not yet *communication* about something outside of this dyadic process (Chapman, 1991b). Although this emerging interactivity may not seem to be communication, it signals the emergence of patterns of interaction that lead to more complex forms of human communication.

Caregivers' actions become significant for infants as they learn to expect what is coming up next. For example, at 2 months infants are already learning about how their parents pick them up, and they stiffen their bodies in anticipation. This coordination in interaction improves over the next months (Reddy, Markova, & Wallot, 2013).

Further examples of dyadic interaction between infants and caregivers include infants' natural actions of leaning and reaching toward their caregivers. These actions are meaningful to their caregivers because they manifest the infant's desires. The meaning is present in the interaction even though to begin with it is unlikely that the infant is intending to communicate. Through learning how caregivers respond to such action, infants come to anticipate their parents' responses; that is, they learn the meaning that their action has for the adult (Mead, 1934). Thus, meaning already pre-exists in the coordination of actions before infants develop awareness of it. As infants learn to anticipate others' actions, they develop expectations, and a new form of communication emerges, based on shared anticipation of what happens in routine situations. Reaching toward a caregiver can develop into the "arms-up" gesture, a common and early developing gesture.

The Transfer of Objects

Beyond the interaction described above, a further step in communicative development is the transition from dyadic interaction between infant and caregiver, or infants and objects, to triadic interaction between all three legs of this triangle consisting of the infant, the caregiver, and objects (Chapman, 1991b). A way to approach the development from dyadic to triadic interaction is to focus on the transfer of objects (Clark, 1978). Here it is important to be cautious about how this activity is described because it is easy to view it from adults' perspective and interpret infants' actions as showing, offering, and giving. But these are already developmental achievements, so it is important to cautiously describe the origins of these social acts in the transfer of objects. That is, from a developmental perspective it is necessary to describe how patterns of interaction such as showing and giving emerge from earlier patterns. By transitioning from dyadic to triadic interaction, infants begin to coordinate their action on objects with other people. The exchange of objects may at first be primarily coordinated by caregivers, as they place objects into the infant's hands, or take objects from the infant. In parental observations from a diary study, infants were reported to hold out a hand with an object in it. This tends to be experienced by adults as the infant showing or giving the object to them. Based on diary reports, an infant was reported to be apparently "showing" an object by extending her arm with an object in her hand, but it was not extended toward anyone. That is, she walked around holding an object in her extended arm. Also, if she extended her arm toward an adult and the adult took the object, she might hold onto it and would seem surprised that it had been taken from her, suggesting that she did not intend to give it. Infants gradually learn the routines of showing and giving and come to enjoy these social situations, showing that emotions are an essential aspect of this interaction.

Infants learn that objects can be a means to gain adults' attention, so that if they do not have an object when an adult comes to visit, they may run to get one. There is evidence infants who did more holding out and showing of objects and whose parents engaged with them in extended interaction around these activity patterns used more pointing gestures in the following month (Cameron-Faulkner, Theakston, Lieven, & Tomasello, 2015). Dyads gradually develop a "stable structure of social activity which is essentially the same in form on different occasions, and of course many different objects are assimilated to the same structure" (Clark, 1978, p. 241). I have described this social process in a way that emphasizes what may be fairly common in human ways of life, but particular objects in particular situations will have cultural significance (Carpendale & Wereha, 2013).

Joint Attention versus Joint Activity

Infants' early social understanding as shown in gaze following and the use of gestures such as pointing has been described as *joint attention* behavior because it involves the coordination of attention with others (Carpendale & Lewis, 2015). However, describing infant behavior in this way tends to overlook essential differences between coordinating attention through following gaze compared to conveying meaning through the use of gestures. In understanding communication I suggest that it is more fruitful to think in terms of *joint activity* instead of *joint attention* (Müller & Carpendale, 2004). Joint activity involves experience with shared social routines and this enables communication because an early action in the routine can elicit the rest of the pattern. For example, infants know about the routine of walking together and so holding out a hand while walking with an adult is understandable (Canfield, 2007).

The two worldviews introduced above entail two contrasting views of meaning. I have noted problems with the view that meaning is transmitted through being attached to words (the code model or message model) and then decoded (criticized by Wittgenstein, 2009), and

I have argued instead for a view of meaning as existing in routines of interaction (Canfield, 2007; Carpendale & Racine, 2011). As infants learn about social routines, they can intentionally communicate and anticipate how others will respond.

Some gestures, like the "arms-up" gesture described above, are based on infants' natural reactions such as reaching toward their caregiver, which becomes a request to be picked up as infants learn how their caregiver responds. Infants can then anticipate this response and use the gesture to communicate intentionally through becoming aware of the meaning that was already there in the interaction for the adult (Mead, 1934). This is one way in which gestures can be learned, and chimpanzees seem to learn gestures in this way (Plooij, 1978). Other gestures, however, such as waving, are culturally specific conventional gestures that do not appear to be based on natural reactions. Adults could potentially learn such gestures through explicit instruction or observation of the social situations in which they are used. Since this is not possible in the case of infants, these gestures must be learned in a somewhat different way, at least partially through imitation of the physical movement. In observations from a diary study, parents reported that infants gradually learned how to approximate the arm movement of waving. But then they waved in all sorts of situations, so imitation cannot be the complete explanation because these infants still had to learn the meaning of the gesture; that is, they had to learn the social situations in which it is meaningful.

Pointing gestures, in particular, have attracted a great deal of research attention. This is partly because they are common and early developing gestures, but also because pointing can be used to perform many different social acts. How this gesture develops, however, is still controversial. One possibility is through social shaping. Infants have been observed to begin to use fingertip exploration of close-by objects. This becomes linked to their own orientation to aspects of the world, and infants then extend the hand configuration to more distant objects. Because this action manifests infants' attention, adults respond to it and infants learn how their action results in this response (Shinn, 1900/75; Bates et al., 1975; Carpendale & Carpendale, 2010).

Social shaping provides an explanation of how infants may use pointing as a means to direct adults' attention—i.e., a protodeclarative. And declaratives are grounded in mutual joy in engaging with another person about something of interest to both of them (Bates et al., 1975). But pointing can be used by infants to serve many different functions, such as informing, and asking as well as answering questions (Carpendale & Lewis, 2015). A question that arises is: do infants develop pointing independently within all of these separate social situations, or do they learn the skill in one situation and then extend it to others?

Extending the Use of Gestures

Parental observations suggest that infants may master a gesture and then extend its use to other social situations. For example, in my diary study some infants have been reported to use waving gestures in various ways. One infant waved when her babysitter arrived, which was understood by her mother as indicating that she wanted the babysitter to leave. Another infant used waving to indicate that he had finished his food, or his book, or that he had lost a toy in his bath. The gesture was understandable by others in these situations, perhaps because it drew on a sense of ending. Pointing gestures, in particular, stand out in their potential to be used to perform many different social acts.

From the "prisoners-in-cells" approach, one explanation is that infants start engaging in various forms of joint attention behaviors because they have acquired the insight that other people are intentional agents with attention that can be directed. This social insight makes it possible to engage in all of these social activities (Tomasello et al., 2005). But the only evidence that infants have acquired this insight is that they can engage in this activity. There is no other evidence;

thus, this approach is circular because it only provides a re-description of infants' activity. That is, infants' actions can be described by an observer as the infants understanding and attributing mental states to other (Bibok, 2011). But, even if this problem is overlooked, how does the infant acquire this insight? The next move in the prisoners-in-cells approach is then to claim that this must happen through an individual going through a process of mental simulation. The claim is that when infants observe others looking, they understand this on the basis of their own experience of seeing (Tomasello & Carpenter, 2013). Although it can be said that infants do experience seeing, in one sense of the word, this is the same sense in which other animals also experience seeing. This does not mean that they can extend this immediate subjective experience to understand others' experience from an external point of view (i.e., to understand it "as seeing"). That would require a complex form of experience (Baldwin, 1906; Carpendale et al., 2013). This approach also smuggles in an understanding of self and other, as well as the ability to treat others' actions as expressive (Scheler, 1913/54). Instead of attributing mental states (so-called "mindreading"), infants' abilities can be more simply explained as action reading through anticipating the outcome of typical human actions (Fenici, 2014; Uithol & Paulus, 2014).

From the relational-developmental-systems perspective presented here, there are several, not mutually exclusive, possibilities for explaining how infants extend the use of gestures, particularly pointing. First, this hand configuration may begin as a manifestation of the infant's own attention, an orienting action toward something of interest. Then caregivers may respond to this differently in various social situations. In the context of feeding, for example, caregivers may respond to a pointing gesture as a request. In one diary observation, a mother reported that her son had begun to use pointing as a declarative, and then during a meal he pointed to a jar of food. His mother reported that she responded as if it was a request, although she noted that it was not clear that it was intended that way. Her son seemed quite happy with getting more food and repeated the gesture. But in situations in which a request does not make sense, adults may not respond to the gesture, or respond to the pointing as a declarative by talking about the event or object of interest.

Alternatively, pointing may be learned as an action pattern that works to direct others' attention, and it is then extended to direct attention in different social contexts for different purposes, such as to share attention or to indicate which object is requested. The request routine (or proto language game; Canfield, 2007) could be learned as a stable interactional pattern. Requests could be learned through reaching actions with the whole extended hand or a grasping action (Carpendale & Carpendale, 2010). The pointing action may have been learned in other situations and recruited for the request (Werner & Kaplan, 1963). Shinn (1900/75) referred to this process as combining habits. In Piaget's terminology this constitutes reciprocal assimilation: the coordination of two previously independent actions. Bates (1976) describes this process of combining action patterns in the context of one of her research participants using a "turning to look" action when hearing a dog bark, and on a later date combining "turning to look" with a pointing gesture, both pre-existing actions.

One mother in a diary study noted that when she was slow in responding, her infant cycled through all of his actions that had worked on previous occasions. In one instance, he first pointed, then vocalized, then attempted to push his mother's hand to get her to reach a toy for him. This fits with Piaget's (1954/71, pp. 298–361) documentation of aspects of the development of infants' understanding of causality as involving a transition from the infant using another's hand by attempting to release the action potential of the adult's hand to understanding others as independent centers of causality. Piaget (1936/63) described the development of sensorimotor development between sub-stages 5 to 6, during which infants attempt to overcome obstacles they encounter through trying out different actions. By sub-stage 6 infants can anticipate the outcome of combining actions (Müller, 2009; Piaget, 1936/63). This is how social skills could be described as an insight developing from an action-based perspective.

This discussion of how gestures develop highlights the view of communication as based on shared understandings of routine social situations. Stable patterns in interaction are important because the infant can anticipate what is coming up next. These patterns of social interaction are routines that are part of common situations such as feeding, cleaning, playing, and so on (Canfield, 2007). Once an infant has learned an action pattern, she can attempt to initiate it with the intention to do so, anticipating what will happen. The basic structure of communication can be seen in prelinguistic gestural communication in which infants have learned about typical social situations. Words can then be added to gestures. For example, words like *look* and *see* can be added to pointing gestures, and words such as *want* can be added to requests (Canfield, 2007).

Communication and Cognition

The ability to talk about aspects of experience provides the potential to reflect on experience in a new way, and communication with others provides a way to learn about the world. Chapman (1991b) suggested that the development of knowledge can be conceptualized as an epistemic or knowing triangle consisting of the child, objects, and others. According to this view, children learn about the world through their own experience, but also through communication with others about their experience. The communicative leg of the triangle can be seen in Vygotsky's work and the early Piaget focus on the social dimension of children's action. In contrast, the later Piaget was concerned with infants' interaction with the world of objects. Combining these dimensions results in an epistemic or knowing triangle (Chapman, 1991b).

Furthermore, Vygotsky (1978) is well known for arguing that language is first a means for communication, which then can be used by individuals as a tool for thought. This is first external through egocentric or private speech, which is gradually no longer vocalized and serves as a tool for thinking. A similar idea is present in Piaget's (1928) early work on the social origins of reasoning and in Mead's words, "man is rational because he is social" (Mead, 1934). Mastering a language can then be used as a form of thinking about both the physical world but also the social and emotional world.

Communication and Morality

If communication is broadly conceptualized as the coordination of activity, then it is linked to many other aspects of human life. In particular, the relational-developmental-systems approach explicated in this chapter has implications for conceptualizing moral development. Thinking of communication broadly as the coordination of activity brings out the point that the roots of morality can be seen emerging in early interaction. In fact, Grice (1975) claimed that conversation is a special case of cooperative interaction in general, and utterances are interpreted based on the assumption that the speaker is cooperating and is attempting to communicate. The principles that constitute cooperative interaction are moral in nature because they are based on treating each other as persons. Any relationship, however, is some mixture between cooperation among equals with mutual respect, and constraint based on one-sided respect. The potential, however, is there in the structure of communication for ideal communication among equals (Habermas, 1983/90; Piaget, 1932/65).

Developmentally, patterns of action and reaction are set up between infants and caregivers beginning in the first year of life. By 4 to 6 months of age infants are learning about the social world through interaction with caregivers. As mentioned above, infants who have experienced contingent interaction try to elicit interaction when their mothers are asked to hold a "still" passive face. Their babies have developed expectations about typical interaction, and, therefore, try to get the enjoyable interaction going again (Mcquaid, Bibok, & Carpendale, 2009).

Caregiver and infant are responding to each other, but at this point the interaction is not yet about the world beyond the dyad (Chapman, 1991b). In this process infants are treated as persons—as someone, not something (Spaemann, 2006). They are given value because their contribution is interpreted as meaningful and they are responded to. This interaction is likely to vary across families and cultures, and the weight and interpretation given to the child's contributions will change as the child develops more advanced skills.

Turn taking has its roots in early interaction as the caregiver treats the infant as a person and responds to actions from the infant as if they are contributions to a conversation. During this interaction, the infant may be engaged in watching the caregiver's response, then, when the adult has stopped, the infant may again do something that the adult treats as part of a conversation. In this way the adult provides the social support for the structure of the conversation in this sequence of actions and reactions. This structure of paying attention to the other's contributions and then responding emerges as the adult folds anything the infant does into the social structure. This social pattern of interaction is based on treating the other as a person, and thus it is ethical at its root. Values are embedded, implicitly, within the structure of conversation through the way individuals are treated. This is a social structure in which infants develop, with the adult doing most of the work to begin with and the child gradually taking on more as they master the routines (Carpendale, Hammond, & Atwood, 2013).

A precondition of interacting socially is that an individual's action is taken as a response to the preceding action. This is *conditional relevance* (Turnbull & Carpendale, 2001)—a second person's action is interpreted in light of the previous person's action. Even a silence is not understood as a lack of response; instead, it is interpreted as a turn in interaction and it could be taken to mean agreement or disagreement, or something else. A lack of response is morally accountable because it implies treating the other as an object rather than a person. If an individual's contributions are not recognized, that person is diminished. He or she is not fully treated as a person.

On top of the moral nature of the preconditions for interaction is built a second moral order concerning how others' identity and dignity are protected (Turnbull & Carpendale, 2001). This is politeness, which is a central aspect of everyday communication. It involves concern for others' wellbeing, and, therefore, avoiding undermining their sense of self (Brown & Levinson, 1987). An understanding of power differences is involved in responding to others and interpreting what others say.

This moral potential on which interaction is built does not mean that conversations and interactions are always ethical. But lying, for example, is possible only because communication is based on the assumption that people usually tell the truth (Holiday, 1988). It would not be possible to lie if people randomly lied or told the truth. In fact, communication would not be possible in this case. Communication is based on ways of acting together. This common ground makes communication possible because of shared experience with routine social activities (Racine & Müller, 2009; Wittgenstein, 1969). Lying only becomes possible once a language is mastered in this way. The ability to maintain a poker face and hide feelings to deceive others must be a developmental outcome, and cannot be present at the beginning of social development.

Conclusion

Approaches to studying human development are based on worldviews, and these sets of preconceptions that researchers begin with influence the way questions are set up as well as the methodology and interpretations of the results (e.g., Overton, 2015). I have examined the development of human forms of communication by analyzing the worldviews on which various approaches to communication are based. Some approaches view communication as

a means for self-expression. But this already starts off with the mind as taken for granted, and then the question is: how does the individual figure out that there are other people who have minds and he or she must learn how to communicate with them? This "prisoners-in-cells" approach (Clark, 1978; Mead, 1934) articulates an adult's perspective, but it provides no way for explaining the development of adult experience. It is incomplete and misleading when taken as a view of communication because this already presupposes selves with something to talk about.

Therefore, a more complete approach starts with development. A relational-developmental-systems approach based on a process-relational worldview begins with the social process in the relations between the infant as an active organism with a caregiver, both with biological characteristics that result in setting up the social process of interaction. From this perspective, it is necessary to explain how the social process begins and how it progresses through levels of complexity as infants become aware of the meaning that already exists within interaction. From this perspective, communication consists of the coordination of actions, and these forms of coordination become more complex through development. Beginning from a process-relational perspective, I sketched in a relational developmental system approach to communicative development that is more fruitful and also has implications for understanding cognition and moral development.

Note

1 In conceptualizing worldviews, Pepper (1942) discussed root metaphors to illustrate worldviews such as an organism or an historical event. Chapman (1991a) considered new root metaphors for new metatheoretical approaches. He acknowledged that the idea of a system comes to mind, but to rule out static systems, an additional word such as *developmental* or *dynamic* needs to be added to the system. He suggested the metaphor of *process* as an alternative. Process approaches have been proposed by a number of scholars. In the historical transition to a process approach, Goethe was an important thinker (Müller & Graves, 2016).

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13 Development of Deductive Reasoning

Robert B. Ricco

Discussions of reasoning traditionally distinguish between deductive or formal reasoning and inductive reasoning. Deductive reasoning yields conclusions that are necessary. Deduction is truth-preserving, content-independent, and assumption-based. In a valid deductive argument, the truth of the premises guarantees the truth of the conclusion. This is because the conclusion is implicit within the premises. It is the form of a deductive inference, therefore, and not its content, that preserves the truth of the premises in the conclusion (Overton, 1990). Consider the modus ponens argument illustrated below. Assuming the truth of the major premise ("If it is raining, then the street is wet.") and minor premise ("It is raining."), the conclusion ("The street is wet.") follows necessarily. The major premise indicates that occasions where it is raining are a subset of occasions where the street is wet, making the latter state-of-affairs necessary given the former. Deductive reasoning is assumption-based or closed-world reasoning. When we reason in this manner, we stick strictly to the contents of the premises and exclude any considerations, including aspects of real-world knowledge, that are not consistent with the premises. For example, although it is relatively easy to think of a circumstance where the street remains dry despite a rain shower (e.g., the street is covered with a tarp), introducing such considerations is not consistent with what is stated in the major premise. By contrast, considering other causes of why the street might be wet (e.g., someone is washing their car) is not inconsistent with the premises. Deductive reasoning is central to several ubiquitous forms of thinking including hypothetical thinking, argumentation, and scientific thinking.

By contrast with deduction, inductive reasoning yields conclusions that hold with some degree of likelihood or probability. Induction is defeasible, content-dependent, and open to considerations that go beyond the information contained in the premises. Under an inductive reading of the previous conditional statement, we would presume that it is raining and then gauge the *likelihood* that the street is wet *given everything we know* about rain, streets, etc. All beliefs relevant to the content of the statement are brought into play when reasoning inductively (including the possibility that a tarp covers the street). Also, new information that leads to a revision of one's beliefs can invalidate an inductive inference. One of the perspectives on reasoning to be considered in this chapter attempts to reduce performance on deductive reasoning tasks to purely inductive processes.

The most widely studied form of deductive reasoning in cognitive developmental psychology involves conditional arguments. Such arguments contain a conditional statement ("If. . . then. . .") as the major premise and a statement indicating whether the antecedent or consequent of the conditional applies in a given case as the minor premise. The four possible forms of conditional argument are described below (Figure 13.1). Note that two of the forms are determinate or valid, i.e. the conclusion is necessary given the premises. These are formally referred to as modus ponens (MP) and modus tollens (MT). The other two forms are indeterminate or invalid, i.e. they allow for no certain conclusion. These are affirming the consequent (AC) and denying the antecedent (DA).

Modus Ponens (MP)	
If it is raining, then the street is wet.	If p, then q.
It is raining.	p.
Therefore, the street is wet.	Therefore, q.
Modus Tollens (MT)	
If it is raining, then the street is wet.	If p, then q.
The street is not wet.	–q
Therefore, it is not raining.	Therefore, –p.
Affirming the Consequent (AC)	
If it is raining, then the street is wet.	If p, then q.
The street is wet.	q.
Therefore, it is raining.	Therefore, p. (Invalid)
Denying the Antecedent (DA)	
If it is raining, then the street is wet.	If p, then q.
It is not raining.	–p.
Therefore, the street is not wet.	Therefore, –q. (Invalid)

Figure 13.1 Four forms of conditional argument. Two forms (*modus ponens* and *modus tollens*) are determinate or valid argument forms. Two forms (affirming the consequent and denying the antecedent) are indeterminate or invalid argument forms.

One particularly pivotal predictor of performance on conditional reasoning tasks concerns the availability of counterexamples to the two indeterminate argument forms (AC and DA) (Markovits & Barrouillet, 2002). The ease with which an individual can pair alternative antecedents, or cases of –p (e.g., someone is washing their car), with the consequent (q) is directly related to the likelihood that she will recognize that AC and DA do not allow for a definitive conclusion. As will be discussed below, the ability to generate alternative antecedents, and recognize the indeterminate nature of AC and DA, improves across adolescence, as does the ability to inhibit retrieval of possibilities (e.g., the street is covered with a tarp) that are inconsistent with the conditional, and to accept MP and MT strictly on the basis of the premises (Markovits 2014a; Markovits & Barrouillet, 2002; Markovits & Lortie-Forgues, 2011).

Dual Systems/Process Models

One of the most significant trends in contemporary research on reasoning has been the ascendency of the dual systems/process meta-theory (Evans, 2008; Ricco & Overton, 2011). According to this perspective, human cognition consists of two distinct systems or types of processing, with the primary basis for the distinction being the question of whether processing engages working-memory resources. Heuristic processing, also referred to as system 1 or type 1 processing, is automatic, effortless, content- and context-dependent, and parallel. By contrast, analytic, system 2, or type 2 processing is resource-dependent, relatively abstract, effortful, intentional, and serial.

Within system 2, several theorists have maintained an additional distinction between algorithmic and reflective subsystems. The algorithmic subsystem consists of the knowledge bases, procedures, strategies, rules, and other cognitive structures underlying norm-based processing

of reasoning and decision-making problems (Stanovich, 2011). This is the "mindware" that supports rational thought. Thus the MP and MT conditional argument forms could be represented as formal inference schemas in the algorithmic subsystem. Alternatively, MT could be represented as a strategy or procedure for disproving a proposition by showing that one of its logical implications cannot be true. The algorithmic subsystem is also the appropriate level at which to consider quantifiable aspects of computational power such as processing capacity, efficiency, and flexibility, along with inhibitory capabilities and attentional control. By contrast, the reflective subsystem consists of practical and epistemic forms of self-regulation that embody, respectively, two primary forms of rationality—instrumental or goal-based rationality and epistemic or understanding-based rationality. Practical self-regulation involves intentional goal formulation and planning, including the coordination of goals with available beliefs or knowledge states (Stanovich, 2009). *Epistemic* self-regulation involves intentional adherence to specific epistemic norms that provide criteria for judging the adequacy of one's beliefs or knowledge claims. Epistemic norms include the notion that a knowledge claim is only valid if it withstands attempts to refute it. Epistemic self-regulation also involves adherence to metalogical norms that sanction particular types of inference *from* knowledge claims (Moshman, 2013). These norms derive from metacognitive knowledge about reasoning and about the cognitive processes that support it. Important metalogical norms for deductive inference include the notion that if the premises are true, then the conclusion must be true, as well as the idea that logical necessity is a function of the form of an argument—not its content. As will be discussed shortly, the development of the algorithmic mindware that supports deductive reasoning is intricately related to the development of complementary metalogical knowledge.

The origins of the dual systems meta-theoretical perspective on reasoning can be found in competence-procedural theory as formulated by Willis Overton (1990) in his neo-Piagetian account of the development of formal thinking. Overton was one of the first theorists to make considerations of development integral to the dual systems/process perspective, and his theory continues to represent an important and fruitful application of the relational-developmental-systems paradigm (Lerner, Agans, DeSouza, & Hershberg, 2014; Overton, 2013, 2015) to the study of reasoning.

Theories of Reasoning: Competition or Rapprochement?

There are currently four primary accounts of the development of deductive reasoning. These are mental logic theories (Braine & O'Brien, 1998; Overton & Dick, 2007), metacognitive theory (Moshman, 2013; Kuhn & Franklin, 2006), mental models theory (Barrouillet & Gauffroy, 2013; Markovits, 2014a), and Bayesian, probabilistic theories (Evans & Over, 2004). Probabilistic accounts unabashedly deny that lay individuals engage in deductive reasoning to any meaningful degree. These accounts seek to show that performance on deductive reasoning tasks can be fully explained in terms of inductive processes. The first three theories are virtually always presented as incompatible and incommensurate. In fact, however, recent findings from within these accounts, and revisions to these accounts, have made it clear that a viable rapprochement is possible (Ricco, 2015; Ricco & Overton, 2011). This is particularly evident from within the assumptions of a relational-developmental-systems paradigm.

In this chapter, it is argued that mental logic theory, metacognitive theory, and mental models theory each represent an important perspective, point of view, or line of sight on the same phenomena (Overton, 2015), and each theory's explanatory focus is necessary to a full account. The theories are competitive and incompatible only from within the counterproductive assumption that there is a single legitimate and privileged perspective, and that alternative perspectives are reducible to the terms of the privileged perspective (Overton, 2013, 2015). As Overton has established in several influential treatises on the philosophy of developmental science, this zero-sum game and reductionist or foundationalist enterprise is

situated in the Cartesian split-mechanistic paradigm (Overton, 2015). Rather than considering each theory's explanatory focus as a moment of analysis en route to a full understanding of reasoning and its development, the split-mechanistic paradigm provides a limiting perspective within which seeming incompatibilities between theories give rise to enduring anomalies. Consequently, the discussion of reasoning featured in this chapter rejects the split-mechanistic paradigm in favor of an approach that acknowledges the importance of multiple perspectives and multiple forms of explanation.

Mental Logic Theory: Algorithmic Competence

Reasoning is an organized mental activity, and an adequate account of the development of reasoning must explain the nature and emergence of this organization at any given phase of development (Overton & Dick, 2007). Mental logic accounts of the development of deductive reasoning (Braine & O'Brien, 1998; Inhelder & Piaget, 1958; Overton, 1990; Piaget & Garcia, 1991) maintain that logics are highly effective ways to model the organizational properties of human reasoning because they are, themselves, abstract, dynamic, rule-governed systems of operations that represent the best available idealization of the rules underlying mature logical competence (Overton & Dick, 2007; Ricco, 1993; Rips, 1994). Logicians have developed a number of deductive systems with a range of distinct organizational properties. By modifying the rules of a logic, new logics, with new organizational properties, can be derived. For example, expanding the role of negation in class logic gives rise to standard propositional logic. The variety of logical systems means that logics are potentially well suited to modeling the different levels of organizational complexity that emerge as outcomes of development in childhood and adolescence (Inhelder & Piaget, 1958; Müller, 1999; Müller, Sokol, & Overton, 1999; Overton & Ricco, 2010).

Mental logic theory will be discussed primarily in terms of Overton's (1990) neo-Piagetian competence-procedural theory. Overton's theory, which is formulated within the theoretical context of a relational-developmental-systems perspective (Lerner et al., 2014; Overton, 2015), generally adopts Piaget's mental logics as competence models.

Overton's theory maintains a strict distinction between operations of mind that are relatively enduring, universal, and applicable to a broad range of phenomena, on the one hand, and individuated, real-time action processes, on the other. The enduring operations are part of an organized complexity that constitutes *competence*, while the real-time processes are the *procedural means* by which these enduring operations are expressed or manifest in particular individuals and contexts (Overton, 2010). The relation of competence to procedure is one of type to token (Overton, 2013; Overton and Müller, 2013). Thus the competence system of adolescence modeled as a highly coordinate, integrated system of propositional operations (type) could be manifest in any number of ways (tokens) in performance on a deductive reasoning problem, including the use of real-world mental models.

Overton's competence-procedural theory was the first major application of a dual systems perspective to the development of reasoning. Considering Overton's theory in terms of the system 2–system 1 distinction, system 2 can be regarded as a competence system. Processing within the algorithmic and reflective subsystems is essentially competence-based processing with the purpose of understanding and explanation. By contrast with system 2, the heuristic systems (system 1) are purely procedural systems. They serve to ensure efficiency, adaptiveness, and overall success in functioning and they are context- and content-dependent in nature (Overton & Ricco, 2010). The procedural component of Overton's theory also includes system 2 real-time processing.

The competence system for formal reasoning in Overton's account is assumed to consist of a mental logic that resembles standard propositional logic. In particular, the combinatorial

logic (INRC group) of Inhelder and Piaget (1958) along with its revision as an entailment logic (Anderson & Belnap, 1975) or logic of meanings (Piaget & Garcia, 1991, pp. 141–158) have been proposed by the Overton group as reasonable candidates for the competence model (Overton, 1990; Ricco, 1993). Piaget's combinatorial logic (Inhelder and Piaget, 1958, p. 134) consists of four transformations (Identity, Negation, Reciprocity, and Correlativity) applied to propositions in the logic, altering the truth values of atomic components and/or changing the logical operator – I(p V q) = (p V q), N(p V q) = (–p & –q), R(p V q) = (–p V –q), C(p V q) = (p & q). The key property of the INRC group is that each transformation is definable in terms of each of the other transformations (e.g., N = RC, R = NC, etc.). This highlights the strong integration and coordination of inference schemas in propositional logic. Further revision of this model as an entailment logic underscores the meaningful and relevant nature of human inference by insuring that all valid inferences in the logic are based in semantic entailments of one proposition by another. This logical model captures the organization of the mature algorithmic system. The competence model for the reflective system is a set of metalogical norms and related epistemic constructs that are fully co-active with the organizational properties of the algorithmic system. Thus the theory considers the algorithmic and reflective components of the competence system to be highly interdependent across development.

The Piagetian propositional logic (or its revision as an entailment or relevance logic) can be derived from a more fundamental logic of classes and relations and, as such, it comprises part of a theoretically viable account of the emergence of deductive reasoning from earlier, more limited, logical competencies. In fact, Piaget's logical competence model is entirely unique in this regard (Müller, 1999). The derivation of Piaget's propositional logic involves, in part, an expansion of the scope of negation in the class and relational logics (Byrnes, 1988; Byrnes & Overton, 1986; Müller et al., 1999; Piaget, 2001). The conditional is often defined in terms of class relations (Byrnes, 1988; Müller et al., 1999). Given the conditional "if p, then q" (e.g., "If something is a rose, then it is a flower."), the extension of the antecedent can be referred to as the set P (roses) and the extension of the consequent as the set Q (flowers). The conditional asserts that P is nested within Q (roses are a type of flower). When the antecedent p is negated, there are two possible states of affairs that might obtain. These are [–p and q] (something that is not a rose, but is a flower) and [–p and –q] (something that is neither a rose nor a flower). In terms of the extensions, then, the negation of the antecedent p can denote an affirmation of a set P' which is the complement of P with respect to Q (all flowers that are not roses), *or* an affirmation of the set Q' which is the complement of Q (all things that are not flowers). Negation has two different senses here—one relatively more constrained, bounded, or narrower in scope (the set P'), and the other relatively unconstrained or unbounded (the set Q').

Class logics, such as the groupings that Piaget proposes as competence models of reasoning in middle childhood (Inhelder & Piaget, 1964), can represent bounded or partial negations. The negation of a class A (e.g., roses) within a hierarchical classificatory system is bounded because it is equivalent to the affirmation of the complementary class (A') (other flowers) under the nearest superordinate (B) (flowers). Bounded negations are signifying negations because they affirm and delimit (Piaget & Garcia, 1991). Full, unbounded, or non-signifying negation (e.g., all non-flowers) cannot be directly represented within the groupings, though it can be approximated by expanding the reference frame for negation beyond the immediate superordinate (e.g., by abstracting from the class of flowers to the class of plants) (Müller et al., 1999). In the competence-procedural account, experience with class relations yields increasingly flexible expansions of this kind tending toward an understanding of relatively unbounded negation and eventually to its coordination with bounded negation (Piaget, 2001).

The theoretical claim that a process of increasing flexibility in the use of a partial, bounded, or local form of negation underlies the emergence of a formal deductive competence from an earlier, concrete competence (Byrnes, 1988; Piaget, 1980, pp. 297–299; Piaget & Garcia, 1991, p. 164) has been supported empirically. Müller et al. (1999) provide evidence that the a priori ordering of logic problems in terms of their complexity with regard to the role of negation corresponds to a developmental progression.

The notion that propositional logical competence develops by way of key transformations within an earlier class-based logical competence provides the most parsimonious and direct explanation for the emergence in middle childhood (but not earlier) of specific concrete precursors to formal deductive competence. These include an appreciation of logical necessity, sufficiency, indeterminacy, and the logic of falsification within *concrete*, problem-solving settings (Byrnes & Overton, 1986; Ricco, 1997). These logical competences precede similar capabilities emerging in adolescence with regard to propositional reasoning tasks. This latter, more formal competence, particularly with regard to relatively abstract content, appears to be lacking in fourth through sixth grades, coming on-line in eighth/ninth grade, and readily available in tenth to twelfth grades (e.g., Foltz, Overton, & Ricco, 1995; Müller et al., 2001; O'Brien & Overton, 1982; Overton, Ward, Noveck, Black, & O'Brien, 1987; Ward & Overton, 1990).

The derivation of propositional reasoning from class-based reasoning also provides a clear structural underpinning for, and explanation of, the most robust finding in the conditional reasoning literature. Children are more likely than adolescents to misunderstand the relation between the two possibilities for the denial of the antecedent in conditional argument, namely [–p, q] and [–p, –q] (Barrouillet, 2011; Byrnes, 1988; Gauffroy & Barrouillet, 2009, 2011; Markovits & Barrouillet, 2002; Overton, 1990; Overton et al., 1987). This is because the negation of p is bounded (by q) in the former possibility and unbounded in the latter. Within the mental logic account, the two forms of negation are not yet fully differentiated and coordinated. This misunderstanding involves imposing a pseudo-distinction upon the two possibilities and failing to recognize that the meaning of the conditional is consistent with *both* possibilities, and not merely with [–p, –q]. The misunderstanding involved in pseudo-distinction amounts to interpreting the conditional as a biconditional (if p, then q AND if q, then p). For example, in assuming the truth of the conditional statement, "If it is raining, then the street is wet," children displaying this misunderstanding will conclude that cases where "it is not raining and the street is wet" must be false while cases where "it is not raining and the street is dry" are either true or indeterminate (Gauffroy & Barrouillet, 2009).

Metacognitive Theory: Reflective Competence

In the theories of Moshman and Kuhn, the development of deductive reasoning is explained in terms of changes in metacognition (Kuhn & Franklin, 2006; Moshman, 2013). From this perspective, reasoning involves explicit conceptual knowledge regarding inference (metalogical knowledge) which, in turn, affords greater metacognitive control over inference. The development of metacognition in general, and of metalogic in particular, involves the reflective system. Moshman identifies two aspects of metalogic which correspond to the distinction between procedural and declarative meta-knowledge. The first aspect concerns metalogical *strategies* for the derivation of conclusions from premises and for the coordination of inferences. These strategies can include *reductio ad absurdum* (reasoning to a contradiction) and falsification or a search for counterexamples. The second, more declarative, aspect of metalogic consists of metalogical *understanding* and includes a recognition that inference is a basis

for knowledge, an understanding of key distinctions among types of inference, an appreciation that conclusions must be consistent with all possible states of affairs represented by the premises, and an understanding of logical indeterminacy, inconsistency, and necessity.

Overton's neo-Piagetian competence-procedural theory characterizes the relation between algorithmic and reflective systems as co-active and co-evolving (Overton & Ricco, 2010; Ricco & Overton, 2011). Thus the development of metalogical understanding and strategies at the reflective level, as described by metacognitive theory, should parallel increasing organizational complexity at the algorithmic level. As inference schemas become increasingly differentiated and coordinated, yielding richer entailments among schemas, metalogical understanding emerges. Children acquire ever more explicit knowledge regarding logical categories and strategies. Increasing metalogical knowledge, in turn, brings greater control over the inference process by way of the intentional use of explicit logical categories as norms or constraints on thinking (Moshman, 2013).

There is ample evidence that the emergence of metalogical understanding in the reflective system is co-active with increasing differentiation and integration (coordination) of inference schemas in the algorithmic system. Consider the four inference schemas for conditional argument. A fully deductive understanding of MP and MT, wherein disablers (e.g., the street is covered by a tarp) of the conditional are ignored to reason from assumptions, emerges in adolescence in parallel with the rejection of AC and DA. This developmental pattern suggests that the schemas become integrated into a coordinate system. This development, in turn, is accompanied by two significant changes in metalogical understanding: 1) an increasingly abstract appreciation that the truth of the conditional is consistent with negation of the antecedent (Markovits, 2014a, 2014b; Markovits & Lortie-Forgues, 2011) and 2) a conceptual understanding of validity and logical necessity (Moshman & Franks, 1986).

Demetriou and colleagues (Demetriou & Bakracevic, 2009; Demetriou, Mouyi, & Spanoudis, 2010; Spanoudis, Demetriou, Kazi, Giorgala, & Zenonos, 2015) provide evidence of an interdependence between expanding knowledge of reasoning processes (metalogical understanding) and emerging deductive reasoning competence. Increasing awareness of reasoning processes "becomes part of the very functioning of the processes concerned" (Demetriou et al., 2010, p. 330). For example, accurate self-evaluation of performance on propositional, spatial, and social reasoning tasks increases during adolescence (Demetriou & Bakracevic, 2009) and these increases parallel improvements in performance. In addition, several mediational analyses have shown that metalogical understanding or cognizance can explain the relation of multiple factors (e.g., processing efficiency, training procedures) to deductive reasoning performance. For example, Christoforides, Spanoudis, and Demetriou (2016) report that the effects of training on deductive reasoning performance with third and sixth-grade children were fully mediated by participants' metalogical awareness of similarities and differences between various kinds of deductive inference (e.g., MP, MT). Thus, training effects on reasoning performance appear to have resulted from the fact that they led to greater metalogical awareness.

Mental Models Theory: Computation in Real Time

Markovits, Barrouillet, and colleagues (e.g., Barrouillet, 2011; Barrouillet & Gauffroy, 2013; Gauffroy & Barrouillet, 2011; Markovits, 2014b; Markovits & Barrouillet, 2002) have extended Johnson-Laird's *mental models theory* into a genuinely developmental account of deductive reasoning. Mental models theory maintains that the cognitive representations with which lay deductive reasoning proceeds in real time are semantic and consist of real-world models generated from the logical relationships specified in a problem.

A mental model is a real-time representation of possible states of affairs denoted by the premises of an argument. Tokens represent these possible states of affairs. Adapting Markovits' notation (Markovits & Barrouillet, 2002), the major premise (if p, then q) in a conditional argument would be represented as follows, where "----" stands for the relation denoted by "if. . . then".

p ---- q

Consider the conditional, "If it is raining (p), then the street is wet (q)." Once a minor premise ("it is raining," "it is not raining," "the street is wet," or "the street is not wet") is added to the problem, one or more mental models will be generated and potentially entered into working memory.

If the minor premise leads to activation of cases where something other than p is combined with the denial of q (e.g., it is a clear day and the street is dry), then a mental model will be generated that consists merely of the affirmation of the major premise (p --- q) and the *complementary* of the conditional.

p --- q
a --- not–q

Here, "a" represents something (e.g., it is a clear day) other than p. Where this mental model prevails, it is likely that the child will impose the pseudo-distinction, noted earlier, between [–p and q] and [–p and –q], failing to recognize that [–p and q] is compatible with the truth of the conditional. Instead, [–p and q] and [p and –q] are each considered to render the conditional false, while [p and q] and [–p and –q] are considered compatible with the conditional (Gauffroy & Barrouillet, 2009). From the perspective of the complementary mental model, the AC and DA conditional argument forms are misinterpreted as valid. That is, the conditional (if p, then q) is interpreted as warranting a conclusion of p, given q, and as warranting a conclusion of –p, given –q.

A second possible model obtains when the minor premise leads to activation of *alternatives* to p. As noted previously, alternatives are cases involving objects or events that are different from p (e.g., the street is being cleaned, someone is washing his or her car, etc.), and where q is affirmed (e.g., the street is being cleaned and the street is wet). In other words, these are alternative ways in which q is realized. If alternatives to p (call any of these "b") should be activated, then an important model is generated allowing for an appreciation that AC and DA are uncertain.

p --- q
b --- q

This is because pairings of the consequent with alternative antecedents alerts the individual to the indeterminacy of these argument forms. Where the *alternatives* model prevails, all states of affairs except [p and –q] are considered compatible with the conditional, while only [p and q] makes the conditional true. Both [–p and q] and [–p and –q] are considered to be indeterminate with respect to the truth of the conditional. Within the perspective of this model, MP and MT are recognized as valid inferences while AC and DA are rejected as invalid.

A third type of mental model results if the premise information activates disabling conditions (d). *Disablers* represent conditions (e.g., the street is covered with a tarp) that, when paired with p, render the conditional false. Disablers must be suppressed or bracketed for the

rule to hold. If a disabler is activated, then at least the following model will be represented, making it likely that the child will indicate that MP is uncertain.

p --- q
p.d --- not–q

Which cases are activated and which mental models are automatically generated in an initial, default representation depends on problem content and on several aspects of system 1 processing, including the availability of alternative antecedents and disabling conditions in long-term memory, and the strength of their associations with problem content (Markovits & Barrouillet, 2002). Aspects of system 2 computational power such as working-memory capacity and processing speed are also considerations in regard to how many models might comprise the initial representation. Even in adults, however, not all possible models are typically represented in the default representation in working memory because there is an overriding concern to minimize cognitive load. Additional models beyond the default must be fleshed out according to the properties of the logical connectives (e.g., "and," "if. . . then," "if and only if") involved. This fleshing-out process essentially amounts to a search for counterexamples—cases where the conditional and the minor premise can be true, but the conclusion false. Fleshing out may also involve inhibitory processes as when disablers or contrary-to-fact content must be inhibited to reason strictly from the premises.

Construction of the initial or default model(s) on conditional reasoning problems is primarily a system 1 process, while the fleshing out of additional models, as appropriate, and their manipulation in working memory, is an analytic or system 2 procedure—i.e., one that is controlled, intentional, effortful, and dependent upon available representational capacity and computational power (Gauffroy & Barrouillet, 2009, 2011). Because each of these aspects of system 2 processing is more available with development, the fleshing-out process is more thorough or comprehensive in older children and adolescents, leading to an increase in the number of models conceived as compatible with the logical form of a conditional statement. As a result, the *alternatives* model becomes more typically invoked with development and the exclusive use of the *compatibility* model becomes less typical, leading to the mature pattern of rejecting AC and DA while accepting MP and MT inferences.

The mental models account of the development of conditional reasoning identifies the same core phenomena (e.g., pseudo-distinction) and developmental patterns (e.g., increasing rejection of AC and DA across adolescence) as mental logic accounts. While the latter focuses on the emergent organizational change that underlies the overcoming of pseudo-distinction, mental models theory identifies key pre-conditions for this emergence, namely an increase in system 2 computational resources with the resulting expansion of possibilities that can be simultaneously considered. Mental models theory also provides a clear account of how an emergent logical competence is expressed in the performance of a physical system characterized by bounded rationality, i.e. a system with limited processing resources. Such limitations mean that real-time processing will take the form of an initial default representation followed by more effortful fleshing out.

Probabilistic Models

Evans (Evans & Over, 2004) and Oaksford and Chater (2007) are among the leading proponents of a probabilistic turn in the deductive reasoning literature. They have argued extensively that the kind of reasoning typically employed on a variety of deductive reasoning tasks is best construed as a non-monotonic, defeasible, and specifically probabilistic form of reasoning that proceeds from suppositions represented in terms of subjective probabilities or degrees

of uncertainty, rather than from categorical judgments of truth and falsehood. In this view, the ordinary language conditional ("if. . . then") is equivalent to the conditional probability, P(q | p), i.e. the subjective probability of q given p. Research to date does not support an attempt to reduce deduction to probabilistic, inductive processes. Interpretations of the conditional as the conditional probability are generally limited to adults. Children and adolescents typically do not make this interpretation (Barrouillet, 2011; Barrouillet & Gauffroy, 2015). In addition, inferences from conditional statements do not conform to the assumptions of probabilistic models, except under task conditions (e.g., time constraints, instructions to take an inductive approach) that prime system 1 processing or that discourage override by system 2 (Markovits, Brunet, Thompson, & Brisson, 2013). At best, probabilistic accounts can model the generation of alternative antecedents where such is based exclusively in automatic retrieval processes exploiting associative connections in semantic memory. These accounts fail, however, in explaining the generation of alternatives through active search and inference, a capability that becomes possible in adolescence (Markovits, 2014b) and that constitutes an irreducible component of adult deductive reasoning (Markovits, Brisson, & de Chantal, 2015).

Conclusions

From within the split-mechanistic scientific paradigm, the principal theories discussed in this chapter appear locked in competition for the privileged status of constituting the one true account of the development of deductive reasoning. Competition is not without its merits. Each theory has benefitted from the need to respond to challenges posed by the other theories. Competition comes at a price, however. That price involves a loss of perspective and explanatory power. This chapter has argued for a different approach. From within the relational-developmental-systems paradigm (Overton, 2015), mental logic, metacognitive, and mental models theories constitute distinct yet complementary perspectives on the development of reasoning. Each theory offers a unique explanatory focus. These are, respectively, algorithmic competence, reflective competence, and computation in real time. Each focus is legitimate and necessary to a full understanding of how deductive reasoning develops.

Mental logic theory explains the development of reasoning in terms of emergent organizational properties of the algorithmic mind (Byrnes, 1988; Müller, Sokol, & Overton, 1999). Because development is an emergent process, some means of modeling spontaneous changes in organizational properties is essential to any fully adequate explanation of the development of deductive reasoning (Overton, 2015). Increasing organization and coordination of inference schemas becomes the investigative focus for this perspective. Metacognitive theory provides a key account of parallel developments in metalogical understanding within the reflective mind. Metacognitive theory makes clear how rationality as epistemic self-regulation emerges, with metalogical knowledge as a core component. Mental models theories are rich accounts of how advances in system 2 computational power, such as increasing working-memory resources, greater inhibitory capabilities, and improved processing speed and efficiency, provide an essential precondition for development by enabling an expansion of possibilities and their simultaneous consideration and integration (Barrouillet, 2011; Barrouillet & Lecas, 1999). Rapprochement requires that these computational advances be construed as necessary, but not sufficient, for the emergence of more complex organizations of inference schemas. To treat them as sufficient is to invoke the reductionist program of the split-mechanistic paradigm and to deny the legitimacy of the mental logic perspective. Mental models theory is also the best available explanation of real-time processing on deductive reasoning tasks. Initial models are represented through default, system 1 processing, with subsequent fleshing out of these models taking place through system 2 processing to the extent that available competence and resources allow.

Mental logic, metacognitive, and mental models theories each provide a stable base from which to conduct empirical inquiry into the development of deductive reasoning (Overton, 2015). While research, of necessity, must proceed from within a particular theoretical base, that base is best understood as constituting one of multiple, legitimate moments of analysis or lines of sight regarding the same phenomena (Overton & Müller, 2013). Each line of sight affords a unique explanatory focus that is irreducible and necessary to a full understanding of how deductive reasoning develops.

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14 Gender Development

A Relational Approach

Lynn S. Liben and Emily F. Coyle

Introduction

> When the big moment came, my daughter slid the knife into the cake, and before she could really reveal the interior to anyone, the knife emerged with blue icing. My son-in-law, David, who had firmly predicted a boy all along, immediately began jumping around with joy.
>
> (White, 2016)

Gender is a basic category of human identity and social interaction. Beginning early—sometimes even before birth (as in the cake-cutting event of a gender-reveal party described above)—human beings receive near-constant reminders of the gender category to which they were assigned at (or before) birth. Knowledge of a stranger's gender category and identity allows one to generate many successful predictions about that person's motivations, competencies, traits, interests, occupations, leisure activities, and domestic or relationship roles they pursue.

During early childhood, boys and girls play with different toys; they play in gender-segregated groups that differ not only with respect to which toys are used and with respect to the gender composition of the group, but also with respect to play styles. Boys, on average, play more with construction toys and more in rough-and-tumble, competitive games. Girls, on average, play more with domestic toys and in cooperative activities (Liben, Schroeder, Borriello, & Weisgram, in press). In elementary school, boys and girls begin to display emotions differently. For example, second-grade boys smile less than girls in photographs, exemplifying a gender difference in smiling and the display of emotion that has been observed in other settings and ages as well (LaFrance, Hecht, & Paluck, 2003). In adulthood, women do more childcare and housework (Pew Research Center, 2015), and even before they enact these differential roles, young girls and women expect that they will bear the primary responsibility for them (e.g., Coyle, Van Leer, Schroeder, & Fulcher, 2015).

Educational and occupational pursuits and achievements are also strongly gendered (Liben & Bigler, 2014). By high school, boys pursue a greater number of Advanced Placement (AP) examinations in science-related subjects than do girls (Liben & Coyle, 2014). By college, distributions across majors (and ultimately, occupations) are still striking. Majors like computer science are dominated by men nearly 4 to 1 (National Science Foundation, 2013). Social science majors like psychology are dominated by women more than 3 to 1. Women are much more likely than men to be grade-school teachers (84 percent female) and nurses (89 percent female), and men are more likely than women to be engineers (85 percent male) and construction workers (97 percent male; Bureau of Labor Statistics, 2015). Thus, despite dramatic historical changes in gender roles and behaviors, many experiences and outcomes remain highly gender-differentiated (Liben, 2016). This generalization holds both within the US (the context on which we focus in the current chapter) and across the globe.

At the level of description, there is generally agreement about the existence of gender differences like these (see reviews by Blakemore, Berenbaum, & Liben, 2009; Hines, 2015; Huston, 1983; Leaper, 2015; Ruble, Martin, & Berenbaum, 2006). At the level of explanation, however, there is far less consensus. Why do gender differences appear? What leads them to persist? What are the processes by which they may be modified? In this chapter we review ways that questions like these have been approached, and discuss illustrative empirical work. Although we provide overviews and examples from multiple traditions, as might be inferred from our chapter title, we emphasize work that is compatible with what Overton (2006) has labeled *Relational* rather than *Split* approaches. We hold that gender development, like other domains of human development, emerges from "relational processes in which child and context inextricably give and take meaning to and from one another" (Liben, 2014).

Following this introductory section designed to illustrate the power and scope of gender, in the next section, Theoretical Approaches to Gender Development, we overview three major approaches to gender development: essentialism, environmentalism, and constructivism. Given that our work falls primarily within the constructivist tradition, we expand on constructivist theories and describe illustrative research in the next section, Gender Development through Constructivist Lenses. In the final section, Reflections on the Study of Gender Development, we reflect on past work, and consider how Overton's analyses of meta-theoretical issues in developmental science (e.g., Overton, 2006, 2007, 2014, 2015) may inform future efforts to understand how gender changes in individuals across lifespans, and in societies across time.

Theoretical Approaches to Gender Development

Overview

Many different theories and models have been proposed to account for specific aspects of gender development such as the development of a personal sense of gender identity or persistence in a gender-atypical occupation. A review of these myriad theories, models, and specialized research areas is beyond the scope of a single chapter; more inclusive reviews may be found in volumes dedicated exclusively to gender development (Beal, 1994; Blakemore et al., 2009; Eckes & Trautner, 2000; Golombok & Fivush, 1994). Here our goal is to offer a brief conceptual review that introduces readers to basic concepts, issues, and methods of the domain and that thereby provides a foundation to explore more specialized interests. As in earlier work (Liben & Bigler, 2002), we organize our review of theories into three families—essentialism, environmentalism, and constructivism.

Gender Essentialism

Gender essentialism is an approach that takes male and female categories and their associated behavioral and physical gender-differentiated qualities as inherent in biology, and as pervasive and persistent across the life course. The appeal to biology may be made with respect to the biological makeup of the human species that has resulted from evolution, or with respect to the genetic makeup of the individual that has resulted from a unique ancestral history. Note that at neither species nor individual levels does a claim about biology imply that environmental processes are unimportant. What the species encounters (e.g., whether by changing climate patterns caused by asteroids slamming into Earth at the end of the Cretaceous era or by the burning of fossil fuels during the current Anthropocene) may necessitate adaptation, set the stage for differential survival, and ultimately change the gene pool. What the individual

person encounters (e.g., good or poor nutrition; sensitive versus abusive parenting) may affect genomic expression via epigenetic processes (e.g., Greenberg, 2014).

Although essentialist positions do not, then, necessarily assert that biology is the *only* factor that affects outcomes, they do include the notion that once one has identified someone as a member of some category, one automatically knows something important, profound, and pervasive about that person (see Fine & Duke, 2015; Gelman, 2003; Gelman & Taylor, 2000). In common parlance, essentialists may express this biological foundation by the phrase "It's in their/my/our DNA." To illustrate from a non-gender domain first, consider a quotation from Brad Pitt (n.d.):

> America is a country founded on guns. It's in our DNA. It's very strange but I feel better having a gun. I really do. I don't feel safe, I don't feel the house is completely safe, if I don't have one hidden somewhere. That's my thinking, right or wrong.

Within the domain of gender, there are plentiful and equally dramatic illustrations of essentialist positions. It is perhaps less surprising to see such views in historical writings than in contemporary writings, but examples abound in both (Liben, 2015, 2016).

At the start of the twentieth century, for example, William DeWitt Hyde, educational philosopher and then-president of Bowdoin College, argued that boys and girls differ fundamentally. He argued that in educational, occupational, and even domestic contexts, girls and women are intellectually "receptive" whereas boys and men are intellectually "productive," stating further that: "This differentiation is a decree of nature, and one which it is useless for us to fight against, and highly profitable for us to recognize" (W. Hyde, 1906, p. 207).

At the start of the twenty-first century, parallel arguments are found in the writings and presentations of Michael Gurian and Leonard Sax, two ardent proponents of single-sex schooling. Sax, for example, has been quoted as saying that "human nature is gendered to the core" (Weil, 2008, p. 43), a textbook example of essentialist thinking, although Sax himself has denied the label (Weil, 2008). These essentialist positions become foundations for gender-segregated education. For example, beginning with the essentialist claim that "Boys are boys and girls are girls," Sax asserts that "the best way to get girls excited about quantum mechanics turns out to be quite different from the best way to get boys excited about quantum mechanics" (Sax, n.d., History section, para. 6). Sax argues that boys' and girls' differential sensitivity to heat and sound means that they should be educated in separate classrooms in which thermostats and teachers' voice-volumes can match students' needs. He also claims that different pedagogies are needed because boys and girls respond differently to stress. That is, because boys are aroused by stress, teachers should act aggressively toward them, for example by moving up close and shouting, "What's your answer, Mr. Jackson? Give it to me!" (Sax, 2006, p. 193). Because girls, in contrast, freeze from stress, Sax recommends using a soft and gentle approach, as in "Lisa, sweetie, it's time to open your book. Emily, darling, would you please sit down for me and join us for this exercise?" (p. 195). Similar claims are made by Gurian in recommendations to teachers, parents, and school boards (see Liben, 2015).

Gender Environmentalism

In contrast to the essentialist notion of inherent qualities that are rooted in the organism and unfold naturally and pervasively across the life course, gender environmentalists view most gender distinctions—like most behaviors—as the result of experiential histories (e.g., Bijou & Baer, 1961). In this view, children develop gender-normative behavior because of the environmental contingencies they experience. Children are reinforced (e.g., by praise, acceptance, attention) when they act in ways that are congruent with cultural gender norms

(e.g., when a young girl dons high-heeled shoes, a purse, and makeup from the dress-up corner of her preschool classroom, or arrives at school in a pink, sequined tee-shirt); they receive no comparable reactions when they appear or act in gender-neutral ways. Children encounter punishments such as disapproving comments or taunting when they act in counter-normative ways (e.g., as when a boy who arrives at the dinner table wearing nail polish is sent to his room to remove it and, perhaps, to miss dinner).

In addition to suggesting differential reward and punishment in response to gender-normative versus non-normative behaviors, social-learning theory (SLT) also posits differential reward and punishment for imitating own- versus other-gender models. Thus, girls are more likely to imitate girls and women while boys are more likely to imitate boys and men (Bandura, Ross, & Ross, 1961; Bussey & Bandura, 1984, 1999). Insofar as children tend to encounter others (peers or adults) who are themselves gender-conforming, children are likely to imitate behaviors that are traditionally associated with their own gender.

Just as those espousing essentialist theories do not necessarily dismiss the contributions of experience, so, too, those espousing environmentalist theories do not necessarily deny the contributions of other processes. Indeed, theorists working within the environmentalist tradition have long acknowledged the relevance of cognitive processes. One of the first social-learning theorists to address gender development, Walter Mischel, suggested that the difference between learning and cognitive approaches to gender development is less about the judged reality or relevance of cognitions than it is about the preferred foci of scientific inquiry. He wrote: "It is often mistakenly assumed that social-learning theories deny the existence of mediating cognitive processes. Men and women, as well as boys and girls, do think. They experience wishes, fears, and hopes; they even dream" (Mischel, 1966, p. 61). He continued by suggesting that the key contrast between the foci of social-learning theorists versus the foci of more cognitively oriented theorists (discussed later within the constructivist approach) was with respect to the "referents selected for the analysis of behavior. In the present [SLT] formulation, discriminable antecedent events, rather than inferred intrapsychic activities, are used to predict and analyze behavior" (p. 62).

More recently, scholars working within the framework of SLT have expanded their scientific work to incorporate individuals' cognitions in their analyses of gender development. This expansion is most readily apparent in the variant of SLT developed by Bandura (1992) referred to as social cognitive theory (SCT). For example, in the course of discussing the meaning of the SCT label, Bandura and Bussey (2004) wrote that "the *social* portion of the title acknowledges the social origins of much human thought and action; the *cognitive* portion recognizes the influential contribution of thought processes to human motivation, affect, and action" (p. 693, emphases in original).

One of the significant child-driven processes identified by Bussey and Bandura (1999) is the child's own role in determining which environments are encountered (hence affecting what a given child actually experiences). That is, although children are passive recipients of experiences they have in contexts over which they have little control (e.g., children are relatively powerless to choose their homes or schools, their parents or teachers), they are active in selecting some environmental settings (e.g., whether they attend ballet or martial arts classes) and relational partners (e.g., whether they play with gender-conforming or non-conforming peers). Selections like these have an impact on the skills children learn, the contingencies (reinforcements or punishments) they receive from those around them, and the models they have an opportunity to imitate. In addition to acknowledging the impact of children's selections of social partners and environments, Bandura (2001) has increasingly acknowledged the role of individuals' self-efficacy beliefs (or other internal, person-level motivations). Individual differences in motivations that affect one's willingness to engage in or persist in various activities can also affect what is taken from any given interaction and environment.

Gender Constructivism

Constructivist approaches to development of gender—like constructivist approaches to development in any other domain—emphasize the active, self-directed contributions that individuals make to their own developmental outcomes. In this view, gender-differentiated outcomes cannot be explained as the result of the automatic execution of some biologically determined process, or as the consequence of the accretion of environmentally provided experiences. Instead they are understood as what the individual constructs or builds from selecting, engaging with, interpreting, storing, and using the environmental aliment. More detailed descriptions of this family of theories and related empirical work are provided below.

Gender Development through Constructivist Lenses

The study of gender development within the constructivist tradition is rooted in early writings of Piaget and Kohlberg. Although core ideas from this early work have been retained in contemporary scholarship, newer theories and models have extended the original formulations. Below we highlight historical and contemporary theories, and describe illustrative empirical work grounded within each.

Cognitive-Developmental Stage Theory

The classic constructivist approach to gender development was formulated by Kohlberg (1966). Like Piaget on whose theory he built, Kohlberg emphasized the child's underlying cognitive achievements as primary. He argued that "Sex-role concepts and attitudes change with age in universal ways because of universal age changes in basic modes of cognitive organization" (p. 83). Kohlberg focused on the ordered emergence of three gender-related concepts: *gender identity*, *gender stability*, and full *gender constancy*. The first of these was simply children's knowledge of being a boy or a girl, marked by their success in applying the terms boy or girl to themselves correctly; that is, matched to birth gender. (Note, therefore, that Kohlberg's use of "gender identity" means only the correct labeling of gender, not—as the term is often used—to refer to someone's personal identification with, or sense of belonging to, one's gender group.)

In Kohlberg's theory, the child's gender identity is thought to be foundational. Having established that gender identity correctly (typically by the age of 2 or 3 years), children are motivated to take on or enact qualities associated with their gender. For a boy, this sequence would be: "I am a boy, therefore I want to do boy things, therefore the opportunity to do boys things (and to gain approval for doing them) is rewarding" (Kohlberg, 1966, p. 89). Kohlberg explicitly saw his proposed sequence as different from the one suggested by social-learning theorists that he summarized as: "I want rewards, I am rewarded for doing boy things, therefore I want to be a boy" (p. 89). In short, the cognitive-developmental view is that the child's recognition of gender comes first and motivates the child to learn and assume culturally defined gender roles. In contrast, the SLT view is that the child first experiences environmental contingencies that differ as a consequence of the child's observable gender, and these experiences lead the child to infer and thus embrace the correct (birth-assigned) gender identity.

It takes several more years for children to develop gender stability, that is, the understanding that gender persists across time and thus that boys necessarily grow into men and girls necessarily grow into women. It bears saying explicitly that both Kohlberg's theory and our descriptions of it reflect the adult understanding of gender that was normative at the time. It is beyond the scope of the current chapter to address the important and as yet insufficiently studied theoretical and practical developmental implications of changes in the way that many adults now conceptualize, enact, and change gender (see, for example, Keener, 2015).

The final stage of gender development, typically achieved by 6 or 7 years, is *gender consistency* (sometimes labeled *gender constancy*, which is confusing because the latter term is often used to encompass all three components as a whole). Gender consistency is the understanding that gender is stable even in the face of physical transformations, traditionally assessed by asking children if changes in appearance (e.g., in clothing or hair) transform one's gender. Consistent with grounding his theory of gender development within cognitive-developmental theory, Kohlberg viewed the young child's emerging understanding of gender constancy as another instance of the young child's emerging understanding of conservation more generally (e.g., conservation of mass).

Gender Schema Theory (GST)

The constructivist theories that followed Kohlberg assigned a central role to *gender schemas*, defined as "cognitive structures that organize an individual's gender-related knowledge, beliefs, attitudes, and preferences" (Liben & Signorella, 1993, p. 141). Particularly influential was gender schema theory (GST) proposed by Martin and Halverson (1981). They argued that children's decisions about whether to approach or avoid something available in the environment depended on two kinds of cognitions. One concerned knowledge about what is defined in their culture as "for boys" and "for girls." The second concerned one's self-identification as a boy or girl. Faced with, for example, a doll, a boy could be expected to reason, "Dolls are for girls; I am a boy; thus this doll is not for me," thus leading him to avoid the doll. The inverse would happen when the boy encountered a toy truck. Martin and Halverson argued that reasoning like this would, over time, increase gender differentiation because boys and girls would repeatedly engage with different objects and activities, thereby developing and refining different interests and skills. For example, boys' greater engagement with vehicles could be expected to foster mechanical interests and skills while girls' greater engagement with dolls could be expected to foster domestic interests and caretaking skills.

Dual Pathway Model (DPM)

Given that data demonstrate that even very young children are highly knowledgeable about what is culturally considered to be appropriate for girls versus boys (e.g., Signorella, Bigler, & Liben, 1993), and given that (as reviewed above in the context of Kohlberg's work) children identify themselves as boys or girls from a very young age, Martin and Halverson (1981) presented GST as a general model of children's constructive processing. A later constructivist model—the dual pathway model (DPM, Liben & Bigler, 2002)—extended this general approach by explicitly specifying individual differences in the model. Specifically, DPM posited that gender-schematic processing was influenced by: (a) the strength of the child's stereotypes (i.e., how strongly the child endorses—not merely knows—gender stereotypes); (b) the child's particular profile of interests and talents, referred to as an interest filter (especially powerful when such interests and talents are gender-nontraditional as when a boy has a penchant for ballet or the harp); and (c) the strength of the child's general attention to gender, referred to as a gender salience filter (e.g., routinely noticing the gender of someone engaged in a particular activity).

In addition, and as tagged by the word "dual" in the model's label, DPM specified two pathways along which gender cognitions and behaviors are modified over time. One, the attitudinal pathway, was like that proposed in other schematic processing models (Bem, 1981; Martin & Halverson, 1981) insofar as it proposes that schematic gender attitudes about what is appropriate for girls versus boys in general influence the child's own behaviors in

particular (i.e., an "other-to-self" pathway). The second, the personal pathway, proposes a complementary and simultaneous pathway in which children's own qualities and behaviors affect their attitudes about others (i.e., a "self-to-other" pathway). Illustrating this pathway are longitudinal data reported by Liben and Bigler (2002) showing that boys who initially—early in grade 6—endorsed a relatively greater number of traditionally feminine traits as self-descriptive, later—at the end of grade 7—reported significantly more egalitarian attitudes about traits than did other boys.

Developmental Intergroup Theory (DIT)

A later theory—developmental intergroup theory (DIT, Bigler & Liben, 2006, 2007)—like other constructivist theories emphasizes how individual children's qualities contribute to the construction of gender. However, DIT is also more explicit about the importance of what children's constructive processes are constructing *from*. In other words, DIT also addresses qualities of the social and physical context. The theory was developed as a way to understand the formation and modification of social stereotypes and prejudices with respect to social-group categories in general, and is thus relevant for race, ethnicity, nationality, religion, socioeconomic status, as well as the topic of interest here, gender. A basic premise of DIT, drawn from social identity theory (Tajfel & Turner, 1986), is that individuals are motivated to identify with and feel positively toward their own groups ("ingroups"), thereby setting up conditions for rejecting and feeling negatively toward others' groups ("outgroups"). But on what basis are own- and other-groups defined?

Rather than accept the premise that humans are hardwired to pay attention to some particular human qualities (e.g., skin color, secondary sex characteristics, see Geary & Bjorklund, 2000), DIT instead proposes that as children interact with the surrounding social context, they apply their constructive reasoning processes to infer what human qualities are important in that context. Such qualities then become the basis for categorization. DIT identifies four conditions that increase the probability that a particular quality will become psychologically salient, including that the quality is visibly distinct, unevenly distributed, explicitly labeled, and appears to be used implicitly to sort people, but without explanation.

As applied to gender, these four conditions mean that gender-based categorization may be expected to be stronger for children in contexts that (a) exaggerate observable differences between males and females (e.g., by socializing gender-specific hairstyles, clothing, or cosmetics), (b) use more highly gender-differentiated language (e.g., gender-differentiated pronouns, given names, occupational titles), (c) explicitly use gender as the basis of assignment to activities or facilities (e.g., boys' versus girls' soccer teams, scout troops, choirs, or rest rooms), and (d) display gender-differentiated groupings that are otherwise unexplained (e.g., the gender of all US Presidents to date).

The identification of a human quality as an important one for categorization is only the first step in developing stereotypes and prejudices. As explained in more detail in the original presentation of the theory (Bigler & Liben, 2006, 2007), DIT includes the proposition that once a human quality has become psychologically salient, that quality is used as a basis for categorizing people into groups, a cognitive process motivated by a drive to reduce cognitive complexity. Once groups are in place, two other child-driven processes are engaged. One rests in the essentialist nature of children's thinking which leads children to presume that members of the same group necessarily share multiple characteristics (Gelman, 2003). The second is ingroup bias which is a self-enhancing psychological mechanism leading people to associate positive traits with their ingroup, and negative traits with the outgroup. Additionally, children's stereotypes and prejudices may be exacerbated if they are exposed to

explicit stereotypic statements (as when boys and girls, or men and women make wisecracks about members of the other category).

As should be evident from the discussion of the various processes, DIT is a good representative of the constructivist theoretical family insofar as children are understood to have an active role in creating ingroups and outgroups that in turn lead them to form stereotypes and prejudices. At the same time, it should be clear that it is not the child, alone, who is responsible for the way that gender categories are developed and used, making it an especially good example of a relational approach. In the next section we illustrate how DIT and other theories have been studied in empirical work.

Illustrative Empirical Work

A Sampling of Early Research

The 1960s marked the start of a rich period of empirical work on gender development. In part, the surge in interest can probably be traced to the political climate at the time in which various civil rights issues, including those related to gender, were receiving general attention (see Liben, 2016). In part the surge can probably be traced to the publication in 1966 of a volume edited by Eleanor Maccoby—*The Development of Sex Differences*—that contained (among other contributions) those by Mischel (1966) and Kohlberg (1966) discussed earlier. Researchers soon began to study basic concepts from these theories, studying, for example, the stages and consequences of gender constancy (e.g., DeVries, 1969; Marcus & Overton, 1978; Slaby & Frey, 1975).

The 1970s and 1980s saw studies addressed to the proposal that children's own gender schemata affect their processing of gender-relevant material and their willingness to engage with it. With respect to the former, for example, investigators demonstrated that children—especially those with particularly strong gender stereotypes—found it difficult to remember gender-nontraditional material at all, or if they did, distorted it (e.g., Koblinsky, Cruse, & Sugawara, 1978; Liben & Signorella, 1980). For example, a picture of a woman dentist might be forgotten entirely or misremembered as a hygienist. With respect to engagement, investigators demonstrated that children respond differently to toys depending on the toys' cultural link to gender. For example, Stangor and Ruble (1989) found that children preferred toys labeled as for their own gender.

During the 1990s, investigators used intervention designs to test the power of hypothesized constructive processes. For example, to test the proposal that gender schemas underlie children's difficulty recalling nontraditional materials, researchers intervened to change children's gender schemas, and then tested whether children's memories were affected accordingly. Illustratively, Bigler and Liben (1990) gave some elementary-school children classroom lessons to teach them that jobs do not depend on the worker's gender, but instead on training and skills. Children in the experimental group who learned these rules were later found to remember gender-nontraditional stories better than did children in the control group who had been taught about jobs, but without instruction about the irrelevance of gender.

As can probably be inferred even from these abbreviated descriptions, it would be impossible to provide an exhaustive review of gender-development research from the last half century. Thus, instead of attempting to provide one, we have selected three studies from our own recent work with preschool children that concretize some of the key concepts from the constructivist theories discussed above, and provide grist for discussions of meta-theoretical analyses in the concluding section.

Individual Differences and Intervention Effects

The first illustration (Coyle & Liben, 2016) is a study that was designed to test the hypothesized role of individual differences as proposed in the dual pathway model (DPM). We tested the importance of one such individual difference variable—the gender salience filter (GSF)—by studying preschool girls' responses to a computer game about occupations. Girls were first pretested for their routine attentiveness to gender. They were also pretested for their interests in various masculine and feminine activities. Two weeks after pretesting, they met with a different investigator to play a computer game in which a feminine character enacted a series of occupations, including some traditionally held by men (e.g., chemist). To test the power of the relative femininity of the character, some children were given the game with a highly feminized character (*Barbie*), and others were given the game with a less feminized character (Playmobil *Jane*). After playing the game, girls were again given the activities measure and a measure of their occupational interests.

Data showed that playing the game with either Barbie or Jane in no way overcame girls' traditional preference for stereotypically feminine over stereotypically masculine jobs. There was, however, evidence that playing the game affected girls in other ways. Specifically, those girls who (a) routinely pay attention to gender (i.e., high-GSF girls) and (b) had been assigned to play with the Barbie version of the game later showed intensified interests in traditionally feminine activities. From a theoretical perspective, the findings are important demonstrations that individual differences affect the way that constructive processes operate on environmental experiences. From a practical perspective, the data are important in showing that using hyper-feminized models with the goal of promoting girls' interests in masculine behaviors may well backfire, and instead result in increasing those girls' desire to pursue traditionally feminine activities. The next empirical example also challenges the assumption that simply exposing children to nontraditional activities will necessarily have the desired effects.

Play Experiences and Outcomes in Relation to Marketing and Parenting

The second empirical illustration (Coyle & Liben, 2015) also involves preschoolers' play with a toy that was explicitly designed to attract girls to a traditionally masculine field, in this case engineering. The toy used was the first in a series of *GoldieBlox* toys that involves a female character named Goldie and poses mechanical challenges for players. In the particular set we used, *Goldie Blox and the Spinning Machine*, Goldie is led via a book narrative to learn how to assemble a belt drive to spin first, her dog, and then to spin additional animals in either the same or in opposite directions. Because we wanted to distinguish between behaviors that might be related to the masculine nature of the activity—mechanics—from the feminine gender of the character in the engineering narrative—Goldie—we created a masculinized version of the toy, *Bobby Blox and the Spinning Machine* (e.g., substituting Bobby for Goldie in all graphics and text, using masculine rather than feminine pronouns, and replacing the pink "belt" of the belt and axle supplies with a dark-green one).

At the most general level, our goal was to explore how preschool boys' and girls' engagement with and learning from toys may reflect not only those children's relatively static repositories of cultural knowledge about gender (i.e., their gender schemas), but may also reflect influences of the ecological system more broadly (e.g., parental behaviors which are themselves influenced by gender schemas and experiences; marketing in the still broader society). Our key interests were in how children would play, what they would learn, and how they would like the toy in relation to the toy's gender packaging (i.e., Goldie versus Bobby). Additionally, we were interested in how mothers would react

to the toy themselves, how they would guide dyadic play with their sons or daughters, and whether these would differ by toy version as well.

Mother–child dyads were invited to participate in a study on play, and were randomly assigned to receive either *GoldieBlox* or *BobbyBlox* versions of the toys. Mothers were given about 5 minutes to familiarize themselves with the toys on their own. Dyads then played together, and finally, children played with the toy alone. Children were tested for mechanical learning at post-test. Among the results was the finding that from the outset, mothers played differently with the toy depending on which of the two toys they had been given, building significantly more with *BobbyBlox*. During dyadic play, mothers guided play differently depending on their child's gender—they focused on reading the book with daughters and on demonstrating building assembly with sons. Particularly interesting (and unpredicted) was the finding that girls learned more from playing with *BobbyBlox* and boys learned more from playing with *GoldieBlox* (Coyle & Liben, 2015), perhaps because having a mismatched character may have led them away from their well-rehearsed normative play scripts and toward attending to the toy's informative book. This set of findings has implications for education, toy marketing, and constructive processing, but more generally is a reminder of the need to examine children as part of a broader relational system.

Constructive Processes and Classroom Contexts

The third illustrative research example was a study that was explicitly designed to test predictions derived from developmental intergroup theory (Hilliard & Liben, 2010). The key question addressed was whether there would be observable changes in preschoolers' gender stereotypes and engagement with own- versus other-gender children in response to a change in the salience of gender in their classroom. To answer this question, we asked teachers assigned to the experimental group to increase their use of gender-differentiated language (e.g., saying "Good morning, boys and girls [rather than children]" or "Could I please have a girl [rather than a student] take this note to the office?"). We also asked teachers to make explicit divisions based on gender (e.g., asking girls and boys to post their work on different bulletin boards and to line up separately to go to lunch). We explicitly asked experimental-group teachers to avoid setting up comparisons or contests (e.g., to avoid comments such as "Let's see who can clean up first, the boys or the girls"). Teachers assigned to the control group were asked to continue their normal school policy which was designed to minimize the use of gendered language or divisions. Both before and after two weeks of this classroom manipulation, children were interviewed to assess their endorsement of cultural gender stereotypes. In addition, they were observed during normal free-play periods during the school day to tally how much they played with children of their own and the other gender.

The data from both measures showed striking group differences. Whereas the children in the control classrooms showed no change whatsoever in either gender stereotyping or play patterns, the children in the experimental classrooms showed striking and significant changes in both. First, after the two weeks, the experimental-group children endorsed a significantly higher number of cultural stereotypes (e.g., saying that "only women should be nurses"). Second, these children showed a significant drop in the number of other-gender children with whom they played.

These findings are consistent with the particular hypotheses generated by DIT. Children apparently used their cognitive processing skills to infer from their teacher's use of gender-specific language and gender-based divisions that gender must be an important category for thinking and action. Experimental-group teachers even reported anecdotes about children's behaviors that suggested that the children themselves began to use gender functionally.

The findings from this study thus join with those discussed earlier to demonstrate that children are active processors of what they have available in the surrounding context. Collectively, the theoretical and empirical work discussed throughout this chapter makes it clear that gender development involves complex contributions from children, their families, media, and peers, to name only a few instances. In our concluding section, we reflect on this complexity through meta-theoretical lenses.

Reflections on the Study of Gender Development

In this final section, we comment briefly on what past theoretical and empirical work on gender development has offered when viewed from the perspective of conceptual analyses of scholarship in human development more broadly.

The last century has seen important changes in the way that gender develops and matters for developmental outcomes, but it has also seen signs of surprising stability (Liben, 2016). In academia, there has been ever more detailed documentation of gender-related differences in a range of domains—neurological, cognitive, socioemotional, and interpersonal. At the same time, however, there continues to be little agreement about how meaningful (and in many cases, about how real) these gender differences are, and about whether the differences that do exist are natural and desirable or are instead the product of unnecessary and constraining socialization practices.

Although public media and the lay public continue to paint the issue as "Is it nature or nurture?," few scholars promulgate single-explanation answers. Sameroff (1975) referred to such explanations as "main effect" models; that is, models that attribute developmental outcomes exclusively to biology or environment. Although he more recently discussed the historical pendulum swings between emphases on biology versus environment (Sameroff, 2010), virtually no serious scholar has argued for either of the two extreme positions. Indeed, as far back as 1958, Anne Anastasi argued that the appropriate question about heredity and environment was no longer "Which?" or even "How much?" but rather "How?"

Posing the question in this way, however, does not necessarily bring all theorists and researchers into agreement. It is in this context that we turn to Overton's writings that identify meta-theoretical assumptions and commitments in theoretical and empirical programs in developmental science (e.g., Overton, 2006, 2007, 2013, 2014, 2015; Overton & Reese, 1973; Reese & Overton, 1970). We use, in particular, Overton's distinction between *Cartesian-Split-Mechanistic* and *Process-Relational* metatheories or worldviews—conceptual contexts within which ideas and empirical research emerge and progress. The split metatheory is "based on a view of the world as decomposable into a foundation of fixed pure forms" while the relational metatheory is grounded in "a view of the world as a series of active, ever-changing forms" (Overton, 2006, p. 19).

Among other points, Overton (2007, p. 156) argues these worldviews entail differing beliefs about where one looks for, and what one accepts as explanation. "Split metatheories are based in Cartesian thought, which divides the world into dichotomous either/or propositions (e.g., nature or nurture, or some additive combination of the two)." They carry the assumption that there is some "ultimate absolute real." Thus in this worldview, explanation relies on finding atomistic, elementary, reductionist bedrock units from which all apparently higher, more complex processes are derived. In contrast, Overton continues, "Relational metatheories are post-Cartesian and inclusive." Rather than rejecting mental constructs, organization, or structure as ephemeral, the relational metatheory embraces them. "Relational metatheories aim to transform classically fundamental dichotomies into indissociable complementarities through the relational principles of holism, identity of opposites, opposites of identities, and syntheses of wholes."

The notion of synthesis entailed in relational systems is more than an additive combination of isolated factors. It is thus not simply that it is necessary to include both A and B as independent contributors in one's explanatory account. Rather, it is necessary to appreciate that what A *is* (now perhaps better written as A′) emerges from its relation with B (and, of course, the inverse; that is, with B′ emerging from its relation with A).

As an example, we refer back to DIT (Bigler & Liben, 2006, 2007) that Overton (2014) characterized as a "developmental science theory formulated within the process-relational paradigm and RDS [relational developmental systems] metamodel" (p. 327). As described earlier, DIT argues that children's constructive processes act on and in the environments surrounding them. To illustrate this point concretely, we return to the study by Hilliard and Liben (2010) in which experimental preschool teachers were asked to increase the use of gender in their classrooms while control teachers were asked to maintain their normal (minimal) attention to gender. As described earlier, results were dramatic. After merely two weeks, children in the experimental classes showed a significant increase in their endorsement of gender stereotypes and a significant decrease in play with children of the other gender. There was no change on either outcome among children in the control classes. These findings are consistent with predictions from DIT, and more generally demonstrate the importance of studying children in context, rather than presuming that constructivist processes are motivated by universal and pervasive processes.

Reflecting on this study in the context of Overton's meta-theoretical analyses of relational developmental systems, it becomes apparent that the primary focus in the preschool study was on individual children. For example, it is children who were assessed for their stereotypes, it is children who were observed during play, and it is child-level data that were analyzed and displayed in the bar graphs in the report of the results (Hilliard & Liben, 2010). What has been less systematically measured or reported are the dynamic relational processes themselves; that is, what was found at the child ↔ context nexus. It would, however, be possible to shine the light more directly on these processes. For example, although the change in playmate gender was examined at the level of individual children, one could instead examine this change at the level of the classroom. The finding that individual children in the experimental classrooms rarely played with children of the other gender during free-play periods must have meant that play groups in experimental classrooms were more gender-segregated than those in control classrooms. Children in experimental classrooms must therefore have observed as well as experienced largely single-gender peer groups, thereby fostering gender-differentiated development even further (e.g., see Martin, Fabes, & Hanish, 2014).

A more dynamic look at the child ↔ context nexus could come from systematically observing behaviors that so far have been reported as anecdotes, as when, for example, Hilliard and Liben (2010) reported that one of the teachers in an experimental classroom "noted that on the second day of the manipulation, without prompting from her, children established separate boys' and girls' snack tables" (p. 1796).

In closing, it is important to recognize that determining whether a given program of work reflects split versus relational worldviews requires more than noting whether the work focuses on biology, environmental contingencies, or self-driven constructive processes. These are all important in human development. Although each (including constructive processes) can be conceptualized and studied as if it supplied the knowable, bedrock, atomistic units that can be assembled into and used to explain all else, they need not be so used. They can instead be understood within a relational developmental framework in which complex processes converge and affect one another. Putting in, and pulling out, a single knife into a single spot in a single gender-reveal cake offers a far too limited slice of data to understand the life of the awaiting neonate. Studying isolated constructs in artificial environments can do no better in revealing the process of gender development.

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15 Positive Youth Development

Applying Relational Developmental Systems Metatheory to Promote Thriving

Jacqueline V. Lerner and Kristina Schmid Callina

Interests in the strengths of youth, the relative plasticity of human development, and the concept of resilience coalesced in the 1990s to foster new ideas about positive youth development (PYD; Lerner, Lerner, Bowers, & Geldhof, 2015).[1] As discussed by Hamilton, Hamilton, and Pittman (2004), the concept of PYD has been understood by developmental scientists, educators, practitioners, parents, and others in at least three interrelated ways: 1) as a developmental process; 2) as a philosophy emphasizing the strengths of youth, as opposed to the traditional deficit model of adolescence; and 3) as the set of practices of youth programs and organizations focused on fostering the healthy or positive development of youth.

The three uses of PYD outlined by Hamilton and colleagues (2004) signified the potential for PYD to shape policy and programming for youth. However, theories of PYD were first needed to frame descriptive, explanatory, or intervention/optimization research across the adolescent period. Since the late 1990s, researchers in the fields of psychology and human development have proposed several different models of the developmental processes believed to be involved in PYD (e.g., Benson, 2008; Benson, Scales, & Syvertsen, 2011; Catalano et al., 2004; Damon, 2008; Eccles, 2004; Eccles & Wigfield, 2002; Flay, 2002; Flay & Allred, 2003; Larson, 2000; Lerner et al., 2005, 2015; Masten, 2001, 2014; Spencer et al., 2015). Despite some variation in the particular variables used to study PYD across the different models, all of the models articulate a strengths-based approach to understanding adolescent development; the role of the individual in shaping his or her developmental trajectory; and a goodness-of-fit between individuals and their contexts that capitalizes on young people's strengths and agentic capacities and allows them to thrive. PYD models therefore reflect contemporary ideas of human development, as they are all embedded within the overarching process-relational paradigm of developmental science and the relational developmental systems (RDS) metatheory derived from it (e.g., Overton, 2015).[2]

In this chapter, we provide an overview of the RDS metamodel, and discuss its importance for framing PYD theory, research, and programming. As a sample case of RDS-based PYD models, we will discuss the formulation that has the most extensive empirical support: the Five Cs Model of PYD (Heck & Subramaniam, 2009; Lerner et al., 2015). Discussion of the Five Cs Model will enable us to describe what is known and what remains to be discerned about PYD among adolescents. Finally, we discuss the burgeoning research on extensions of the PYD model beyond adolescents to children and young adults, including several new studies of character virtue development. We conclude this chapter by pointing to important methodological issues to be addressed in future PYD research.

The Relational Developmental Systems Metatheory

From the late 1960s through the early twenty-first century, the study of human development evolved from a field dominated by split, reductionist (psychogenic or biogenic)

approaches to a multidisciplinary and interdisciplinary scholarly domain. The goal of this new scholarship has been to integrate variables from biological through cultural and historical levels of organization across the life span into a developmental system of mutually influential relations (e.g., Elder, Shanahan, & Jennings, 2015). Prior reductionist accounts of development that adhered to a Cartesian dualism pulled apart, or split, facets of the integrated developmental system (Overton, 2015). For instance, reductionist views typically elevated the importance of such split formulations as nature versus nurture, continuity versus discontinuity, stability versus instability, and basic versus applied science (Lerner, 2002, 2012). Science that proceeds from such reductionist views often concerns itself with identifying singular "mechanisms" that can explain complex behaviors, such as whether particular genes cause delinquency among adolescents.

In contrast, proponents of RDS metatheory reject such split approaches to human development. These scholars recognize that theories of human development should be integrative rather than reductionist to be most useful in explaining and predicting developmental phenomena, and in optimizing individuals' chances for positive development. RDS metatheory is derived from a process-relational paradigm (Overton, 2015), in which the organism is seen as inherently active, self-creating (autopoietic), self-organizing, self-regulating (agentic), nonlinear/complex, and adaptive (Overton, 2015). Science that proceeds from a process-relational paradigm seeks to understand developmental processes within a system and the role of the individual in directing such processes. To illustrate, within a process-relational paradigm, research on delinquency among adolescents might investigate diverse developmental trajectories that predict delinquent behaviors, as well as the role of individuals' agency in committing such behaviors or the threats to self-regulatory processes that are associated with maladaptive functioning (Champine, in press).

Within the RDS metatheory the integration of different levels of organization frames the understanding of life-span human development (Overton, 2015). The conceptual emphasis in RDS-based theories is placed on mutually influential person ⇔ context relations that vary across place and time (Elder et al., 2015). The "arrow of time," or temporality, represents history, which is the broadest level within the ecology of human development. History imbues all other levels with change. Such change may be systematic, or it may be stochastic (random), such as when non-normative life or historical events alter the course of development (Baltes, Lindenberger, & Staudinger, 2006).

The potential for systematic change constitutes a potential for (at least relative) plasticity across the life span. As explained by Lerner (1984), the concept of plasticity was emphasized by developmental scientists who were interested in countering the idea of fixity in human development. This idea that developmental pathways are fixed, such as by genetic inheritance or neuronal "hard wiring," is a primary example of reductionist views that contemporary, RDS-based developmental science seeks to counter. Accordingly, the idea of plasticity arose to communicate the capacity in human development for systematic and relatively continuous changes across the life span. Such systematic change can arise through individual ⇔ context relations that are either ontogenetically or historically normative, or from non-normative life or historical events (Baltes et al., 2006).

In sum, contemporary developmental scientists subscribe to a process-relational paradigm (Overton & Molenaar, 2015), and the models derived from the RDS metatheory emphasize that all levels of organization within the ecology of human development are systemically integrated across life. Any variable from any level is embodied in, or fused with, variables from all other levels. In other words, the structure and function of one variable is governed or regulated by the structure and function of other variables. Accordingly, developmental *regulations*—not genes, neurons, or any other specific component of the biological or social world—are the basic unit of analysis within human development.

Moreover, the temporality of the ecological systems model imbues all of the other levels with change (Elder et al., 2015). Therefore, individual ⇔ context relations have the potential for relative plasticity in human development.

Developmental scientists, guided by the RDS perspective, should be optimistic that they can help find—or create—mutually beneficial person ⇔ context relations to promote more positive human development among all people, and to promote social justice by providing opportunities for all individuals to optimize their chances for positive, healthy development (Lerner & Overton, 2008). Such promotion and optimization efforts require multidisciplinary research, the use of change-sensitive methods, and the translation of research into policies and programs.

We noted that there are several models associated with RDS-based ideas that have been used to study processes pertinent to, or explicitly about, PYD (e.g., see Lerner et al., 2015, for a review). As also noted, however, the Lerner and Lerner (Lerner et al., 2015) Five Cs Model of PYD has been tested more thoroughly than any other PYD model. Thus, the Five Cs measures ("competence," "confidence," "character," "caring," and "connection") have become widely used to inform PYD programming and evaluation, and to assess PYD outcomes.

PYD: The Five Cs Model and Youth Development Programs

A key, sample case of the application of the RDS metamodel is the Lerner and Lerner formulation of PYD (Lerner et al., 2015), of which the Five Cs are a component. This model has been developed specifically for understanding developmental processes among adolescents, a period of life marked by quantitative and qualitative changes, changes that make the second decade of life an ideal "ontogenetic laboratory" to study individual ⇔ context relations as bases of change (Lerner & Steinberg, 2009). As is the case with all RDS-based PYD models (see, for example, Benson, 2008; Benson, Scales, & Syvertsen, 2011; Catalano et al., 2004; Damon, 2008; Eccles, 2004; Eccles & Wigfield, 2002; Flay, 2002; Flay & Allred, 2003; Larson, 2000; Lerner et al., 2005, 2015; Masten, 2001, 2014; Spencer et al., 2015), the Lerner and Lerner conception is a strength-based model of development that seeks to understand and enhance the lives of diverse adolescents through engagement with key contexts in their ecology, including families, schools, peer groups, and out-of-school-time programs. Indeed, a major focus of the Lerner and Lerner PYD research has been the study of the latter setting (see Lerner et al., 2005).

There is considerable research assessing if and how the lives of diverse youth can be enhanced through engagement with community-based youth development programs (Vandell, Larson, Mahoney, & Watts, 2015). Just as RDS metatheory emphasizes the importance of mutually beneficial relations between person and context, one of the main requirements for youth programs to promote PYD is that youth strengths must be aligned with resources that support those strengths. The emphasis for PYD programming, therefore, is on the positive fit between a young person's interests and strengths and the opportunities provided by a particular program. The model further recognizes the abilities of young people to regulate their relationships with different aspects of their contexts, and thus emphasizes the role of *adaptive developmental regulations* in promoting thriving (Lerner, 1982).

The model of the PYD process constructed by Lerner, Lerner, and their colleagues (e.g., Lerner et al., 2005) has drawn explicitly on RDS metatheory as its foundation, with a particular focus on alignment between youth strengths and the strengths of their contexts to promote thriving. Figure 15.1 presents an illustration of this conception of the PYD developmental process. As indicated in the figure, the developmental process of PYD envisioned by Lerner and Lerner involves adaptive developmental regulations between the strengths of youth and the developmental assets present in their contexts. Such ecological assets may include the institutions, social networks, and individuals (parents, mentors) that support youth

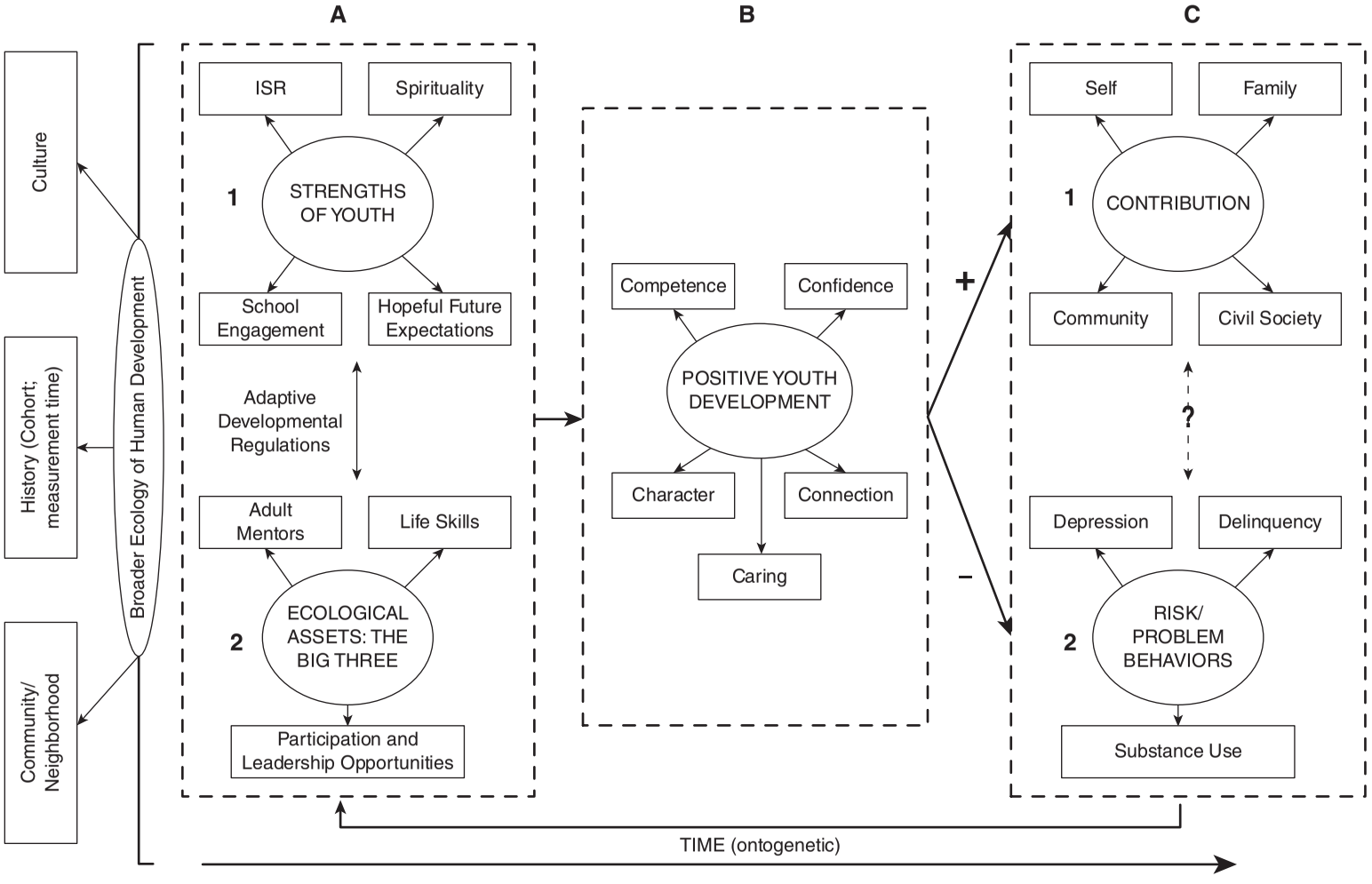

Figure 15.1 A relational developmental systems theories-based model of the development of thriving. Within the context of the broader ecology of human development, adaptive developmental regulations lead to positive youth development, which in turn leads to positive civic engagement and reduced risk and problem behaviors. This is the model that was used to frame the 4-H Study of Positive Youth Development.

strengths (Theokas & Lerner, 2006) or, as shown in Figure 15.1, what Lerner (2004) has termed the "Big 3" features of youth development programs: positive and sustained adult–youth relationships, skill-building activities, and youth leadership opportunities.

These mutually beneficial individual ⇔ context relations are shown to promote the Five Cs of PYD. In turn, PYD leads to youth contributions to their ecology and to lowered probabilities of risk/problem behaviors (Lerner et al., 2005). Youth contributions to self, family, community, and civil society represent the Sixth "C" of PYD (i.e., "contribution"; Lerner et al., 2005). As shown by the recursive arrow, the outcomes of these adaptive developmental regulations are thought to feed back to the individual and his or her context and thus create a basis for further adaptive developmental regulations. The figure illustrates, as well, that these developmental regulations and their potential positive and/or problematic outcomes exist within the broader ecology of human development. This ecology includes families, schools, community institutions, and culture. In addition, historical (temporal) variation introduces change at all levels of organization within the relational developmental system.

Through using the model shown in Figure 15.1 to frame a theory of change, the goals of a youth development program—to enhance youth thriving—can lead to positive outcomes through the activities of the program. This model has been evaluated using data from the longitudinal 4-H Study of Positive Youth Development conducted by Lerner, Lerner, and colleagues at the Institute of Applied Research in Youth Development (IARYD) at Tufts University. The 4-H Study of PYD collected data from approximately 7,000 youth and 3,500 of their parents from 42 states over a period of eight years (2002–10; see Bowers et al., 2014; Lerner et al., 2005, 2015, for more details about the study). This research sought to identify the individual and ecological relations that may promote thriving and that may have a preventive effect in regard to risk/problem behaviors. Within the 4-H Study, thriving is understood as the growth of attributes that mark a flourishing, healthy young person. As shown in the figure, these characteristics are the "Five Cs" of PYD—competence, confidence, character, connection, and caring.

The core hypothesis tested in this approach to the developmental process of PYD is that if the strengths of youth can be aligned with the resources for positive growth found in youth development programs, young people's healthy development will be optimized. Strengths of youth were operationalized within the 4-H Study as a young person's cognitive, emotional, and behavioral engagement with the school context, having hope for the future, spirituality, or possession of intentional self-regulation (ISR) skills. Findings from the study showed that ISR, in particular, is an important indicator of the agency young people need to garner resources from their context and contribute positively to it. For example, using data from the 4-H Study of PYD, Urban, Lewin-Bizan, and Lerner (2010) explored whether youth ISR skills moderated the effect of participation in youth development programs on PYD scores among adolescents living in neighborhoods with relatively low levels of ecological assets. Overall, youth in these settings who had the greatest capacity to self-regulate benefitted the most from involvement in youth development programs, with respect to high PYD and low depressive symptoms and risk behaviors. These relations were particularly strong for girls.

Youth development programs provide resources for youth, as well. For example, Lerner and Lerner point to the "Big 3" attributes of youth development programs—positive and sustained adult–youth relationships, skill-building activities, and youth leadership opportunities—and note that these program features may be especially important for promoting or capitalizing on youth strengths (Lerner et al., 2011). Moreover, findings from the 4-H Study of PYD indicate that youth who engage in community-based programs and school activities show greater active and engaged citizenship, including civic participation, civic skills, valuing civic duties, and neighborhood connections (Zaff et al., 2010; Zaff, Li, & Lin, 2011).

Contribution is thought to be the most important positive outcome of the PYD process in the Lerner and Lerner model (e.g., Lerner et al., 2005). If positive development rests on mutually beneficial relations between the adolescent and his/her ecology, then thriving youth should be positively engaged with and act to enhance their world. A young person's desire to "give back" shows that he or she is helping to maintain the mutually beneficial relations between person and context that are so critical for his/her future positive development. The focus on contribution, both as an outcome of PYD and in regard to the individual's agentic contributions to adaptive developmental regulations, coincides with a focus in developmental science and youth development programming on educating young people for character virtues that motivate them to engage in prosocial behaviors (Lerner & Callina, 2014). We turn to this burgeoning area of PYD research in the following sections.

Studying PYD from Childhood through Young Adulthood: The Sample Case of Character Development

The model of PYD during adolescence that is presented in Figure 15.1 may be regarded as an instance of a more general conception of the adaptive individual ⇔ context relations that constitute the basic process of positive development across the life span (Lerner et al., 2015). By adjusting the lens, scholars may use this model as a tool to study particular aspects of PYD. For example, in recent studies the authors—and our colleagues at the IARYD at Tufts University and at Boston College—have begun to focus on the "C" of character, for several reasons. First, youth development programs are increasingly interested in character virtues and moral and character development and education. Second, programs and institutions that focus on young people's character education and development are especially rich contexts for understanding PYD and, in particular, the mutually beneficial person ⇔ context relations that are essential for thriving and contribution (Lerner & Callina, 2014). Finally, this research program addresses some of the methodological limitations of the 4-H Study of PYD, by using multi-method, multi-rater studies to better understand strengths of both the individual and context.

Accordingly, researchers at IARYD and Boston College have developed a new series of studies that focus on the "C" of character. Using Figure 15.1 as a conceptual model for understanding all aspects of thriving, this new work is concerned with the variables that constitute bases, covariates, or outcomes of character development (Lerner & Callina, 2014; Johnson et al., 2014). Here, we summarize some of this new research. Because of space limitations, we describe only three programs of research (but see Callina, Mueller, Napolitano, Lerner, & Lerner, 2016, for more details). In later sections we address the methodological challenges to conducting applied research on PYD and character development within an RDS framework.

Current Studies on Character Development

Three studies at IARYD are currently underway that examine the development of character within educational and out-of-school-time settings. First, the Connecting Adolescent Beliefs and Behaviors (CABB) project, supported by the Templeton Religion Trust, is designed to answer the question, "Why do adolescents who believe themselves to be of high character, virtue, or morality behave in ways that fall short of their standards?" The major purpose of the project is to examine the role that intentional self-regulation skills and character role models play in the virtuous behaviors of adolescents. The CABB study is a short-term longitudinal study of students in grades 5 through 11. The study is testing the links among self-regulation, character development, character role models,

and youth contribution. Pilot data were collected from 220 students (*M* age = 13.4; 45 percent White, 15 percent Hispanic; 11 percent Black) from schools in Massachusetts and Connecticut in spring 2015. Youth, parents, and teachers are providing ratings of youth character attributes as well as other individual strengths and behaviors.

Initial analyses of CABB pilot data have focused on young people's character role models, a central component of the project (see Johnson et al., in press, for further details). Participants were asked to nominate a character role model (CRM), defined as someone they knew personally and looked up to as an example of how to be a good person. Among the participants, 142 (64 percent) listed a CRM, with family members (especially mothers, but also fathers, grandparents, aunts, uncles, siblings, and cousins) nominated most frequently. Other participants nominated friends or non-familial adults (e.g., teachers). Youth cited how their CRM treated them as well as other people as reasons for selecting their CRMs, which suggests that youth understand the relational nature of character. Participants also rated the quality of the relationship, role-modeling behaviors, and the ways in which their CRMs socialized them around character actions. There were similar positive characteristics associated with the three CRM types, but there were also differences (e.g., family CRMs were rated most positively on relationship quality as well as role-modeling behaviors, whereas friend CRMs provided lower levels of character socialization). These findings point to the potentially powerful role of CRMs in promoting young people's character development.

Second, the Character and Merit Project (CAMP), supported by the John Templeton Foundation, is a multi-method longitudinal study that seeks to examine whether and how Boy Scouts of America (BSA) programs promote character development among participating youth. For this study, researchers from IARYD collaborated with council and pack leaders from the Cradle of Liberty Council of the greater Philadelphia area. Quantitative and qualitative data were collected from adults and youth to understand the impact of individual-level strengths and ecological assets on PYD in the context of a youth-serving organization. In this study, PYD was operationalized by increases in scores on positive character attributes, such as those emphasized by the Boy Scout Law ("A Scout is: Trustworthy, Loyal, Helpful, Friendly, Courteous, Kind, Obedient, Cheerful, Thrifty, Brave, Clean, and Reverent").

Findings from CAMP indicate that scouting positively impacts youth character development, particularly for Scouts with longer duration, greater intensity, and higher engagement in the program (Lynch, Ferris, Burkhart, Wang, Hershberg, & Lerner, 2016). The findings also highlighted the importance of positive relationships between the youth participants and the scouting program. Engagement was assessed by participants' interest, enjoyment, and commitment to the program. Data were analyzed at both the individual and pack levels to better understand processes of character development in the scouting context. Individual-level engagement was significantly associated with cheerfulness, hopeful future expectations, helpfulness, kindness, and intentional self-regulation. Pack-level engagement enhanced the effects of individual engagement on character development, especially for highly engaged youth (Lynch et al., 2016).

A third study, called Project Arete, examines the development of character and leadership among cadets at West Point (the Templeton Religion Trust also funds this project). The goal of this study is to identify character development strategies and activities at the United States Military Academy that are especially salient in promoting cadet character virtues (including the character domains of moral, performance, civic, leadership, and social). Quantitative and qualitative data will be integrated with administrative data about cadets' military, academic, and physical performance, enabling researchers to link character and leadership development to performance outcomes. The results will also enable researchers to determine which cadets benefit the most from certain experiences. This research will serve to assess, inform, and enhance character and leadership education within the Corps of Cadets.

Conclusions

The CABB study, the CAMP study, and Project Arete are three examples of programs of research on positive development across the first three decades of life that are being undertaken at IARYD and Boston College, in collaboration with schools and other institutions, as well as out-of-school-time programs, that serve young people (see also Callina et al., 2016). This research examines the role of character strengths in promoting the adaptive individual ⇔ contextual relations that are necessary for youth to thrive in particular contexts. Our aim is to provide a conceptual and methodological template for understanding how healthy, positive development may unfold across at least the first three decades of life, and for understanding the links among youth strengths, ecological assets, and important life outcomes associated with youth thriving, such as academic success, moral virtues, entrepreneurship, and national leadership.

The sample programs of research described above provide information about the several antecedents, concomitant phenomena, and developmental sequelae of thriving, in general, and character development in particular. Nevertheless, the sampling and measurement variation across studies makes it difficult to provide an integrated understanding of the ontogenetic course of thriving across the first three decades. We believe that such a holistic depiction of this portion of the life span is needed to both understand and enhance the development of diverse youth across these decades of life. How, then, may sound developmental research proceed to provide this information? We address this question in the following section.

Methodological Issues in the Further Testing of RDS-Based Models across the First Three Decades of Life

Overton's (2015) influence on theory and methods in developmental science, and in PYD research in particular, has been considerable, as scholars use his ideas to frame their research. However, conducting research that derives from the RDS metatheory also requires that theoretical ideas about development be actualized through methodological approaches involving change-sensitive research designs, measurements, and data analysis methods. This obligation is an essential feature of "good science—selecting features of one's methodology based on the nature of the (theoretically predicated) questions asked" (Lerner & Overton, 2008, p. 250). In this section we highlight how methodologists have responded to the concepts presented by Overton (2015).

In testing RDS-based ideas about development, researchers must make methodological decisions that acknowledge that the developmental system is *embodied*. Embodiment means that the way individuals behave, experience, and live in the world involves their being active agents with particular kinds of bodies. The body is integratively understood as form [a biological referent], as lived experience [a psychological referent], and as an entity in active engagement with the world [a sociocultural referent] (Overton, 2015). As such, individuals actively participate in the production of their own ontogenetic development (Lerner, 1982, 2002). Thus, RDS-based research must focus on the individual and on the specific course of his or her changes (in PYD, for example). This person-centered requirement has profound implications for the future study of the development of PYD across the first three decades of life.

Molenaar (2014) explained that the standard approach to statistical analysis in the social and behavioral sciences is not focused on change but is, instead, derived from mathematical assumptions regarding the constancy of phenomena across people and, critically, time. He noted that these assumptions are based on the *ergodic theorems*. These theorems indicate that 1) all individuals within a sample may be treated as the same (this is the assumption of homogeneity) and 2) all individuals remain the same across time; that is, all time points yield

the same results (this is the assumption of stationarity). If the concept of ergodicity is applied to the study of PYD among children, adolescents, and young adults, then within-individual variation in PYD across time would either be ignored or treated as error variance. In addition, any sample (group) differences in PYD would be held to be invariant across time and place.

However, within the process-relational paradigm (Overton, 2015), development is nonlinear and characterized by autopoietic (self-constructing) and, hence, idiographic intraindividual change, features of human functioning that violate the ideas of ergodicity (Overton & Molenaar, 2015). As such, interindividual differences in trajectories of PYD (i.e., in the course of intraindividual changes in thriving) are important foci for research and, as well, for program and policy applications aimed at enhancing PYD among diverse youth across ontogenetic periods, time, and place. Thus, use of the RDS metatheory as a frame for research or application requires a rejection of the use of data-analytic tools predicated on the ergodic theorems that constitute the bases of traditional statistical procedures (Molenaar & Nesselroade, 2015; Nesselroade & Molenaar, 2010).

To obtain valid information about developmental processes, it is necessary to study intraindividual variation within single individuals, and Molenaar and Nesselroade (2015; Nesselroade & Molenaar, 2010) have developed procedures such as the Idiographic Filter (IF), which involves use of the dynamic factor model at the level of the individual but then generates group-differential or nomothetic latent constructs to enable generalization across participants. Through use of procedures such as the IF, developmental scientists can both capture the nonergodic nature of intraindividual change and produce generalities about groups that apply to the individuals within them.

How, then, may research proceed? Consistent with the Bornstein (2006) "specificity principle," we suggest that addressing a multi-part "what" question is the key to conducting programmatic research about the function, structure, and content of development across the life span. To test RDS-based ideas about the ontogenetically changing structure of development across the life span, researchers must examine empirically the process-relational conception of intraindividual change (Sokol et al., 2015; Overton, 2015). Therefore, developmental researchers must ascertain answers to the following multi-part "what" question: 1) What structure–content relations emerge that are linked to 2) what antecedent and consequent adaptive developmental regulations (to what trajectory of individual ⇔ context relations) at 3) what points in development for 4) what individuals, living in 5) what contexts, across 6) what historical periods?

The integration of the dynamic factor model (DFM) and the IF provides one promising way to ascertain what individuals have in common first, and then build generalizations on that information (Molenaar & Nesselroade, 2015). This approach stands in marked contrast to initially aggregating the individual-level information and extracting generality from it in the form of average tendencies—the approach of traditional differential psychology. The integration of the DFM and the IF replaces static trait conceptions with an approach that embraces development and complexity (Molenaar & Nesselroade, 2015).

The work of Molenaar and Nesselroade is an example of the application of systems science methods to developmental science framed by relational developmental systems theories (also see Molenaar, 2014). For instance, dynamic factor analysis is an example of a state space model in that it integrates a model of the dynamic evolution of the state process and another model linking the state process at each time point to the observed process at that time.

Using Systems Science Methods to Evaluate the Developmental System

Overton's (2015) work has had far-reaching implications beyond theory. His ideas have also framed the application of developmental science. For example, evaluation methods have been developed to address the developmental system (e.g., Urban, Hargraves, & Trochim, 2014).

> Systems science methods are designed to address complexity, that is, change. . ., nonlinear relationships, bidirectional relationships (feedback loops), time-delayed effects, and emergent properties of the system—phenomena that are observed at the system level but cannot be linked to a specific individual component of the system.
>
> (Mabry & Kaplan, 2013, p. 9S)

Examples of systems science methods are computational/mathematical modeling and simulation; micro simulation; agent-based modeling; system dynamics modeling; network analysis; and discrete event simulation (e.g., Urban, Osgood, Okamoto, Mabry, & Lich, 2014). We now provide a discussion on how to use these methods in the evaluation of PYD programs.

Use of these methods is predicated on the RDS concept of embeddedness or holism; for example, the idea that PYD programs are located within a complex context. Such methods are useful for describing and explaining the range of variation associated with individual youth participants in the program and/or in understanding if adaptive developmental regulations go beyond the "doorways" of the program. Information derived from systems science methods about the embodied place of the program within the larger developmental system may enhance the ability of developmental scientists to address the multiple purposes of program evaluation (Lerner, Lerner, Urban, & Zaff, 2016; Urban et al., 2014). These are: 1) To provide information about how to strengthen an existing program in an existing context with an existing population (e.g., see the above-listed "what" questions); 2) to test whether a given program is currently working in a given place with a given population; and 3) to understand whether a given program with a given population at a given time can be translated to a different place with a different population and at a different time (e.g., "scaling" a program either through privately funded means or through public policy). Of course, there are other purposes for evaluation, but addressing these three purposes have overlapping, but also distinct, methodological needs, and provide overlapping but distinct information for practitioners and policymakers (and for other researchers). Systems science methods may generate what will likely be the nuanced and complexly interrelated answers to these questions.

The use of systems science methods in developmental science is a sample case of the opening of the field to innovations in methodology, perhaps especially those associated with other disciplines. Scholars have recognized that new methodological tools are required for understanding the change processes involved in an epigenetic, agentic, and autopoietic system (Lerner & Benson, 2013). New tools are required to appraise the qualitative changes marking this system and to model/test the revised understanding of causality within such a system. Accordingly, qualitative research and mixed methods research are important and increasingly more prominent cases in point (e.g., Burton, Garrett-Peters, & Eaton, 2009; Lerner & Tolan, 2016; Tolan & Deutsch, 2015).

Conclusions

Through the influence of Willis F. Overton (2015), developmental scientists have, in the repertoire of models and methods in their intellectual "tool box," the means to promote thriving and, in turn, to promote more active and positively engaged civic lives and contributions among young people. Furthermore, through enhancement of the adaptive developmental regulations between individual and context, developmental scientists may afford diverse individuals the opportunities needed to maximize their aspirations and actions by engaging with social institutions that support individual agency, freedom, liberty, civil society, and social justice (Fisher, Busch, Brown, & Jopp, 2013; Lerner, 2004; Lerner & Overton, 2008). To contribute significantly to creating a developmental science aimed at promoting such social justice-oriented outcomes, scholars need to identify the means with

which to alter individual ⇔ context relations in ways that enhance the probability that all individuals, regardless of their individual characteristics or contextual circumstances, have greater opportunities for PYD (e.g., see Fisher et al., 2013).

The theoretical orientations and interests of contemporary cohorts of developmental scientists, the aspiration to produce scholarship that matters in the real world, and the needs for evidence-based means to address the challenges to freedom, liberty, and democracy in the twenty-first century have coalesced to make Kurt Lewin's (1952, p. 169) quote, that "[t]here is nothing so practical as a good theory," an often-proven empirical reality. The theoretical writings of Willis Overton (2015) have helped the field to clarify the nature of the "system" and of the role of the "relation" between person and context. The scientific and societal merits upon which developmental science will be judged will be based on whether its theoretical and methodological tools accurately reflect the diversity and dynamism of human development and are centered on promoting thriving among all the youth of all nations. Promoting such features of life across the first three decades will be the most significant lens through which the contributions of developmental science will be viewed. Professor Overton's career contributions have widened the lens of developmental scientists and brought the human development system into sharper focus.

Notes

1 The writing of this chapter was supported in part by grants from the National 4-H Council, the Altria Corporation, the John Templeton Foundation, and the Templeton Religion Trust.

2 Because of space limitations we cite here Professor Overton's most recent and thorough presentation of his work. Readers are directed to the references in his 2015 chapter for his seminal papers on concepts and theories of human development.

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16 Development of Relational Wisdom and Happiness in Late Adulthood

Masami Takahashi

The field of adult development and aging has focused primarily on the issue of the well-being of the older adult (Lamb & Freund, 2010; Overton, 2010).[1] Two central issues related to well-being are wisdom and happiness. It is generally assumed that wisdom and happiness increase with age, but this assumption still warrants further examination. For example, while several studies in the U.S. support this relationship (e.g., Ardelt, 1997, 2004), data in Japan, the "grayest" country in the world, reveal a different pattern. These studies suggest that happiness declines with age (Frey & Stutzer, 2001).

This chapter reviews the meaning, history, and cultural variability of these central concepts as well as recent empirical work that contributes to understanding the well-being of older adults. First, I will illustrate various research approaches in the field of wisdom followed by a proposal framed by a relational developmental systems metamodel (Takahashi & Overton, 2005). I will then present prevalent interpretations of wisdom from antiquity to contemporary narratives, pointing out a general trend moving from broad and inclusive definitions to more articulated yet exclusive interpretations. I will also discuss how wisdom and happiness are related. Although they were once considered closely intertwined, I will argue that significant shifts in demography, economics, and cultural milieu may have changed this relationship. I will use Japan as an example because it has experienced remarkable shifts and now has more people over 65 than any country. Finally, I will present data from our recent ethnographic case study in southern Japan where these dramatic shifts never occurred. There, the presence and wisdom of elders are genuinely respected, and older people regard their lives as happy and fulfilled.

Definition of Wisdom

The most prominent research program, initiated at the Max Planck Institute of Human Development in Berlin, defines wisdom as an extension of broadly defined crystalized intelligence or an "expert knowledge system," consisting of five domains: factual knowledge, procedural knowledge, life span contextualism, relativism, and uncertainty (Baltes & Staudinger, 2000). While this research program has produced much-needed empirical investigations for the past three decades, it has also been criticized as having defined wisdom too narrowly with its exclusive focus on the cognitive skills (Ardelt, 2004; Labouvie-Vief, 1990). Within this theoretical framework, wisdom expertise can be a stand-alone database or "collectively anchored products," such as legal texts and the Holy Bible, which do not require an assumption of the ultimate truth or a person who embodies that truth.

Others conceptualize wisdom more inductively. Clayton and Birren (1980) pioneered the contemporary implicit theory research program, asking people what wisdom meant to them. While earlier studies involved samples only from North America and Western Europe, later studies included other ethnic groups (e.g., Levitt, 1999; Yang, 2001).

Still other researchers define wisdom deductively as a developmental construct, borrowing ideas from Erikson's epigenetic principle and/or Piagetian post-formal operations. The Eriksonian (1982) approach suggests wisdom as a virtue accrued through a series of psychosocial conflicts culminating in the healthy resolution of the ego integration vs. despair crisis. The neo-Piagetian narrative, on the other hand, emphasizes higher levels of psychological competence (e.g., post-formal operation) emerging with life-long assimilation and accommodation processes.

Similarly, Takahashi and Overton (2005) propose an inclusive relation-developmental theory of wisdom. In this metatheoretical framework, it is assumed that observed behavior reflects two distinctive functions: expressive-constitutive and instrumental-communicative. The former reflects an aspect of behavior considered creative and expressive of underlying systems or organization (e.g., cognitive, emotional, etc.). The latter refers to a part of action that is inter-subjective and instrumental in attaining some practical goal (Overton, 1998, 2015). Both levels of analysis can be a legitimate focus of scientific inquiry. Thus, an observed behavior of saying a prayer can be interpreted as an expression of awe toward a higher power (expressive-constitutive) or as a means to win a lottery (instrumental-communicative). The frequency of the behavior (praying) would be interpreted differently depending on the focus of inquiry.

From the inclusive relational developmental perspective, wisdom is postulated as a psychological strength emerging relatively later in life with two complementary modes: analytic and synthetic (Takahashi & Overton, 2005). The analytic mode refers primarily to the instrumental-communicative part of action. It is well articulated, but often narrowly focused on cognitive skills and performances. It resembles the Berlin paradigm of wisdom, which excludes the presumption of underlying psychological organization while emphasizing several information-processing functions "instrumental" in solving problems.

The synthetic mode refers primarily to the expressive-constitutive aspect. It regards wisdom as an expression of underlying dialectic processes. The psychological structure transforms and moves toward a state of increased integration through the actions of the person operating in the world. The transformational processes in this mode highlight the human tendency to move toward an increasingly adaptive level of integration that enables a person to reflect upon his/her previous self (e.g., heightened morality), whereas an integrated mind of a wise person implies a well-coordinated psyche implicating different mental domains (e.g., emotion/cognition integration).

In sum, the relational framework regards both the analytical and synthetic modes as necessary and complementary. Thus, the analytical mode, often operationalized as accumulation of knowledge, is thought of as a part of wisdom only if the person is seen as an integrated whole who also expresses the synthetic qualities of various psychological domains such as emotional (e.g., sympathy), interpersonal (e.g., caring), intuitive (e.g., humility), etc. In other words, wisdom is not an extremely high level of a particular psychological skill, but an integration of multiple psychological functions that are well developed.

Wisdom in Historical Context

Like many ancient concepts, wisdom may not have been an abstract construct, but rather a set of observable actions or a code of conduct. Ancient Greek scholars took it a step further because they preferred articulated and systematized conceptualizations for Greece's citizens to have a common understanding in public dialogues.

One dimension of wisdom for the Greeks was *episteme*, or scientific knowledge (Osbeck & Robinson, 2005), which entails a collection of facts and the logic that organizes them. *Phronesis* is practical wisdom wherein a wise person behaves for the sake of human good. But it is perhaps *sophia*, the third type, that eventually came to be understood as wisdom in the

post-Greek era. *Sophia*, theoretical knowledge of reality/essence, is what ancient philosophers pursued (Robinson, 1990).

In essence, then, the Greek philosophers transformed wisdom from a naïve list of daily behaviors to more abstract definitions. Their approach was not so much to reduce the concept to some set of behaviors, but to maintain wisdom inclusive of personal, cognitive, emotive, and behavioral levels. More importantly, they saw wisdom not as a unitary construct, but as a multidimensional one, and for the first time related it to happiness.

When Rome fell, wisdom largely lost its Greek heritage and became more of a theological concept rooted in Judeo-Christian teachings. The original Judeo-Christian narrative was far from monolithic, and its diverse narratives were evident in both Talmudic and biblical hermeneutic traditions exploring numerous interpretations of ancient treatises. Their different interpretations of wisdom fit on a continuum from blind faith to the transcendental God rooted in Neoplatonism, to a more logical and analytical argument rooted in the Aristotelian tradition (Robinson, 1990). For example, in early Christianity, St. Augustine, a Neoplatonist, argued that properly cultivated *scientia* (scientific knowledge) is essential for living in both the secular and the spiritual world, but it was believed to be merely the means to *sapientia* or divine wisdom (Meaghre, 1978).

Subsequently, the empirical and humanistic Aristotelians pushed back the mystic Platonists, and changing views regarding the nature of deity and wisdom began to emerge. Thomas Aquinas (1225–74), a Dominican who called Aristotle "the Philosopher," viewed wisdom as a posteriori intellect, a judgment based primarily on reasoning (Snell, 2003).

However, even as the Aristotelian Christians attempted to re-conceptualize wisdom from a nearly blind faith to a belief that involved reasoning and analysis, the prevalent metanarrative underlying the relation between Creator and creation remained unchanged and their hierarchical relation was inevitable (Takahashi, 2000).

This overarching Christian metanarrative continued until the seventeenth century. The Renaissance was a definite movement away from the Divine, and the subsequent Age of Enlightenment brought about the complete secularization of knowledge in general and of wisdom in particular. For the new breeds of intellectual authority, such as John Locke and David Hume, the absolute truth was no longer in the realm of god but rather an independent objective reality within reach of knowledge (Robinson, 1981).

Ontologically speaking, however, both these new breeds of intellectual authority and the earlier medieval Christians embraced split metanarratives but with different sets of polarities. For the medieval Christians, the split existed between the Creator and creation, and that abyss was never intended to be bridged. Conversely, for the intellectual authority of the New Age, a split fostered by Descartes came to exist between the knower and the known. This New Age followed novel scientific methodologies religiously, and the Newtonian mechanical explanation of induction through rigorous pristine observation provided a perfect tool (Overton, 1998, 2015). This "new" split framework suggested that there was no "wise person" per se who had a deeper, more profound understanding of the reality, because the ultimate reality was, or should be, knowable by anyone who uses the proper scientific methods. Thus, wisdom can be either knowable (and if so, it is nothing but a technical knowledge) or unknowable (and if so, it is irrelevant in science).

While this "new" split metanarrative was sweeping away other accounts, there emerged during the Enlightenment a competing philosophical movement, led primarily by Leibniz, Kant, and Hegel. This group affirmed the mind and the inherent activity of mind, and worked toward healing the split and creating a relational perspective. Immanuel Kant (1724–1804) was central to this movement. He argued against Hume's extreme skepticism concerning the possibility of valid knowledge and proposed a theory of an active structured mind. Kant proposed two distinctive moments in the acquisition of valid knowledge. These moments were

phenomena (thing as we see it) and *noumena* (thing in itself). Only *phenomena* were observable and these were structured by the nature of mind. Through his work he was able to re-establish the legitimacy of various intellectual domains, including religion and philosophy (which included wisdom), and save them from the dustbin of radical empiricism.

Friedrich Hegel (1770–1831) later advanced the relational perspective by proposing a dialectical logic to integrate what until then had been the *phenomena–noumena* conundrum. Hegel acknowledged the importance of these binary oppositions, but argued that the binaries can be transformed into a complementary relationship only if these opposites are regarded as essential components (thesis and antithesis) of a larger system (synthesis). Hegel mended the *phenomena–noumena* split by including both as two moments of consciousness. Kant's *phenomena* became Hegel's "moment of knowledge" and Kant's *noumena* became Hegel's "moment of truth" (Hegel, 1807).

While a potential discrepancy exists between these two moments—what one thinks to be the case ("moment of knowledge") may not necessarily be what it is ("moment of truth")—Hegel maintained that such a discrepancy would create an opportunity for consciousness to transform knowledge "to make it conform to the object" (p. 54), thus making knowledge developmental. Here, wisdom is seen not as a static "collectively anchored product," but as action that transforms itself when the mind experiences a discrepancy between the two moments. Wisdom is an alternative way of knowing that includes various psychological aspects (Robinson, 1990). As such, wisdom is also regarded as a more inclusive construct; e.g., a public virtue that involves not only merely "thinking" but also emotions and (moral) actions for the good of humanity (Csikszentmihalyi & Rathunde, 1990).

As we will see, this Kantian-Hegelian program did not fare well with the zeitgeist of the radical empiricism which eliminated the Subject and celebrated the Object. Moreover, despite the efforts of Hegel and others in the phenomenological movement (i.e., Edmund Husserl, Martin Heidegger, and Maurice Merleau-Ponty) to keep subjective consciousness within the mechanistic scientific arena, traditionally metaphysical and/or theological concepts such as wisdom were treated as epiphenomena, pushed aside from mechanistic empirical science that dealt only with the objective world. The emergence of neopositivism in science and closely aligned behaviorism in psychology eventually cemented the mechanistic idea that it was unwise to study wisdom that may involve things in the world of *noumena*.

In addition, the scientific study of wisdom has had other obstacles including its conventional association with "undesirable" old age in the era of modern science (Baltes & Smith, 1990). As a consequence, despite multiple theories put forth, the predominant approach seems to split the dialectic poles and views wisdom as nothing but a type of analytical knowledge, detached from its dialectic counterpart or the synthetic processes of integration and transformation.

Thus far, I have described how wisdom has been treated in the West. This by no means implies a lack of interest in the concept in the East, where the discourse may be traced back to even more ancient roots. Although it is simplistic to dichotomize our cultural heritage into "East" and "West," each tradition does reflect certain idiosyncratic values. In the following section, I will briefly describe some of these differences. I argue that in many regions of the East, the meaning of wisdom became less distinctive from that of the West due to re-interpretations over the years (Takahashi, 2014).

One of the distinctive cultural characteristics in Eastern ideologies, including Hinduism, Buddhism, and Taoism, may be its "non-split" or relational ontology. For example, this tradition embraces unity of all things—Being and Nothingness, Subject and Object, etc.—and this idea often permeates many aspects of people's daily lives (Paranjpe, 1984). Perhaps the most dramatic example to Westerners is that a person in a Buddhist tradition would say that he/she is a Buddha (analogous to someone in a church saying that he/she is God!). This does

not mean that Buddhists are fanatic and grandiose. Rather, Buddhism's basic tenet is that everything, including people, is simply a manifestation of the Buddha; the Buddha and the universe are not discernible from each other.

Although this idea is similar to the Hegelian dialectic that *phenomena* (e.g., Jesus) are seen as an instantiation of *noumena* (e.g., Christ; Norton, 1976), Eastern philosophies often fail to distinguish the foundational dichotomy of what one can and cannot perceive. Thus, while the *noumena–phenomena* conundrum in the Hegelian dialectic is "reconciled" through a process of insightful and logical articulation, the Eastern tradition preemptively abandons the ontological discussion of the split altogether. Instead, their approach to wisdom is integrative: by-passing cognitive understanding while stressing the phenomenological "awakening." Northrop (1947) calls this "the genius of the East" and explains its primary tenet as "[things) must be immediately experienced to be known" (p. 363).

Buddhism is illustrative of this point. It teaches the totality of wisdom by emphasizing both *enlightenment* (implying cognitive and emotional transformation) and *compassion* (a procedural part of wisdom referring to the most profound form of "friendship"). Hence, a wise person not only possesses transformed and expanded consciousness to discern the unity of all things, but is also able to act upon this understanding and treats everyone and everything as true friends.

Whereas the ancient Eastern account of wisdom highlighted its transformational and integrative characteristics, the meaning of the concept became more compartmentalized and narrow as tenets were re-written over the years. India, where the Buddhism wisdom tradition originated, exemplifies this; less than 1 percent of its current residents are Buddhists (Government of India, 2010). As the tenet was repeatedly re-written to conform to prevailing political and secular narratives, ancient concepts such as wisdom were constantly redefined (Crossette, 1993). This trend continued when Buddhism was "exported" from India to China around 1 AD (Hill, 2009). There, the original Buddhist conceptualization of wisdom as *vid*, a type of inclusive knowing or "knowing directly with emotion," was re-interpreted. With the Chinese translation of 智慧 from the Sanskrit, a more formal and analytical language than the original Buddhist language of Pali, the concept placed less emphasis on inclusivity of various psychological processes, but more emphasis on knowledge per se accentuated with analytical and practical properties (Takasaki, 2000).

Japan is another country that underwent a transformation in the meaning of wisdom over the years, but in a direction opposite to that of India and China. The concept of wisdom also did not garner intense debate in Japan as it did in India. This may have been due to Japan's cultural tendency to intentionally leave the precise meaning of a concept unarticulated to enhance the flexibility of its interpretation (Rohlen, 1979). As a result, although originally imported from China as a Buddhist concept, wisdom transformed to become an unexamined secular concept. In fact, wisdom is no longer expressed as the original Chinese characters, with exclusive religious connotation, but as a set of new, secularized and simplified characters (知恵). This new Japanese wisdom maintains the ancient and inclusive nuances of the non-split ontology that emphasizes personal properties, but is clearly distinguished from related analytical concepts such as knowledge (Takahashi & Bordia, 2000). A lack of theoretical articulation has yielded a vague definition that is at the same time broader and more inclusive. At present, Japanese wisdom generally refers to both religious and secular, cognitive and emotional, condition and action, good and evil, etc.

In short, the Western and Eastern views of wisdom have been distinctive from each other for millennia, the former emphasizing exclusivity and the latter inclusivity. This gap has narrowed in some Eastern regions (e.g., India) for various political/religious reasons, while other regions such as Japan have a more vague but inclusive understanding of wisdom. Accordingly, the relationship between wisdom and happiness also varies by region.

Wisdom and Happiness

The association between wisdom and happiness has been implied since antiquity. But it is also one of the least-examined areas, with complex and multiple definitions of each construct engendering confusion. As we have seen, distinctive definitions of wisdom were proposed in the past, and confusion seems to arise especially when wisdom is defined from the tradition of exclusivity. For example, the old adage, "ignorance is bliss," confuses wisdom with an exclusively cognitive function of possessing a large knowledge database. More importantly, self-claimed knowledgeable individuals often fail to see the whole picture and may feel superior to others (Csikszentmihalyi & Rathunde, 1990). Thus, both extreme knowledge, disguised as wisdom, and extreme ignorance are undesirable, and perhaps this awareness that we should pursue knowledge that is *due to us* is the key to happiness (Plato, *Republic*, I, 350).

Eastern philosophy expands this notion of moderation and situates it at the center of their philosophy of the wisdom–happiness relationship. Because this tradition has a tendency to remain inclusive and vague, the notion of happiness has not been well articulated and has yielded several nuanced meanings over the years ranging from "sheer chance" that can be good or bad, to positive affect. A more important question may be how much of the "sheer chance" or "positive affect" one should desire and pursue. Buddhism teaching, which emphasizes "keeping a mean" or "middle way," is instructive in this regard. This teaching is derived originally from Buddha's personal experience when he was trying too hard to attain enlightenment. He eventually realized that a guitar cannot produce pleasant music if the strings are too tight or too loose. A sense of "letting go," and being content with what is *due to us*, was the key to enlightened wisdom and happiness.

The *Oxford American Dictionary* refers to happiness as a positive psychological state such as "pleasure or contentment." However, like wisdom, it is a complex and multilayered construct that defies more precise definition.

One line of Christian narrative, rooted in transcendental Platonism, suggests that happiness requires minimal emotional fluctuations and carnal pleasures. Conversely, the Aristotelians believed that human emotions play a significant role in liberation and even regarded laughter as a spiritual path to happiness (Jones, 2015). Some argue that this discrepancy comes from two distinctive interpretations of happiness in ancient Greece: *hedonistic* and *eudaimonic* (Kings & Hicks, 2012).

Hedonism refers to sensual pleasure that Plato despised; it is a self-serving vice or subjective well-being with satisfying self-evaluation (Diener, Suh, Lucas, & Smith, 1999; Waterman, 1993). Since Aristippus in 400 BC, Hobbes, Mill, de Sade, and others encouraged pursuing sensationalistic happiness often uninhibited by morals and social obligations to fulfill natural laws (Ryan & Deci, 2001).

Eudaimonia (*eu* [good] + *daimon* [par excellence]) is a feeling of gratification toward a desire that aligns with one's true self. It is a condition of self-actualization, marked by a distinctive emotional state of intrinsic reward (Norton, 1976). The person realizes the inner voice or "I must," and understands and pursues his or her imperative authentic self (p. xi). Aristotle encouraged others to pursue wisdom for its own sake regardless of possible rewards such as fame and respect (*Metaphysics*, 1.2). It has also been suggested (e.g., Waterman, 1993) and empirically demonstrated (e.g., Ryan & Deci, 2001) that *eudaimonia* is closely associated with a meaningful life characterized by "virtuous living" (Kings & Hicks, 2012). *Eudomonac* thus involves a commitment to greater good, necessarily implicating others in the process.

Several empirical studies have examined the relationship between wisdom and happiness. For example, Ardelt (1997) found a positive correlation between inclusive wisdom and the *hedonistic* happiness (i.e., subjective well-being), while Konig and Gluck (2014) found that wise people exhibited *eudaimonic* characteristics (e.g., gratitude). Kings and Hicks (2012)

found a "very real link" between the grander experience of meaningful life as a *eudaimonic* quality and a quotidian experience of positive mood as a *hedonistic* quality. If wisdom can be located somewhere on the *hedonistic* and *eudaimonic* continuum, it is reasonable to assume that it is near the middle. Thus, wisdom is neither the pursuit of extreme pleasure nor a total stoic commitment to one's belief to the point of self-destruction. Rather, a wise person is content while living a virtuous life for the greater good, which resembles an enlightened, self-actualized, or "fully functioning" individual who has a keen sense of self and surrounding. Erikson (1982) describes this state as "dis-involved involvement," a fundamental characteristic of wisdom. In fact, cross-cultural data generally suggest that older people who outperform younger cohorts on wisdom assessment (Kramer, Kahlbaugh, & Goldston, 1992) and are "top performers" of various wisdom tasks (Baltes & Smith, 1990) feel happier than their younger counterparts (Blanchflower & Oswald, 2008).

Given these empirical data about wisdom and happiness, it is interesting to note that older people in Japan, where over a quarter of its population is over 65 (Japanese Statistics Bureau, 2015), tend to be less happy as they age ("White paper," 2010). Despite reports that Japanese and American older adults are equally wise (Takahashi & Overton, 2002), why are the former not feeling as happy as the latter? Many Japanese researchers regard this inverse relationship between age and happiness as "peculiar" and a significant "concern" ("White paper," 2010, p. 61).

One possible explanation is the seismic demographic shift that took place in the late 1980s after unprecedented post-war economic growth crumbled, and this resulted in changing the context in which happiness is defined. Whereas the total Japanese population has steadily declined due to low birth rates since the 1970s, the older population has more than doubled from 12 percent (15 million) in 1990 to 25 percent (32 million) in 2015 (Ministry of Internal Affairs, 2015). Further, Japan has a mandatory retirement age, and most retirees take marginal and part-time jobs to survive their prolonged retirement years. As the economy weakens and the sheer number of retirees increases, the traditional image of a happy older adulthood seems less likely.

This shift also suggests a rapid change in the meaning of being old and wise. While older adults were rare and valued just a few decades ago, they are now ubiquitous. In a depressed economy, age-associated characteristics such as wisdom are no longer valued in a society where instrumental-communicative skills are far more important than expressive-constitutive properties (e.g., cognitive-emotion integration and a high level of moral development). In this setting, people tend to be less *eudaimonic* and less concerned about others, but more *hedonistic* and more focused on self-preservation. In a society where mutual dependence and communal living style are in decline, people tend to pursue only "petits et vulgaires plaisiris," while disregarding traditions and customs that serve the greater good (de Tocqueville, 1981, p. 385).

Recent transformations of death rituals and burial practices in which older people traditionally played an important role are illustrative. Suzuki (2013) claims that Japan gave away its traditional tribal, collectivistic system and replaced it with a more cosmopolitan, individualistic orientation as the country went through a dramatic modernization. Death rituals became less communal and more about individual necessity. Suzuki points out that commercial funeral services have overtaken tradition by standardizing the entire process. Hence, traditional funerals where people carry out rituals for the deceased (and the remaining community) have been replaced by "McFunerals"—sterilized, mass-produced funerals with professional MCs and pricing structures to match.

Furthermore, some families no longer keep a cemetery plot inherited by the family over many years (symbolizing the unity of all generations) for the cremated ashes. This is due in part to periodic assessments and annual maintenance fees. Increasingly, families opt to keep

the ashes of the deceased in a gym-room-type small locker housed in a modern building. As a consequence, any wisdom older people have to offer regarding the spiritual world and funeral protocols and rituals is no longer valued.

Shifts in the meaning of wisdom and devalued status are not the only factors decreasing the happiness of older Japanese adults, who are feeling the squeeze of dwindling societal resources shared by an increasingly larger older cohort. In a large multi-year survey between 1978 and 1999 (n = 30,007), Kurokawa and Otake (2012) found that stress levels increase with age between 20 and 70 years. Even more troubling, the adult population in general is becoming more pessimistic about their own old age ("New Public," 2013).

In our recent ethnographic field work, we examined the relationships between gerotranscendence and life satisfaction. Although gerotranscendence—a late-emerging meta-perspective that transcends materialistic and rational vision—is a distinctive construct coined by Tornstam (2005), he also believes that it is the hallmark of wisdom and that they share similar characteristics such as transformational changes from middle age to old age in various perspectives regarding self, society, and the universe (Tornstam, 1997).

As a part of our research on factors contributing to longevity, we have been interviewing older adults and their family members (e.g., Tomizawa & Takahashi, 2010). It was ironic to find that a group of older adults reporting high levels of gerotranscendence and life satisfaction reside in rural regions of Japan where the residents did not experience unprecedented economic growth after WWII. In these places, where people have been suffering hardships such as substandard living conditions, racial discrimination, and a harsh environment, we found among the "oldest old" both a high level of life satisfaction and some of the inclusive gerotranscendence characteristics.

For example, we interviewed 102 "oldest old" (mean age = 90 and SD = 3.95) in the Amami Archepelago where the centenarian ratio is significantly greater than neighboring Okinawa (115.54 vs. 67.44 centenarian per 100,000). Despite their hardships, these older adults demonstrated a positive outlook that seemed to give them high levels of psychological strengths through a sense of "sharing" with family members and the community. We found they had a "will to live to 100 or more years," not for their own sake but to make those who care for them proud. Put another way, reaching 100 is not an individual achievement but a collective accomplishment. Further, this sense of "will" also provides a common ground for understanding the meaning of life for both the "oldest old" and others who have shared similar hardships in this region.

Because this region of Japan is known to have a particularly strong emotional involvement related to death and dying, there was great apprehension in the community when a modern "locker room" cemetery was built in one of the small villages when the traditional cemetery was no longer viable due to a shortage of (younger) people to provide regular plot maintenance. The design of the gym-room lockers is similar to those found elsewhere. But unlike those facilities built in crowded suburbs of Japanese metropolitan cities, this one is part of a larger plot on a grassy hill overlooking a beautiful shoreline. The project became a success story, and it has been attracting distant relatives, visitors, and even researchers.

Since residents have a local custom of socializing with family over food and drinks next to their ancestors' tomb stones, it was reasonable for them to hold school and communal events in the new cemetery. During these occasions, the older adults are invited to sit at the front and center of the stage as a token of genuine respect from the community. Even a sterile and indifferent locker room cemetery can symbolize the unity of generations and community in a supportive environment that values the wisdom of the elders. Indeed, we found a large majority of older Amamians feel that "they are attached to the community" (93.7 percent) and that they do not have "a feeling of being forgotten" (96.2 percent).

What these findings reveal is a complex relationship between wisdom and happiness among older adults. Here, I illustrated this point by juxtaposing two scenarios in Japan. First,

I described the case of Japan as a whole where older people were once regarded as wise and valuable, but because of a shift in demography and economics, a radically altered cultural environment has been created in which age may bring wisdom but not happiness. Second, I presented an ethnographic case study of the Amami islands, where the shift in demography did not translate into a dramatic cultural transformation. As a result, older people here are content with their lives, and their presence and wisdom are genuinely respected by others around them. It will be interesting to see whether the definitions of wisdom and happiness change as the nation of Japan continues to experience substantial graying in the next few decades.

Conclusion

In this chapter, I have described various research approaches and historical interpretations of wisdom across cultures. Although as a general trend the field is moving away from a broad and inclusive definition to a more articulated yet exclusive interpretation, I also presented an inclusive framework of wisdom that emphasizes its developmental and relational qualities. In essence, this approach regards wisdom relationally; East/West, expressive-constitutive/instrumental-communicative, and synthetic/analytical are all viewed as two poles of an inclusive psychological process. However, wisdom's inclusivity and exclusivity should not be regarded as a dichotomy where one approach is considered more legitimate than the other. Instead, what is proposed here is recognition that they are part of an integrated whole, and as such a scientific research program on wisdom can and should shift its focus on this spectrum depending on the domain of inquiry.

While the debate regarding wisdom's inclusivity and exclusivity continues, another important but overlooked area is the relationship between wisdom and happiness. This seemingly simple relationship is muddled due to varied semantics that each concept carries, especially on the part of happiness whose definition stretches from *eudaimonic*, par excellence for the greater good, to *hedonistic*, self-serving sensual pleasure. I presented an ethnographic case study among the oldest old living in the Amami archipelago who displayed these two types of happiness. For these older individuals, self-serving materials and a pleasant environment become less important than the fact that they share their lives with their significant others who are either living or deceased. While these wise elders enjoy a certain degree of hedonistic pursuits, as we all do, their lives become much more focused on contributing to a shared experience with the others. Wisdom in this context becomes a balancing act of staying in the "middle way" between *hedonistic* and *eudaimonic* pursuits, and achieving contentedness with what is *due to* them.

Note

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17 Environmental Context and Social Relationships

A Relational Perspective on Health Disparities

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Introduction

Recent research findings have documented the important role of environmental factors in life span biopsychosocial development (Antonucci, Birditt, & Ajrouch, 2011; Glymour, Ertel, & Berkman, 2009). This research has identified the environment as a significant source of vulnerability and resilience, thereby highlighting its critical role in shaping the development of health disparities across groups (e.g., racial/ethnic, socioeconomic, etc.). Despite theoretical advancements and methodological innovations in the study of social relations, and a growing body of research documenting their influence on health disparities across the life span, there is still a fundamental lack of knowledge regarding how characteristics of the environment intertwine with social relations to play a role in this process.

Health disparities are present at all stages of the life span. For example, at the earliest stages there are higher rates of infant mortality and low birth weight among racial and ethnic minorities as well as among those with access to fewer economic resources (Lane et al., 2001; Geronimus, 1996). These disparities play a role in shaping later life disparities. They accumulate across the life span, culminating in the experience of more health problems, e.g., chronic conditions and disabilities in later life, and ultimately shorter life expectancies (Dannefer, 2003; Marmot & Brunner, 2005).

In this chapter we propose that in order to gain a more complete understanding of the causes of health disparities and their life span developmental context, a theoretical expansion of health predictive models is needed. This theoretical expansion, we argue, is best achieved by applying Overton's (2013) Relational Developmental Systems (RDS) metamodel. Doing so will facilitate theoretically driven, empirical examinations of how the environment in which people live and their social relationships are related, and how they together shape health disparities. This level of understanding is needed to determine where, how, and when to effectively intervene to reduce and ultimately eliminate these disparities.

A theoretical expansion of health disparities models guided by the RDS will incorporate a relational perspective, moving the field away from a Cartesian-Split Mechanistic paradigm. This paradigm, as Overton (2013) argues, has been progressively failing as a scientific program of research. It promotes a world-view that consists of oppositional forces or dichotomies. In regard to theory and research on the causes of health disparities, one dichotomy often discussed in the literature is between structure and agency (Link & Phelan, 1995; Breslow, 1978). More specifically, researchers have posed competing theories and presented results showing the role of structural factors (e.g., the environment and the opportunities restricted or afforded by this context in which one lives) or agency (e.g., individual choices to engage in certain behaviors and social relationships that promote or hinder health) as the major contributor of health disparities. However, it is unfair to group all approaches to health disparities into this camp, as many researchers have tried to examine agency within the context of structural constraints

(Gee & Payne-Sturges, 2004; Alegria, Vallas, & Pumariega, 2010). These studies, we argue, more closely align with Overton's RDS metamodel.

A Relational Approach to Health Disparities

Beyond the structure v. agency debate, we argue that there are additional traces of a Cartesian-Split Mechanistic paradigm within the health disparities literature. One instance specifically relates to the role of the environment and social relations. For example, on one hand, many important insights, policies, and programs have resulted from research examining the unique influences of the environment and social relationships on health disparities. On the other hand, research on each of these topics has largely been conducted in isolation of the other. This approach, we argue, can only take the field so far in attempts to gain a more holistic understanding of the causes of health disparities, as evidenced in part by their persistence.

The environmental and interpersonal contexts in which disparities develop are not intuitive dichotomies as are nature v. nurture or structure v. agency, as typically studied within a Cartesian-Split Mechanistic paradigm. For example, environmental context and social relations are not theoretically and purposely viewed and studied as opposites. However, their scientific examination in isolation we argue resembles a Cartesian split, precluding interventions from learning how best to integrate both simultaneously.

The split or dichotomization of these two concepts can be attributed in part to the isolationist tendencies within disciplines. Major exceptions to this do exist (e.g., symbolic interactionism within sociology or social psychology within psychology), and there have been growing calls for research programs to move beyond such tendencies. Some examples include the growing attention to systems science in the study of development (Urban, Osgood, & Mabry, 2011) or understanding developmental systems from cells to society (Antonucci & Webster, 2014). This has led to a realization that one discipline does not contain all the answers, and that as developmental scientists we must work in inter, multi or transdisciplinary research teams (Antonucci, 2015) to achieve a holistic and more complete understanding of developmental processes.

We focus on environmental and interpersonal contexts because they are two particularly influential factors that have been linked to health disparities throughout the life span. We also focus on these two due to their logical, but largely unexplored relational linkage with each other, a key component of RDS-guided theories. In taking this deliberate and specific approach, we do not argue that these are the only two factors needed to gain a complete understanding of health disparities. Rather, we use these as illustrative examples to call for scientists and researchers to approach the study of health disparities from an RDS perspective. Our hope is that these models will then continue to build, drawing from additional disciplinary expertise with an ultimate goal of understanding the myriad of factors linked to disparities and how these factors all link together to create systems of advantage and disadvantage.

Overton's RDS metamodel is particularly relevant to the developmental study of health disparities for multiple reasons. First, the RDS advocates for a holistic approach to developmental science. This is essential in the study of health disparities, as we briefly illustrated. We advocate here for a unified understanding of the role of environmental and interpersonal contexts in health disparities. Furthermore, grounded in the RDS, our call for exploring the relational links between environmental and interpersonal contexts to better understand health disparities helps unite both intended and unintended dichotomies within this field. Through RDS, these opposites, we argue, can be unified to better understand the linkages between multiple concepts involved in shaping health and ultimately lead to more effective interventions.

Second, RDS calls for multiple levels and perspectives of understanding. The environment in which individuals live and their interpersonal context are parts of a whole system that play a unified role in shaping health outcomes. However, these factors operate and exert influence from different levels and influence each other across these levels. The RDS suggests all levels need to be integrated theoretically and examined simultaneously to gain a more complete understanding of developmental processes. As indicated above, some studies within health disparities research engage in this type of research already by examining environmentally or geographically based causes of disparities within the same theoretical or empirical model, while at the same time including individual health-related behaviors (e.g., smoking, drinking, etc.). In terms of multiple perspectives, we argue a large range of academic disciplines together can inform health disparities processes by achieving a more complete understanding; for example, architecture, engineering, economics, history, medicine, public health, psychology, sociology, etc., with each offering valuable perspectives on health disparities. Yet it is not enough that each of these disciplines focuses on health disparities; projects need to be developed that incorporate these perspectives simultaneously.

RDS advances that individuals and the context in which they act continuously influence one another. We focus our attention in this chapter on the influence of the environment in which people live as a key context, and their social relationships as individual actions to better understand individual health. It is plausible, however, that individual health can have consequences for interpersonal relationships as well as the environment in which these relationships are embedded. Through availability of longitudinal data and expanded theoretical models, understanding these dual influences is possible and essential. Overton (2013) refers to the examination of one causal direction over the other as specific moments within a program of research necessary to piece together the synthesis of the whole. We begin with the one direction, but advocate for future moments of theoretical and empirical research to investigate the other direction or moments.

In this chapter we specifically propose a RDS-guided expansion to the Convoy Model of Social Relations (Kahn & Antonucci, 1980; Antonucci, 2001), a heuristic framework designed to describe how an individual is supported by a core group of people who either help or hinder her/his ability to meet life challenges. The model also argues that personal (e.g., age, gender, etc.) and situational characteristics (e.g., roles) shape exactly what those resources or stressors might be, all of which influence, either positively or negatively, an individual's health via social relations. We begin by presenting relevant background information regarding the influences of the environment and social relations on health disparities. This is followed by a description of our proposed theoretical expansion along with specific hypotheses and examples. We conclude by articulating some possibilities for future research to test these theoretical assumptions.

The Influence of Environment and Social Relations

For the purposes of our proposed expansion to the Convoy Model, we classify environmental characteristics into two groups: resources (e.g., access to supermarkets) and stressors (e.g., crime). We hypothesize that environmental characteristics influence health disparities through social relations depending on whether the characteristic is a resource or a stressor. Specifically, we hypothesize that social relations will mediate the link between environmental resources and health disparities, while social relations will buffer the link between environmental stressors and health disparities. Furthermore, we hypothesize the mediation will be stronger earlier in the life span while people are solidifying their networks, and moderation will be stronger later in the life span when support networks play an increasingly important role in shaping health outcomes. The link between environment and health is reviewed below, followed by a discussion of social relations.

Environment and Health

A large and growing body of research from multiple disciplines including environmental toxicology, epidemiology, psychology and sociology has established links between both the physical (e.g., access to exercise and food resources, housing quality, etc.) and social (e.g., crime, social cohesion, etc.) aspects of environments and health (Diez Roux & Mair, 2010; Glymour, Ertel, & Berkman, 2009). The inclusion of these characteristics has been an exciting but also challenging scientific development since it serves to redefine potential causes and consequences of socio-demographically linked health disparities. Moreover, environmental characteristics are often indicative of socioeconomic inequities which intersect with age, gender, race, and education.

With socioeconomic inequalities increasing at faster rates than any other time in recent history, this added awareness of the role of the environment opens new avenues for scientific inquiry and important implications for social justice. Furthermore, rising inequality is resulting in unprecedented shifts in the environmental landscape of urban communities at a similarly alarming pace (Kawachi & Berkman, 2003). Some characteristics of this change include disappearance of well-paying jobs, massive population loss, foreclosure crises, and now a deteriorating and highly vacant housing stock in urban areas. Adler and Newman (2002) note that communities with a higher proportion of people living in poverty tend to have multiple environmental disadvantages such as exposure to toxins through lead paint and asbestos, as well as neighborhood proximity to highways, polluting industries, and toxic waste sites. They report that housing quality in disadvantaged communities is often poor, characterized by residential crowding, high noise levels, and unsafe physical conditions, all of which are known to be associated with numerous health problems in adults and developmental disabilities in children. In addition, environmental resource deficits and stressors have been known to lead to social isolation, strained or smaller social networks, and a lack of social cohesion, which in turn are associated with higher levels of morbidity and mortality (Webster, Ajrouch, & Antonucci, 2013). Finally, as Diez Roux and Mair (2010) noted in a recent review of links between the environment and health, research has grown significantly in the last 15 years, producing an impressive body of empirical evidence.

With increased socioeconomic inequalities have come commensurate inequalities in environments, and these appear to be exacerbated over time. Thus, the expansion of the Convoy Model to include the role of environmental characteristics in shaping health disparities via social relations is especially warranted. Including environmental characteristics will aid in understanding how these factors may influence and shape social relations, a key resource shown to impact health.

Social Relations

Social relations are widely recognized to influence health and to impact health disparities (Durkheim, 1951; Berkman & Syme, 1979; House, Landis, & Umberson, 1988; Antonucci, Ajrouch, & Janevic, 2003). We now understand that while social relations are essentially universal, they manifest differently, are multidimensional, can be both positive and negative, and are influenced by personal and situational factors (Antonucci, Birditt, & Ajrouch, 2011). Recent findings make clear that to achieve the next level of understanding of human development, a longitudinal, in-depth approach which recognizes the complexity of social relations is necessary (Antonucci, Birditt, & Ajrouch, 2011).

The Convoy Model provides an overarching framework that affords an in-depth examination of social relations and support exchanges in varying contexts across the life span (Antonucci, Birditt, & Ajrouch, 2011; Antonucci, Ajrouch, & Birditt, 2014). The model in many ways aligns with the RDS by combining and synthesizing multiple perspectives,

e.g., from developmental psychology and the sociological tradition of symbolic interactionism as well as being rooted in theory and research on social networks and support (Kahn & Antonucci, 1980; Antonucci, 2001; Antonucci et al., 2009).

Convoys are conceptualized as a person's social network. They are comprised of people who surround an individual, protect and socialize, shape and change the individual, and their health across the life span (Kahn & Antonucci, 1980; Antonucci, 2001). The Convoy Model proposes that individuals are surrounded by (optimally) supportive others who have a significant influence on their health. Convoys can be described in terms of their structural characteristics (size, emotional closeness, contact frequency, geographic proximity, and composition), and are considered dynamic, influenced over time by personal (e.g., education, race, and age) and situational (e.g., role positions) characteristics. These situational characteristics can also include macro-level factors, such as variability in access to economic resources (Berkman, Glass, Brissette, & Seeman, 2000; Ajrouch et al., 2005). Antonucci and colleagues (2004) have called for more research to investigate specific pathways through which social convoys and exchanges of support influence health across the life span and also how these pathways vary across contexts.

Research grounded in the Convoy Model has led to many insights into the complex and nuanced role of social relations in shaping health disparities across the life span. For example, lower levels of education have been linked with smaller and more family-dominated networks (Ajrouch, Blandon, & Antonucci, 2005). However, the same study found no link between education and the number of close social ties. In terms of links to health, older adults having more family members in their convoy have been shown to report fewer depressive symptoms over time (Fuller-Iglesias, Webster, & Antonucci, 2015). However, in other contexts, older adults with convoys comprising a mix of family and friends report better mental health (Fiori, Antonucci, & Cortina, 2006). These findings highlight that the way in which social relations influence health and differential health outcomes across groups varies across contexts and the life span.

The role of social relations in shaping health outcomes has also been shown to vary by situational characteristics (e.g., roles such as being a spouse/partner) across the life span. For example, among spouses, positive relationship quality has been linked to increased resiliency among older adults in the context of stressful life events (Birditt, Jackey, & Antonucci, 2009; Fuller-Iglesias, Sellars, & Antonucci, 2008). Similarly, Antonucci, Ajrouch, and Janevic (2003) found that among middle-aged men, high-quality social relations can offset the negative influence of lower socioeconomic status (SES) on health. Specifically, those with less education, but larger networks, reported health on par with their more highly educated counterparts. Also, research grounded in the Convoy Model has highlighted the potentially protective influence of non-traditional social relations such as volunteering, which may provide an overlooked pathway for enhancing active and multiple roles in later life (Ajrouch, Antonucci, & Webster, 2016).

Proposed Expansion of the Convoy Model

In Figure 17.1 we present our proposed version of an expanded Convoy Model to incorporate relational systems through inclusion of the environment as a situational characteristic composed of both resources and stressors. In the original Convoy Model, situational characteristics are described as roles (e.g., parental, marital, or employment status) that can have profound influences on the structure, support, and quality of one's social relations. In the paragraphs below we detail the unique addition of the environment as a situational characteristic and its potential and hypothesized role in influencing health through or in combination with social relations. Presenting the environment as a contextual factor in tandem with individual-level

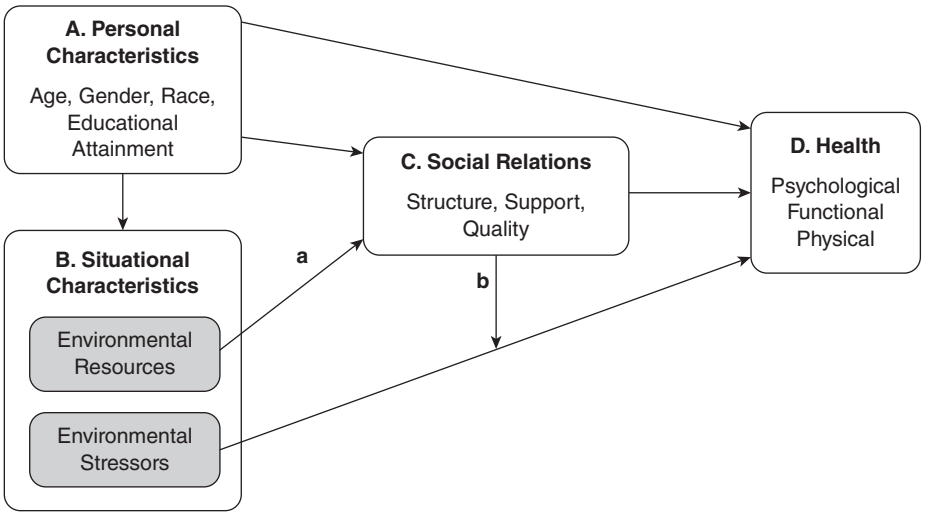

Figure 17.1 An expanded Convoy Model including environmental characteristics.

factors inherent in social relations (engendered by and between individuals), we move beyond dichotomies. The expanded Convoy Model, therefore, advances a relational approach as proposed by Overton (2013). Specifically, we propose that environmental characteristics can be conceptualized either as resources or stressors which can influence health disparities through (path a) or in combination with (path b) social relations. Such a theoretical framework is needed, we argue, to guide future empirical investigations of this topic.

Environment and Health: Potential Mechanisms

Studying the relationship between environmental characteristics and health across the life span, and in particular identifying causal mechanisms or protective factors over time, may increase opportunities for primary and secondary prevention of disease and illness. Ultimately, examining environmental factors along with social relations may contribute to a healthier older adulthood and opportunities for greater equity.

Conceptualized as a resource (Ensel & Lin, 1991; Martin, Grunendahl, & Martin, 2001), social relations have been identified as one of the many psychosocial mechanisms that may mediate or moderate SES-related health disparities (Anderson & Armstead, 1995; Turner & Marino, 1994; Vaillant, Meyer, Mukamal, & Soldz, 1998; Williams, 1990). However, little research specifically examines the link that social relations may have to the association between the environment and health. While a growing body of research has explored associations between environmental characteristics and social capital (Subramanian, Lochner, & Kawachi, 2003), little to no research has explored in-depth how the characteristics of the residential environment are linked to the structure, support, and quality of social relationships. One exception is the qualitative work of Cattell (2001), which showed that social relations can affect health by offsetting some, but not all, of the negative aspects of an impoverished environment with multiple disadvantages.

We propose this association may take two possible forms. The "mediation hypothesis" holds that the link between environmental resources (as measured by, e.g., supermarket access, homeownership rates) and health is mediated by (or operates through) the size of their social

network and the individuals' perception of social support from key others. In other words, individuals living in low-homeownership areas might possess fewer social resources, the lack of which might account for poorer health. Alternatively, the "moderating hypothesis" posits that social integration and perceived support from important others buffer or moderate the impact of living in areas with high environmental stressors (as measured by, e.g., crime and vacancy rates) on health.

Research has examined how social relations moderates the effects of SES on health, with unique and intriguing findings (e.g., middle-aged men of lower SES showed few health disparities in the presence of key supports; Antonucci, Ajrouch, & Janevic, 2003). Preliminary analyses examining links between environmental context and social relations have shown that the availability of environmental resources plays an important role in shaping later life vulnerabilities such as functional health declines (Webster & Antonucci, 2012). A better understanding of which environmental factors can be offset and which aspects of social relations play a role in this process can guide future prevention and intervention efforts aimed at reducing health disparities.

The inclusion of built and social aspects of the environment as a situational characteristic in the Convoy Model has the potential to offer a major step in the advancement of theoretical and empirical understandings of the social determinants of health and the mechanisms through which environmental characteristics perpetuate optimal health. This expansion, we hope, will lead to a fundamental rethinking concerning the causes and consequences of health disparities. Health disparities have most often been considered an individual or at best family-level issue, but we believe that this expansion and subsequent empirical investigations will lead to evidence that characteristics of the environment independently and in interaction with interpersonal characteristics influence health disparities both cross-sectionally and longitudinally. Once this evidence is available, policy makers should be encouraged to recognize this as a social justice issue and rethink how health disparities are addressed. They should, for example, be encouraged to include individual, interpersonal, and environmental programs in an integrated and holistic manner as advocated by RDS to both prevent and alleviate health disparities.

In the following paragraphs, we provide illustrative examples of both built and social aspects of the environment that can be conceptualized as resources and stressors that may play a role in impacting health disparities through mediation and moderation.

Environmental Resources

1) Built: Access to Supermarkets. We use access to supermarkets as an illustrative example of a built environmental resource. Supermarkets provide an actual physical space for residents to meet (whether planned or unplanned), interact, and develop and/or strengthen social ties with other nearby residents. These potential benefits of supermarkets are often overlooked and understudied in the health disparities literature, where the bulk of the attention is on their role in providing access to healthy foods (Webster, Ajrouch, & Antonucci, 2013). Other examples of the built environment that can be viewed as resources that may shape one's social network characteristics (e.g., size, proximity of network members, frequency of contact, etc.) include the availability of parks, well-maintained sidewalks, and convenient public transportation. All of these examples, we argue, can help facilitate social interactions, leading to potential future and positive support exchanges, which have been linked to better health outcomes.
2) Social: Homeownership rates. We use homeownership as an illustrative example of how stable versus more transient neighborhoods or proximate environments may be in which people are living over time. We hypothesize that environments with higher rates of

homeownership allow for greater consistency of residents over time, thereby allowing for more opportunity and time to develop social ties with residents. Over time, residents may be more willing and comfortable to call on neighbors for help and support when it is needed and to reciprocate to previous provisions of support (Antonucci & Jackson, 1989).

Mediation Hypothesis

We expect that people with more resources in their environment, such as the built (e.g., greater access to supermarkets) or social (e.g., more homeowners) environment, will have larger networks than those with fewer resources available in their environment. This will in turn be associated with better health outcomes. Evidence of this pathway can lead to specific policy guidance about what types of facilities and resources to invest in lower-income neighborhoods, which have been linked with poorer health outcomes. The way in which social network characteristics mediate the environment–health link we expect varies across the life span (i.e., by age of the respondent) and is subject to both intra- and inter-individual variability. Specifically, we expect the mediation effect to be the strongest earlier in the life span when social networks are largely being developed and solidified.

Environmental Stressors

1) Built: Vacancy rates. We propose household unit vacancy rates as an illustrative example of an environmental stressor. Specifically, vacancy rates, we argue, can be viewed as a proxy measure of the housing condition in an area, which can be linked with a number of stressors. Living in an area with increasing rates of vacancy can lead to stress about one's own property value, worry about the potential for arson or illegal activities occurring in vacant homes, etc.
2) Social: Crime. The FBI's Uniform Crime Reports collects yearly data on murder and non-negligent manslaughter, forcible rape, robbery, aggravated assault, burglary, larceny-theft, motor vehicle theft, and arson (U.S. Department of Justice, Federal Bureau of Investigation, 2015). The frequency of such types of violent crimes where one lives can lead to considerable worry about one's own safety as well as the safety of family members and friends. Given data about these stressors are publicly available, they can provide an important direction for intervention as we seek to prevent or intervene in the reduction of health disparities.

Moderation Hypothesis

We expect that the association between stressful built (e.g., many vacant homes) and social (e.g., more crime) environments and health will be offset when more positive social relations are available. In contrast to our expectation that mediation would be stronger early in the life span, we expect the opposite here. Specifically, we hypothesize that the way relationship quality buffers the environment–health link will also vary across the life span and will be strongest later in the life span, when support networks have been shown to play an increasingly important role in shaping health outcomes. As biological factors are less plastic later in life, an important source of later life improvement or reduction of stressors will be environmental.

Future Directions

There is little prior research on the dual influence of social relations and the environment on the development of health disparities across the life span. One reason for this may be

the lack of sufficiently detailed, longitudinal studies that follow social relations of the same individuals and their environment over time. Fortunately, the recent availability of such data makes future examinations possible. Below we outline some possible future directions for this research, using the proposed RDS-guided expansion to the Convoy Model as a framework.

Geospatial Data

We recommend that future studies that uphold a relational approach to the study of health disparities include data on social relations across the life span as well as incorporate geospatial data to permit the examination of the impact of environmental resources and stressors. Recent research has capitalized on the relatively new technique of geocoding and has noted that health disparities are often geographically clustered (Diez Roux, 2001; Krieger et al., 2002). This has made available a large amount of data on environmental stressors and resources at multiple levels of environmental influence (e.g., block, neighborhood, etc.). With these data, future studies can empirically test our proposed expansion of the Convoy Model to specifically examine the associations between environmental characteristics, social relations, and health disparities.

This research will facilitate an improved understanding of whether and how health disparities evidenced in less advantaged environments can be further linked to patterns of social relations. Selection of which aspects of the geospatial environment on which to focus should be guided by theory as well as previous empirical findings linking the environment to health and health-related behaviors. Doing so, we expect, will provide evidence for how and where social relations can have the largest and most profound impact on reducing or mitigating environmentally driven health disparities. Further examination of these patterns of associations by population subgroups can also yield important new insights and provide the specificity needed to develop targeted interventions, e.g., by age, gender, race, and education.

Geospatial and Longitudinal Data

We argue for the need to collect and incorporate geospatial data into longitudinal studies of social relations. This will permit more expansive and detailed examinations of the causal and developmental processes involved in shaping health disparities, and in turn their potential reciprocal effects on communities. In particular, this type of data is needed to better understand how health disparities are shaped within and across multiple inter-related levels of influence (e.g., environment, interpersonal, and individual levels). Furthermore, the use of longitudinal data with life span samples followed up at key developmental time points will allow for a unique opportunity to examine how these multi-level processes unfold similarly or differently at different points across the life span.

Summary

Our proposed expansion of the Convoy Model of Social Relations from a Relational Developmental Systems perspective has a primary goal of integrating environmental and interpersonal contexts within a unified framework to better understand the causes of health disparities. This framework, we hope, will enable theoretically grounded empirical examinations that move the field away from dichotomies as it allows for the examination of how longitudinal links between environmental factors and development of health disparities are mediated and moderated by social relations. This focus builds on two of the primary goals in the social relations literature to a) identify the circumstances under which characteristics of social relations are most prominent; and b) elaborate those characteristics of close social relations that have the most influence on health.

Such research has the potential to lead to a fundamental reevaluation of how we understand the causes and consequences of health disparities and how they develop across the life span. Specifically, this could include insights into the complex associations between socioeconomic factors, social relations, and health. Empirical research grounded in this type of framework can lead to the identification of individuals who are most vulnerable and most resilient in the context of their environment, thereby providing direction for the development of prevention and intervention efforts and policies that target multiple levels, including the individual, their interpersonal ties, and their environment.

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18 Developing Persons and Clashing Cultures

Jeanette A. Lawrence

Contemporary twenty-first-century life is experienced in expanding social landscapes where rapid changes in communication (e.g., telephones, social media) and global trans-national movements (e.g., of immigrants, refugees, guest workers, travelers) place people in complex social environments marked by competing and even clashing cultures. The contexts of these competitions may be global or localized, but competitions between cultures are so common that cultural isolation is a rare contemporary experience.

In this chapter, I propose an analysis of people's developmental experiences in the globalized environment of competing cultures, grounding the analysis in a relational-developmental-systems framework that sees persons and cultures as *interpenetrating* each other and *coacting* in ways that bring about change for persons and for cultures. The chapter is in six sections. The first sets the context of competing cultures; the second examines the central concepts of "culture" and "cultural" and the significance of culture in people's developmental experiences; and the third examines the integration of culture into contemporary developmental science. The fourth section extends the analysis to the contemporary environment of competing cultures, revisiting traditional accounts of enculturation and acculturation processes, and how they are considered together developmentally. The fifth section presents an illustrative study of person-by-culture coactions in Australian Aboriginal women's activities to preserve a unique cultural ceremony within an environment of clashing cultures. The conclusion is that a relational-developmental-systems approach gives developmental science a solid basis for discussions of culture in the lives of contemporary young people.

The Contemporary Phenomenon of Clashing Cultures

How can cultures be said to clash, and what meaning do researchers attach to terms like "culture" and "cultural group" when focusing on competing cultures? This competition is important because culture plays a significant role in people's developmental experiences, particularly in how persons and cultures become mutually intertwined (e.g., Lerner, 2011; Overton, 2010, 2015). Cultures clash when people encounter opposing cultural offerings and requirements for living in a contested space. Opposition may arise from ethnic, religious, political, or recreational differences, or from disjunctions between everyday and virtual worlds.

Young people, in particular, find themselves living in environments in which cultures jostle for their attention and allegiance. The numbers leaving Western countries to fight for or against the Islamic State of Iraq and Syria (ISIS) represents one extreme example of young people giving their allegiance to distinctive cultural groups. The rise of far-right nationalist groups is another.

Cultural competition is to be expected by migrant and refugee young people whose families resettle in countries that differ from their homelands and from their experiences of war, displacement, and relocation. Similarly, young people from indigenous and other marginalized groups grow up embedded in their birth culture (e.g., Native American; Australian

Aboriginal; Canadian Inuit), but find themselves negotiating with another, national culture that controls the routes to educational and vocational advancement. They have the added pressure of realizing that they belong in the contested space, but still are dispossessed or disenfranchised. For Native Americans, for example, this experience is often described as "walking in two worlds" (LaFromboise, Albright, & Harris, 2010).

Competition, however, does not only involve ethnic and national cultural groups. It may arise between community, religious, or specialized interest groups as diverse as lesbian, gay, bisexual, and transgender (LGBT) and bible study groups, or as competitive as rival school or sports communities (Cole, 2010). For many young people, the competition involves distinctions between everyday life and virtual life in social media and games that absorb their attention, energy, and motivations (e.g., Park, Kee, & Valenzuela, 2009).

Even if global explosions in transportation and communication do not on the whole provoke more cultural clashes now than in earlier eras, they make the clashing of cultures more common for people in remote villages as well as major cities. Technology and social media bring reports of natural and human-made disasters into the evening's entertainment for millions, along with international festivals and sporting events. Travelers encounter challenges of their previously accepted way of life, precisely while they are challenging other people's ways.

People are challenged to make adjustments that become catalysts for changes in life-style and identity. They may choose to integrate both concordant and discordant cultural messages into their meanings for their lives and for the lives of the people surrounding them. When messages are discordant and cannot be reconciled, people may make a deliberate choice of one way over another (e.g., by religious conversion), or they may try to avoid the choice and live outside any identifiable cultural groups (Weinreich, 2009). Issues for developmental scientists revolve around analyzing how people manage the challenges that come with clashes between cultures, and that analysis largely depends on the role scientists assign to culture.

The Significance and Meaning of Culture

Culture is central to human activity, being largely responsible for population differences (Foley & Mirazón Lahr, 2011), and for the organization of environments suitable for people to inhabit (Cole, 1996). Humans are not greatly diverse genetically, so much human diversity can be attributed to culture that, as a second inheritance system, operates in addition to and in interaction with genetic inheritance (Whiten, Hinde, Laland, & Stringer, 2011, p. 938).

There is no dispute across the social sciences that culture is significant. Disputes abound, however, about how to conceptualize culture and its role, and how to integrate analyses of culture into analyses of development (Mistry & Dutta, 2015). Questions of definition and meaning have been answered differently within psychology for decades, and according to Overton (2014), there are as many approaches to understanding the significance of culture as there are meta-theoretical frameworks that form the "conceptual context(s)" of scientific paradigms (p. 324). Although the experience of culture is prominent in everyday discourse and social arrangements, the "culture concept" persistently defies any universally accepted definition by social scientists (e.g., Causadias, 2013; Cole, 2010; Cole & Packer, 2011; Gjerde, 2004; Goodnow & Lawrence, 2015; Jahoda, 2002).

Goodnow and Lawrence (2015) recently proposed using the "culture" concept sparingly, and instead using the adjective "cultural" for groups, ideologies, and contexts. This proposal follows Cole's (2010) note that the "cultural" descriptor

> applies equally to small groups of people who have engaged for some time in joint activities to achieve some common object, such as working in the same business or same office, or the same Little League team or army unit or in the same classroom.
>
> (p. 462)

The cultural descriptor can also be applied to the beliefs and values cultural members hold as their own and are said to "share"; to the practices and routines in which they engage with other members; and to the material tools made available as their collective resources.

Integrating Culture into Development: A Relational-Developmental-Systems Approach

The relational-developmental-systems approach laid out by Overton and colleagues (e.g., 2010, 2014, 2015; Overton & Lerner, 2014) provides an appropriate basis for analyzing the role of culture in development. By focusing on the activities of developing persons in relation to culture, it not only avoids the dichotomies and splits of past Cartesian accounts, but it also renders untenable logical positivist views that attribute the outcomes of human activities to either strictly environmental or strictly genetic influences, effectively denying agency to developing persons and masking the bi-directional, co-constructive nature of person-by-context exchanges (Overton, 2010, 2015).

A relational-developmental perspective, in contrast, focuses on the centrality of human activities as part of a complex, organized, holistic system. Overton (2013) makes it clear that any parts of the total system must be seen in relation to the whole system and its other parts; "Holistically, the whole is not an aggregate of discrete elements but an organized system of parts, each being defined by its relation to the other parts and to the whole" (p. 44). Consequently, it is inappropriate to try to understand either developing persons or cultures in isolation from each other, or to neglect their joint activities within the system; "*analysis of parts must occur in the context of the parts' functioning in the whole*" (Overton, 2013, p. 44, original emphasis).

The Role of Culture

Mistry and Dutta (2015) demonstrated how a relational-developmental-systems approach gives culture its proper role in the developmental experiences of persons. They first compared analyses of culture currently proposed in cross-cultural, cultural, and developmental sub-disciplines of psychology, showing how these subfields diverged in their treatment of culture either as a comparative independent variable (mostly in cross-cultural psychology) or as a system of meaning (in various cultural and sociocultural psychologies).

Causadias (2013) made a similar critique of sub-disciplinary preoccupations that have impeded the formulation of strong psychological explanations of the role culture plays in specific people's life experiences—in his case, life experiences that are studied in the field of developmental psychopathology. Causadias proposed that productive analyses of person-by-culture connections would be aided by specifying the individual and social elements of culture and their connections:

> Social-level cultural processes are associated with important changes in multiple domains of development (e.g., cognitive, emotional, social, biological, psychopathology), and . . . personal engagement in such social processes can be considered a developmental domain in its own right (e.g., cultural development).
>
> (Causadias, 2013, p. 1379)

This specification of the different aspects of culture gives a useful way of taking up Cole and Packer's (2011) resolution of the ideal–material dichotomy that pervades traditional definitions of culture proposed within psychology's sub-disciplines. It also facilitates seeing the

social and personal as distinct but inter-connected aspects of the role of culture. The cultural medium is both material (in the artifacts passed on by prior generations) and mental (in the cognitive activity of current individuals): "the subjective/ideal and objective/material aspects of culture are inextricably interconnected" (Cole and Packer, 2011, p. 76).

Emphasizing connections between the material and the mental is important for integrating culture with development, because it avoids the splitting and reductionism belonging to either an exclusively environmentalist or an exclusively biological conceptualization (Overton, 2013, 2015). Gjerde (2004) succinctly specified the public/private connections: "cultures can be said to exist as contested representations, situated in public domains or institutions in which power is both exercised and resisted" (p. 146). Serber and Hirschfeld (2004) similarly pinned the connections to the flow of information. "'Culture' refers to this widely distributed information, its representation in people's minds, and its expressions in their behaviors and interactions" (p. 40).

The Role of Persons

Cultural meanings and resources become personalized in the process of being taken in and interpreted in a continually-being-constructed intra-psychological *personal culture* (Valsiner, 2014). In the process of internalizing and externalizing the conceptual resources of cultural meanings and signs, the person works on these and turns them from "resources" (belonging to the culture) into "assets" (belonging to the person; Fergus & Zimmerman, 2005) that s/he can express in this and other encounters with culture. By the inter-related activities of internalizing cultural messages and externalizing newly constructed personalized versions, the person is engaged with the culture in co-constructing messages and signs. Valsiner (2014) proposed a model of the complex layers through which persons take cultural messages into their own value and belief structures. Not all cultural messages are admitted, but those that are admitted are transformed into personally workable ideas that are composed and re-composed in relation to existing personal knowledge and beliefs (Lawrence & Valsiner, 2003).

These personal versions are *cultural* because their origins are in the social discourse and retain cultural meanings; they are *personal* as they are worked over by the person and expressed back into the culture:

> Persons actively *decompose* messages—*communicated to them by signs*—and *recompose* them into *new intra-psychic* patterns which are then constructively brought into the sphere of accessibility by others.
>
> (Valsiner, 2014, p. 63, original emphasis)

The cultural discourse is susceptible to how persons accept, modify, or resist the cultural discourse held out to them, and therefore it too is susceptible to change. While in Gjerde's (2004) terms, cultural power resides in the representation and control of in-group knowledge as "natural"—to be taken up and practiced—so-called natural arrangements may be modified or over-turned by family members experiencing the pressures of contemporary life (Goodnow & Lawrence, 2013). Izuhara (2004), for example, found that adult children in Japan were revising the tradition of bringing elderly parents to live with them. They continued to observe the norm of elder care but changed how it is enacted. Some Asian young adults similarly explained that in choosing their own marriage partners, they were still observing the spirit of their parents' wishes without surrendering personal choice (Kwak, 2003). By acting in the social domain, these people initiate new forms of cultural discourse and practice.

Person and Culture in Coactions

Such changes occur as culture and person and the whole system of which they are parts are located in a specific space/time where culture and person exercise their distinctive roles while being merged into each other (Overton, 2015). Culture and person so interpenetrate that their joint actions can best be described not as "interactions" but as "coactions." Overton explained this merging

> as parts of a single identity while maintaining their individual identity as differentiations, that the terms *interpenetration* (merging) and *coaction* (← →) (Gottlieb et al., 2006) must be substituted in place of *interaction*, except in those cases that refer to a simple additive combination of elements, such as statistical interactions.
>
> (2015, p. 52, original emphasis)

The culture organizes how life is and should be lived through its discourse and practices. The person participates in the culture's discourse and practice, leaving traces of personal versions. By their interpenetrations and coactions, person and culture are transformed in the process.

Culture Organizes Developing Persons' Lives

All cultures invite adults and children to sign up for the benefits and responsibilities of cultural membership. The signing may be literal or symbolic, as people take up into their own thinking the culture's distinctive discourse (the individual or personal dimension) and join in the activities and expressions of the collective culture (the social dimension). Participation is organized and routinized in culturally specific ways, especially for the young (e.g., where they sleep, what they eat, how they learn, the participatory roles and responsibilities they are expected to take up as they gain more cultural competence; Rogoff, 2014; Shweder et al., 2006). In its organization of people's lives, however, culture is not remote from persons, is not unchanging, and does not contribute to children's lives in a single directional "trickle down" way (Goodnow, 2011). Goodnow and Lawrence (2015) accordingly argued against treating culture as a remote influence, situated at the outer edge of a collection of nested influences, and affecting child development by influencing the behavior of parents or by "trickle down" effects through other more proximal influences as it is treated in Bronfenbrenner's (1979) classic ecological model. Current developmental models need to reflect the coactive, bi-directional constructions of development in which the child is actively engaged with culture.

Pattel (2007) described an Australian Aboriginal image of culture as always present and central in people's minds. When Aboriginal people describe circumstances or events to health professionals, for example, they do not simply refer to their own presence, but to the collective "we": the kin or others who are intimately connected to the person speaking and whose stories and conditions are part of the situation being described. In effect, culture is carried as an intrinsic part of Aboriginal ways of thinking and acting. People who hold Western hierarchical views of contexts, Pattel (2007) argued, do not understand the holistic, integrated structure of the Aboriginal universe. The concepts of coaction and interpenetration developed within a relational-developmental-systems approach, however, are consistent with a holistic understanding.

Regardless of its world-view, a culture exercises its power by its public institutions that channel individual people's developmental trajectories through approved family, educational, and vocational structures (Valsiner & Lawrence, 1997). Cultural directions and sanctions do not simply identify what *can* be done, but also what *should* be done, and the range of behaviors that will and will not be tolerated (Goodnow & Lawrence, 2015). They also usually

allow some loopholes so that members can avoid full compliance, but still participate in the collective life. Acceptable ways of fudging strict criteria to avoid severe penalties seem to be part of many cultural systems; for example, Omani women's strategy of substituting goat's blood for wedding night demonstrations of the bride's virginity (Wikan, 1982). At another level of cultural organization, Borgeson and Valeri (2015) reported the level of tolerance allowed in cultural groups of skinheads in the USA. Although masculinity is one of their markers, gay skinheads experienced acceptance and safety within the culture.

Developmental analyses need to account for normative views and practices within a culture's institutionalized organization in relation to how people participate and make adaptations that have potential for changing both person and culture. Alcalá and colleagues (2014), for example, described culturally organized and fostered differences in children's contributions to their parents' work, help at home, and sibling care in two communities in Guadalajara, Mexico. One group of Indigenous-heritage children routinely contributed help as responsible members of the family collaborative team. In another, cosmopolitan community, children were developing in an environment where participation was not expected or valued, and they did not pursue it.

Developing Persons Participate in Cultural Life

Children identify with the culture as they acquire and personalize cultural knowledge and participate in culture-specific practices. The parents' expectations and children's activities in the Alcalá et al. (2014) study point to children's integration in family endeavors. The Indigenous-heritage children's happy involvement in family work was illustrative of Rogoff's (2014) "learning by observing and pitching in" style that had no part in the organization of life in the cosmopolitan community, even on occasions when children contributed to family efforts.

Participation, however, is not automated. Children are not carbon copies punched out from some idealized cultural mold (Gjerde, 2004), but active interpreters of cultural preferences. Diesendruck and Markson (2011), for example, found that young children work at decoding the norms, practices, and symbols so that they can know what others expect of them and so that they can also signal what they themselves wish to happen. Similarly, Harris and Corriveau (2011) found that 3- and 4-year olds were more inclined to trust adult informants if the adults were members of a consensus (cultural) group, abided by group norms, and had a history of being accurate.

Early in life, children develop strategies for bargaining over adult directives and cultural norms (Kuczynski & Hildebrandt, 1997). They are also able to alter the traces of cultural knowledge they leave for others to take up and use. Flynn (2008) observed how young children used individualized shortcuts when asked to imitate the procedures used by other children or adults, and in the process changed the traces left for other children to follow in the chain of imitations. Such embodied activity is not only adaptive and efficient for the individual child; it is also a way by which culture may be changed.

In summary, the relational-developmental approach integrates culture into developmental analyses, acknowledging its sense-giving and organizing role and its provision of resources and tools. It also emphasizes the agentic part played by developing persons in coactions with culture, thus locating both personal developmental and cultural change in the interpenetrations of person and culture. It follows, then, that if a person's total environment includes conflicting cultures, that person's developmental experiences cannot be considered in isolation from the conflicting opportunities and challenges belonging to the two or more cultures. What do people do with conflicting cultural messages, and how do they manage competing cultural activities and coactions?

Persons Developing in Relation to Competing Cultures

Continuing inter-cultural encounters can take many forms (from benign melding to violent confrontation), with each form able to challenge the developmental accomplishments and trajectories people have been constructing. While challenges open up new pathways for some people, they are unwelcome disturbances for others (e.g., changes to entrenched customs; Izuhara, 2004; Kwak, 2003).

Ground-breaking research by Chandler and Lalonde (2009) underlined how personal life can be dramatically disturbed when cultures collide. Rates of suicide among Canadian Aboriginal youths were dramatically lower in First Nations bands that secured some measures of self-government, health, policing and cultural resources, proportions of women in band government, and control of child protection services. In other bands, suicide rates were far higher than national averages.

Clearly complex inter-connections between cultures have significance for people's individual developmental trajectories, and require active engagement and choices. Ogbu's (2004) historical analysis of how African-Americans have "passed as white" illustrates the range of strategies people use to make personal adaptations to racial pressure. Strategies changed historically as well as by situation, and involved some people physically leaving areas where they were subjected to discrimination. Others disguised their personal reactions to discrimination, redefining themselves as freedom fighters instead of victims, or adjusting to living in two worlds, switching language and behavior patterns to fit into different situations.

Self-redefinitions also appear in migrant young people's constructions of hybrid or hyphenated cultural identities. Self-presentations as "ABCs" (Australian-born-Chinese), "Sudanese-Australian," or "Vietnamese-Australian" are frequently offered by people who are asked about their cultural background in multicultural Australian society. These personalized self-descriptions can be seen as externalized expressions of people's personal constructions and reconstructions of their places in their social worlds. Skandrani, Taïeb, and Moro (2012) asked young women whose families had immigrated to France from the Maghreb how they constructed identities for themselves in a society that was often hostile to Muslim cultural practices (e.g., wearing the hijab). The women asserted their re-appropriation of their Muslim identity, but with novel "hybrid Muslim identities" that also incorporated their French identity. One explained: "Euh, being Muslim and French, that's connected for me . . .. I can even say, that the French part of myself doesn't go without the Muslim one. Both parts live together" (p. 87).

Take, for example, a 10-year-old boy whose Somali refugee family resettled in an Australian city before he was born. He is not only developing in engagements with his Somali cultural group, but also in engagements with the wider Islamic culture centered around the mosque and another culture centered around his Arabic language classes. At the same time, he is engaging with the community of his local elementary school and his class, the local junior soccer team, and any other community group he may join. He may find himself navigating his way between different cultural meanings and practices that conflict in his variously situated activities (Mistry & Wu, 2010). He may "culture-switch" his thoughts or practices as he moves from one situation to another (Dodds et al., 2010; Oppedal, 2006). Like Skandrani et al.'s (2012) young women, this Somali boy has to work out his development in the context of competing heritage and mainstream cultures.

Dodds, Albert, and Lawrence (2014) found evidence of this culture-switching in comparisons of the self-descriptions of school-related skills of Somali refugee children and non-Somali local children from the same elementary school. The Somali children agreed with their parents that they were skilled in spelling but not in music. Non-Somali children and their parents gave the opposite response. The Somali children, however, agreed with their local peers, but

disagreed with their own parents, that they were skilled at sport. In rejecting music, they were following their Muslim cultural practices, but their endorsement of sport was aligned with mainstream Australian sporting passion.

Revisiting Enculturation and Acculturation Processes

Traditionally, development in the context of one's heritage culture is discussed as *enculturation*, and adaptations to another, second culture as *acculturation*. They are mostly considered as separate processes. However, once the activities of the developing person are framed in terms of person-by-culture interpenetrations and coactions, it makes good sense to bring them together as processes that occur within the life-course development of individual persons in particular cultural contexts. This blending also appropriately sees these culture-related processes in terms of developmental changes in individuals rather than as more-and-less adaptive group strategies (Dodds et al., 2010; Oppedal, 2006; Weinreich, 2009).

Enculturation has retained its focus on people's development in their heritage culture since Herskovits (1948) formulated the concept to describe the adaptations of children and adults that, for him, made social life possible: "Every human being goes through a process of enculturation, for without the adaptations it describes he could not live as a member of society" (p. 40). Children become progressively enculturated as they internalize and externalize their personal cultures (Lawrence & Valsiner, 2003; Valsiner, 2014) and actively engage in cultural discourse and practices. The specifics of cultural identities and competences differ across cultures, and the accumulations and modifications of person-by-culture constructions contribute to the emergence of, for instance, a Tamil Tiger, an Arrente Australian Aboriginal woman, or a fundamentalist Christian, Jew, or Muslim.

Acculturation processes come into play when people move from single to dual or multiple cultural contexts. Cultural identity and knowledge that is in the process of construction is open to challenge by new images and possibilities. Acculturation studies mostly examine the effects of cultural groups' jostlings for dominance or survival, often with accompanying patterns of acculturation stress (e.g., Berry, 2015; Schwartz, Unger, Zamboanga, & Szapocznik, 2010).

According to Sam and Oppedal (2003), developmental changes in children living in contexts of competing cultures cannot be exclusively attributed to either their heritage-related experiences or acculturation processes. Migrant and minority group children come into contact with mainstream institutions at the same time that they are going through the processes of enculturation. The practices and values of the local school, for instance, may be particularly challenging for children whose home culture is alien (Oppedal, 2006). Developmental transitions and achievements cannot be put on hold while the opportunities and challenges of a dominant culture are processed. Cultural offerings and inducements are unlikely to wait for the achievement of some personal developmental milestone. Consequently, when integrating culture into developmental analyses, we also need to integrate acculturation processes.

Oppedal (2006, p. 98) specifically linked children's "acculturation development" to migrant children's enculturation, and Weinreich (2009) went further, proposing that particularly in relation to identity development, acculturation should be seen as just one aspect of enculturation. Young people's agentic selections from mainstream offerings should be seen as part of their individualized enculturation, because the incorporated cultural elements "become elementary aspects of the person's overall-identity" (p. 128). To illustrate this selective incorporation, Weinreich pointed to Simmons' (2006) study of the development of black pride in women from the Dominican Republic. They visited the USA and, through their encounters with African-Americans, "reflected on their own racial enculturation" and began to self-define as "Afro-Dominican" (p. 125).

Regardless of whether people's activities are called enculturation or acculturation, developmental science needs to incorporate their exceptional developmental experiences in the context of multiple, often conflicting cultures into analyses of their culturally defined normative developmental experiences. These analyses also need to focus on the patterns of adaptation that emerge within seemingly homogeneous groups (Dodds et al., 2010).

Competence and belonging, as well as cultural preservation, are at stake for the person when cultures clash. A qualitative study of the efforts of Aboriginal women elders to preserve and pass on a unique cultural ceremony brings out the critical dimensions of people's heritage and mainstream cultures in conflicting cultural contexts.

Illustrative Study of Efforts to Preserve a Cultural Ceremony

An illustrative cultural ceremony is the *Yawalyu/awelye* ceremony of Central Australian Aboriginal communities. Barwick, Laughren, and Turpin (2013) conducted a qualitative study to examine how Aboriginal women saw the future of their ceremonies. The *Yawalyu/awelye* ceremonies are exclusively conducted by women, and women elders are the custodians.

Culturally specified women dance, sing, and paint their torsos following Cultural Law and patterns that are passed down with some uniformity and some variations in several Central Australian Aboriginal language groups. The ceremony is still performed, but its preservation is mostly in the hands of women elders now in their seventies and eighties. The elders told how its future is uncertain "in the light of lifestyle changes wrought by colonization and ensuing rapid changes in Central Australian society" (Barwick et al., 2013, p. 191). The ceremony is an important part of cultural life, and the activities of these elders and younger women are illustrative of the expression of culture by people living in a competitive cultural environment.

Several cultural themes emerged from interviews Barwick and colleagues conducted with older and younger women across a wide geographical region. Themes included 1) women's perspective that it was imperative to both preserve and display this aspect of the culture if it was to survive; 2) the contemporary constraints placed on achieving that goal through loss of language and traditional ceremonial performances; 3) the cultural changes coming from young women's adjustments to living in two cultures, and 4) older women's adaptations of the ceremony.

The imperative to sustain and to display culture to members of heritage and mainstream cultures was strongly expressed, for example, by one elder:

> That's how you show these people, so they know, "Oh yeah, they've got the strongest ceremony," you know, "and the cultural way of showing us."
>
> (Dianne Stokes Nampin, community leader; Barwick et al., 2013, p. 199)

Loss of language and traditional ways of learning by watching and joining in were part of the fall-out of movements away from traditional country and the break-up of family groups. Culturally appropriate descendants (nieces and great nieces) were not available to be taught, and regular ceremonial events had come to an end.

Changes in young women's constructions and reconstructions of culturally endorsed practices were reflected in their inability to take up and pass on the ceremonies. Some changes came from loss of language and infrequent performances. Others came from contemporary young women's unwillingness to participate in culturally endorsed ways. They did not want to appear in public with painted naked torsos, or to sing loudly, especially if they did not know the songs.

Adaptations to preserve the ceremony involved novel features brought in from modern technology to counteract the scarcity of performers. These were mostly introduced by younger

women, but older women also came to use resources of books, CDs, and DVDs. Several senior performers, for instance, were willing to depart from tradition and make pedagogical DVDs to leave permanent traces of rules, and to use modern teaching styles. One senior performer, Mona, who had learnt by listening and observing, now accommodated to young women's learning styles. Traditionally, learning was the responsibility of the learner and senior performers did not actually teach. Mona now taught them and also made available cassettes and CDs of herself singing that could be used by the young as they painted-up.

The elders' further adaptations included dancing the ceremony in modern courtrooms and having it accepted as evidence of Aboriginal groups' continuing attachment to country in land claims. Another novelty involved adding the singing of selected *Yawalyu mungamunga* songs during a high school play, with elder permission. The play was *Romeo and Juliet* and the selected songs were about lizard lovers. They were sung in everyday dialect rather than with special words used only in song. On other occasions, song lines were mixed together, a practice that would have been impossible in past eras.

These adaptations and innovations were seen as ways of addressing the all-important aim of maintaining the cultural practice; for example, "Then I thought, I can't forget this *awelye*, I've got to keep it going and teach it to my children and grandchildren" (Mona Haywood Nungarrayi, senior performer, Barwick et al., 2013, p. 206).

This study demonstrates how persons are part of culture and how persons and culture are changed in their interpenetrations and coactions. The activities of the Aboriginal women were situated within the total environment of the clash between their traditional cultural ways and their life circumstances after 200 years of white settlement. Aboriginal people in Central Australia live in an environment where heritage and mainstream cultures are in continuing contact and offer alternative and often opposing ways of personal development. The study demonstrates how traditional Aboriginal cultural practices had been eroded by physical and conceptual changes (e.g., movements away from traditional country and loss of language), and also how women navigated their activities across two cultures. They drew on the tools of heritage and mainstream cultures as resources for engaging with the other culture, and in the process left traces that brought change in each culture. Those cultural changes, however, also worked toward cultural preservation. The women used technological resources of Australian society (e.g., CDs, DVDs) to preserve cultural songs and dance procedures that could have been lost. Ceremonial practice and courtroom justice were both preserved and changed by women's interpenetrations of cultural discourse and practice.

Conclusion

I began by proposing that twenty-first-century life is marked by competing and clashing cultures, and that this feature of contemporary life is important for understanding how people develop and how cultures change. Cultural competition takes many forms globally and locally, and many developing persons are currently engaged in navigating their ways through culturally conflicting situations. In its endeavors to incorporate analyses of culture into analyses of development, developmental science must also address how developing people negotiate their ways of thinking, feeling, and acting in environments where cultures compete for attention and allegiance. Cultural competitions and clashes affect contemporary people's life circumstances and developmental experiences in diverse ways. Some people's attempts at resolution, irresolution, or escape from the competition bring them into conflict with authorities, family arrangements, or community norms. Developmental science needs to be at the table, particularly when young people's cultural conflicts and allegiances are being discussed. To warrant a place, developmental science needs an expanded perspective on person-by-culture coactions. A relational-developmental-systems approach, as I have demonstrated, provides a solid base

for that expansion. Approaching persons and cultures as interpenetrating parts of a total environmental system allows us to account for the many person-by-culture interpenetrations and coactions in which persons develop and cultures are changed.

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19 The "Spaces In-Between"

Applying Relational Developmental Systems to Identity and Moral Character

Bryan W. Sokol, Michael J. Chandler, Stuart Hammond, Kelly McEnerney, and Peter Marle

When history finishes writing the story of Willis (Bill) Overton it will be, first and foremost, a story about history itself. What Overton has accomplished over a span of more than forty years has been to fundamentally alter the ways in which the temporal flow of developmental theorizing is understood. Short generations ago, graduate students in developmental psychology were routinely duck-marched through some obligatory course on what was typically called "The History and Systems of Psychology." No one knew exactly why. The exercise seemed a throwback to still earlier school days when baseball trading cards served as currency: "I'll swap you my John Locke for your Leibniz." The justification for all of this was generally taken to be that, while somehow honoring the past, we should all learn to avoid its mistakes. Unsurprisingly, successive cohorts of young psychologists, all eager to keep their collective eye on the newest prospects, happily bought into this view of the past as a sinkhole for failed ideas. Really learning about our discipline's history, however, was widely regarded as a colossal waste of time.

What was *not* generally acknowledged, and what Overton (along with strong hands-up from Hayne Reese, Klaus Riegel, Jack Meacham, and others) has served to bring to the fore, was that, rather than standing as decorative figureheads from a discredited past, the real historical contenders for our attention were actually earlier combatants in still ongoing struggles between competing research paradigms or world views (Overton, 1975; Overton & Reese, 1973; Reese & Overton, 1970). From this perspective, the serious task facing any contemporary student is less about shunning the ghosts of the past and more about finding a coherent place for themselves within today's scattered ideological landscape.

More recently, Overton (2013, 2015) has worked to re-focus our attention on what he has chosen to call *Relational Developmental Systems Metatheory* (or RDSM for short), a hermeneutic framework that directs attention to the "spaces in-between" the more usual antinomies in psychology—ill-chosen, presumptive opposites such as nature versus nurture, biology versus culture, reason versus emotion, agents versus patients, mind versus body, and selves versus society. RDSM views such dichotomies not as oppositional claims, but as differently grained accounts of one and the same thing—a series of complementary polarities embedded in a common holistic framework.

In the pages that follow, we mean to illustrate the class of problems that Overton has worked to overcome by focusing attention on the relational dimensions of moral character and identity, as evidenced in several developmental transitions typically experienced during adolescence. More specifically, we will undertake to sketch out a relational model of moral character—a view that revolves around those alignments and misalignments that can occur, in the natural course of development, among three general psycho-social processes: self-regulation, perspective-taking, and identity-formation.

Then we will finish this short reading of Overton's attempts to bridge the divide that separates selves and societies. Here attention will be turned to our long-standing program of research into those identity-transforming processes at work in Canada's First Nations youth, and the several ways that alignments and misalignments in their communities can either buffer or heighten Indigenous youth's risk of suicide. Before coming to any of this, however, more must first be said about theoretical approaches—such as RDSM—that, by virtue of having rejected more usual Cartesian splits, challenge a more dated dichotomized past.

Blurry Boundaries and Relational Developmental Systems Metatheory

RDSM holds out the hope of providing some better conceptual grounding for the uncertain and shifting boundary conditions of the psycho-social constructs of selves and cultures. As we have argued elsewhere (Sokol, Müller, & Chandler, 2013), what social scientists call the *self* or *culture* is not best understood as an entity or monolithic thing, but rather as a set of socio-cognitive processes that yield moments of both stability and change within a multi-dimensional psycho-social network. More specifically, Overton's most recent views extend, and help to resolve, a much earlier debate on socio-cognitive processes which he himself helped stage (Overton, 1983; see also Chandler, 1977). At that earlier time, the differing sides of the social and cognitive split—yet another classic Cartesian dualism—were thought to be made up of either: a) those researchers who imagined that social cognition meant examining children's thought as it is directed outward toward the social world; or b) those who, more radically, understood social cognition to mean that social practices are part-and-parcel (and therefore constitutive) of children's thought. In the former instance, social cognition is framed as "thinking *about* social *content*," and the *mechanisms* of cognition (because they are seen as being rooted in the distinctive bio-physical structures of the human brain) are understood as being separate from social content, which is thought to exist independently in the world of human relationships. Alternatively, in the latter and more relational instance, social cognition is construed as "thinking *within* the social world." That is, thought is seen to emerge within social interaction and, because of its constitutive link to social practice, draws on the form of these interactions. As a result, bio-physical and socio-cultural categories are blurred, and the distinct categories of "social" and "cognition" are rejected in favor of a more fluid, relational form of analysis.

Although any step away from those classic Cartesian splits that have, for so long, handicapped the social sciences qualifies as a step in the right direction, there remains the looming possibility that our newly acquired capacity to critique a dichotomized past may have dangerously outstripped our capacity to whistle a different and better inspired tune for the future. That is, while decidedly high-brow talk of *fuzzy boundaries* and *interpenetrating complementarities* may actually offer some solace, all of this remains a far cry from having hit upon a new rhetoric for making our way through a dichotomy-free world. Overton (2006, 2013, 2015) provides some hint of these difficulties in his repeated reliance on M.C. Escher's famous illustration of two hands drawing each other. In addition to providing still more evidence that a picture is worth a thousand words, Overton stresses that Escher's image simultaneously affirms and negates the identities of the two hands in question, showing how they are, all at once, both the same and different. "There is a sense," Overton (2013, p. 45) argues, "in which each hand is different (opposite left and right hand) and a sense in which the hands are identical (each is drawing and being drawn)."

As handy as this imagery may be, Overton (2013) draws much more of his relational inspiration from the work of Bruno Latour (1993, 2004), who

> proposed a move away from the extremes of Cartesian splits, to a center or *middle kingdom* position where entities and ideas are represented, not as pure forms, but as forms that flow across fuzzy boundaries . . . a meta-theoretical space where foundations are groundings, not bedrocks of certainty, and analysis is about creating categories, not about cutting nature at its joints.
>
> (p. 42; italics in original)

Based on this view, the psychological and social poles of self-systems and human agents are not foundational dichotomies rooted in nature, but interpenetrating complementarities, just as social cognition entails "thinking *within* the social world," rather than just *about* it.

Interestingly, Overton's account also harkens back to still another debate in developmental psychology for which he again set the stage (Overton & Gallagher, 1977; see also Riegel, 1976; Riegel & Meacham, 1978; Youniss, 1978) by highlighting the way in which Piaget's views about development involved dialectical activity—a notion that never easily fit within the functionalist paradigm of most North American researchers. Here, as Kitchener (1996, p. 245) described, the "ultimately real" for Piaget "are the basic transactions between individuals, or between individual and environments," not one or the other in isolation. That is, reality was best understood by Piaget and other dialectical theorists as the ever-shifting "spaces in-between" the entities of the social world. At that time in the field, this relational notion manifested in whether *inter*-action or *trans*-action was the better way to capture the relationship between individuals and their social contexts. As Meacham (1977, p. 264) pointed out: "*Interaction* assumes elements can be located and described independently of one another . . . [and that] each element acts causally upon the others within some organization" (italics added). On the other hand, the counterpart notion of *transaction* refers to the formal, idealized spaces "in-between" such material elements. That is, the so-called individual elements in a transactional relationship do not exist independently from each other, but are, as Meacham (1977, p. 264) claimed, "derived as secondary categories within the transactional system." For instance, the notions of buyer and seller only have meaning within a broader system of exchange, the so-called marketplace. The activity of exchange, he argued, once it is assumed as primary, serves to define and distinguish the elements of buyer and seller. In similar fashion, Sameroff and Chandler (1975) provided a more developmental example in which infants and caregivers are the two "terms" defined in a relational network. They exist as meaningful units of analysis only because of the way they are situated within a system of relations (see Sokol & Chandler, 2004). Overton (2015), in much the same way, has described holism as "the principle that the identities of objects and events derive from the relational context in which they are embedded. Wholes define parts and parts define wholes" (p. 40). Still, according to Overton, the alternative principles of logic—the *identity of opposites* and the *opposites of identity*—are what provide the fluid, and interpenetrating, boundary conditions necessary to make sense of psycho-social constructs like the self and moral character. As these notions are covered in Chapter 1, and in the Afterword, we will not expand on them here. However, it is sufficient to emphasize that in this framework, biology and culture are understood to be co-equals in the constitution of both culture and personhood.

Applied to our research, although there remain certain pitfalls in these relational principles (see Sokol & Martin, 2006), they nevertheless provide a useful conceptual place from which we understand the development of identity and moral character. Not only do psycho-social constructs like identity and character benefit from category structures that blur traditional boundary conditions, but these principles also point to the need to better understand how natural moments of stability and flux across developmental time might impact whole persons

and cultural groups. In the next sections, we will focus on the way such transitional moments in adolescence can result in either psycho-social alignments or misalignments, promoting risk or reward in young people's lives.

Fault Lines in Moral Selfhood and Character

Traditionally, moral character has been understood in terms of trait-like qualities associated with virtuous conduct (e.g., the cardinal virtues of courage, temperance, justice, and prudence). As a result, educational programs and interventions designed to promote character have typically focused on practices that effectively inculcate positive personality traits (e.g., Wynne & Ryan, 1993). These virtues or traits are typically thought to be sufficient to impress moral character on individuals regardless of their social or psychological circumstance (e.g., Ryan, 1989).

In contrast to this trait-oriented view, developmental psychology, and especially relational developmental systems theorists and ecological theorists of human development (e.g., Brandstädter, 1998; Lerner, 2006, 2011; Lerner & Overton, 2008; Overton, 2013, 2015; Spencer, Dupree, & Hartmann, 1997), offer an alternative way of defining character, one that emphasizes processes of developmental change over more fixed personality outcomes. Within interpretive frameworks such as Overton's RDSM, researchers, including ourselves (Lerner & Schmid Calina, 2014; Nucci, 2016; Sokol, Hammond, & Berkowitz, 2010), are beginning to frame character as the dynamic intersection of multiple psychological and social processes that enable individuals to function as competent moral agents and socially responsible community members. As applied to character education, such accounts work to bridge the gap that is sometimes seen to stand between moral and performance character (Davidson, Lickona, & Khmelkov, 2008; Lickona & Davidson, 2005), and highlight the integrated and holistic nature of moral conduct (see Dewey, 1922). Given this emphasis on complexity and integrated systems, it follows that, over time, character development naturally encounters moments of transition and temporary *dis*integration. Our focus here will be on the kinds of momentary psycho-social disintegrations—or misalignments—that normally arise in the course of development, and are sometimes cast as character faults. These fault lines in moral character generally involve some sort of upheaval in the areas of an individual's self-regulation, perspective-taking, and identity-formation.

When the psycho-social processes in these general areas are properly aligned and operating in complementary ways, a person's overall character is cast in a positive light and associated with healthy, or adaptive, outcomes. These outcomes include prosocial conduct, competent moral reasoning and problem-solving, as well as various forms of academic success (Zins, Bloodworth, Weissberg, & Walberg, 2004). Conversely, when these processes are misaligned, or otherwise out-of-sync, a person is seen to suffer a "breakdown in character" that has maladaptive or dysfunctional consequences, including antisocial conduct, poor problem-solving, low academic achievement, and self-harm.

Misaligned psychological processes are most common in periods of rapid developmental change such as adolescence (Noam, Chandler, & Lalonde, 1995). At least in part, adolescence is a period of "storm and stress" (see Arnett & Cravens, 2006) because of the frequent psycho-social misalignments that arise in this period of life. In addition to being a time of significant psychological adjustment and growth, adolescence is also a period of dramatic social change—that is, when children suddenly "grow up" and are faced with the transition of "joining society" (Perret-Clermont, Pontecorvo, Resnick, Zittoun, & Burge, 2004).

The special challenges that adolescents face in new social contexts are often captured in broader ecological terms (e.g., Spencer, Dupree, & Hartmann, 1997; Swanson et al., 2003). Ecological and contextual models tend to emphasize how the developing person is nested in social systems, such as the family, school, workplace, and the broader community or

society (Bronfenbrenner & Morris, 2006). RDSM offers a similar view, but reasserts the personal agency of individuals who operate in these embedded systems (Lerner, Dowling, & Anderson, 2005; Lerner & Overton, 2008; Lerner & Walls, 1999; Sokol, Hammond, Kuebli, & Sweetman, 2015). Although a broader ecological framing within RDSM still tends to apply the depersonalized language of risk and protective factors to characterize adolescents' lives, it nevertheless recognizes that individuals can manage or exert control over these factors such that psychological processes may be seen to mediate challenging experiences in productive or unproductive, adaptive or maladaptive ways (Sokol, Hammond, Kuebli, & Sweetman, 2015). This means that even an individual with certain vulnerabilities or risks (e.g., living in an impoverished neighborhood) can effectively manage or overcome the adversities he or she faces by taking advantage of available protective factors. Conversely, an individual who possesses many protective factors (e.g., a relatively stable, middle-class home) may fail to effectively use his or her resources and, instead, develop in dysfunctional ways.

Our relationally informed approach to character "breakdowns" or "faults" relies heavily on acknowledging the agency and adaptive processes of individuals within broader ecological systems. The psychological misalignments we describe are understood as vulnerabilities or risks for adolescents, whereas the social contexts—such as intentionally designed school programs or community planning—serve as protective factors upon which young people might draw to build resilience. Typical development involves a balance of risk and protective factors for any individual, just as the development of moral character involves a relational balance of psycho-social processes. While the psycho-social system that constitutes character may become misaligned in a variety of ways, these can be combatted with strategies to re-achieve alignment, as we will show in the case of First Nations communities that have effectively countered adolescent suicide and self-harm. Before coming to this work, however, it is important to outline how some of these processes can go awry in the normal course of adolescent development.

Self-Regulatory Breakdowns in Character

Self-regulation is the ability to control one's thoughts, emotions, and actions. Many regard self-control as central to psychological, social, and moral development (e.g., Baumeister & Exline, 1999). Demonstrably, poor self-regulation leads to impaired moral and social behavior (Anderson, Bechara, Damasio, & Damasio, 1999). However, high self-regulation, in and of itself, is not necessarily indicative of good moral character. As noted personality psychologist Jack Block has claimed, there are "contexts wherein spontaneity rather than self-control is appropriate and desirable, where self-control may be maladaptive and spoil the experience and savorings of life" (Block, 2002, p. 9). This is especially true of risk-taking.

Risk-taking is generally seen as a normal part of otherwise healthy exploration during adolescence (Lightfoot, 1997). In terms of misaligned psychological processes, risk-taking may be seen to emerge when the exploratory dimension of identity-formation and advances in perspective-taking are matched with poor self-regulatory abilities. Adolescent risk-taking has been associated with negative outcomes such as substance abuse and sexual promiscuity. On the other hand, when risk-taking is properly channeled through carefully designed educational programs—programs, for instance, that allow students to participate in structured travel abroad and immersion experiences (Sokol, Donnelly, Vilbig, & Monsky, in press), or engage in broader efforts to improve their communities—adolescents can develop a sense of "self-transcendence" (Youniss & Yates, 1997) that enables them to feel like they are part of circumstances extending beyond themselves. This sense of "making history" serves as a form of resilience, buffering whatever adverse circumstances in which young people may find themselves.

Perspective-Taking Breakdowns in Character

Perspective-taking is often characterized as the way in which individuals coordinate and integrate their own understanding of a situation in relation to others'. Developmentally, such understanding may include pre-reflective forms of coordinated inter-subjective activity (Martin, Sokol, & Elfers, 2008), but, more typically, it is framed as a psychological, or reflective, "ability to 'put oneself in the place of' another person and to make inferences concerning the [other]" (Light, 1979, pp. 9–10). The developmental transformations of perspective-taking have been well documented by Piaget (e.g., Piaget & Inhelder, 1948/63; see also Kesselring, 1993) and further formalized in Selman's (1980) model (see Martin, Sokol, & Elfers, 2008). The affective aspect of this ability—that is, the understanding of others' feelings in relation to one's own—is commonly referred to as empathy (Hoffman, 2000). Individuals who experience or understand others' emotional states are expected to be motivated to help alleviate their distress (Batson, 1991; Eisenberg, 1986). More generally, perspective-taking abilities have been positively related to individuals' moral reasoning competence (Walker, 1988) and prosocial conduct (Underwood & Moore, 1982), and understood to play an important role in civic, or democratic, participation (Nassi, 1981).

In terms of psychological misalignments, when poor perspective-taking is matched with otherwise robust self-regulatory abilities that promote social compliance, the individual's sense of autonomy may be compromised or his or her identity may be prematurely foreclosed (Marcia, 1980). This pattern of misaligned perspective-taking skills may lead individuals to unreflectively conform to dominant trends or social patterns, even when these trends perpetuate maladaptive or detrimental behaviors such as adopting the prejudiced or racist attitudes of antisocial groups (e.g., neo-Nazi gangs in Europe, Hundeide, 2004) and to participate in gang violence or even larger-scale atrocities such as genocide (Moshman, 2007). On the other hand, perspective-taking interventions have been used to effectively combat negative stereotypes (Galinsky & Moskowitz, 2000) and facilitate a richer appreciation of ethnic and cultural diversity (Schultz, Barr, & Selman, 2001), all in ways that promise to promote positive character development. For this reason, perspective-taking and empathy are often at the heart of positive youth interventions (Gibbs, 2010).

Identity-Formation Breakdowns in Character

Erik Erikson famously characterized identity-formation as the central challenge of adolescence (Erikson, 1968). This is, in part, because thinking during adolescence becomes increasingly future-oriented. As Erikson and other developmental researchers have noted (Marcia, 1980; Piaget, 1965/95; Youniss & Yates, 1997), the typical adolescent begins to imagine her- or himself beyond the here-and-now and to foresee their place in the future of society. Indeed, many adolescents and emerging adults are especially primed to gain from opportunities that intersect with issues of identity, personal responsibility, and authentic action (Arnett, 1998; Finlay, Wray-Lake, & Flanagan, 2010). Far from fitting the exaggerated stereotypes of being irresponsible and self-absorbed, many young people are seeking a sense of greater purpose and belonging. Youniss and Yates (1997) have suggested, "instead of being focused primarily on the question 'Who am I?' youth are concerned about the society they will inherit and have to decide how they can best relate to it" (p. 22).

In terms of psychological misalignments, vulnerabilities in the processes of identity-formation appear to emerge when advances in perspective-taking and the increased autonomy that adolescents typically experience are not met with a hopeful or meaningful vision of the future. More specifically, a young person who is unable to conceptualize a future of integration

with others and society bears certain risks—such as a sense of hopelessness that may lead to depression or suicide (Weiss & Garber, 2003, p. 406). Our own research program with Canada's First Nations youth supports this view (Chandler, 2000, 2001, 2013; Chandler & Dunlop, 2012; Chandler & Lalonde, 1998, 2009; Chandler & Sokol, 2003; Chandler, Lalonde, & Sokol, 2000; Chandler, Lalonde, Sokol, & Hallett, 2003).

Identity-formation is a multi-faceted psycho-social process, but one of its key dimensions concerns the way in which individuals come to understand themselves as the self-same person, despite inevitable change. That is, *self-continuity*, or the interpretive strategies by which individuals link their past, present, and future conceptions of the self, is not only a constitutive requirement of one's enduring identity, it is also, we have learned, a critical plank in mitigating the risk of suicide in First Nations adolescent youth. Family, school, and community factors that bolster young persons' sense of continuity, especially with the cultural traditions of their Indigenous community (Chandler & Lalonde, 1998; Chandler, Lalonde, & Sokol, 2000), serve as critical protective factors in maintaining the mental and physical well-being of these adolescents. We will describe these cultural markers of continuity in more detail in the next section.

Conversely, the seeming protective factors of a mainstream, middle-class home may include overly responsive and accommodating parents that can inadvertently contribute to depression and isolation in youth (e.g., Allen et al. 2006; Waters & Barrett, 2000). This can arise, for example, because middle-class adolescents have resources that permit privacy and self-exclusion (e.g., a private bedroom) typically not available to youth who fall into the lower socio-economic strata. Paradoxically, such aloneness and self-exclusion do not promote autonomy, but instead set up a dependence relationship with accommodating parents, which can then get coupled with a loss of purpose and self-efficacy for the adolescents (Swanson et al., 2003, p. 748). Channeling the psychological processes related to identity-formation in ways that give youth a sense of empowerment and purpose is a critical step in combating the malaise that often attends adolescence and the transition to adulthood (Damon, Memon, & Bronk, 2003; Sokol, Donnelly, Vilbig, & Monsky, in press). In many cases, these channeling efforts may take the form of a broader community that is structured to support the personal agency of its members through programs and institutions that give them voice. Our work on native suicide and the cultural buffers that may prevent suicide and self-harm provides one example of how social contexts intersect with psychological resilience in young people and their communities.

Identify-Formation and Suicide Among First Nations Adolescents

A precondition for successfully identifying possible community and cultural factors that might influence the rates of First Nations youth suicide begins with recognizing that not all of Canada's otherwise diverse Indigenous communities share a common suicide rate (Chandler et al., 2003). Our observations have been drawn primarily from the province of British Columbia (BC) and its more than 200 distinct First Nations bands. These data covered the period from 1987 to 2000. From a very high altitude, the observed suicide rate for the entire First Nations population of BC during this period is generally seen as double the provincial average (Statistics Canada, 2001). Still, by drilling down to the community level, what becomes apparent is the considerable variability in this alarming statistic, with some of BC's Indigenous communities suffering no youth suicides during our 13-year window, while, for others, the rate is many times higher than the provincial average. In fact, the data show that nearly 90 percent of Indigenous youth suicides occur in less than 10 percent of BC's native communities. In more than half of all bands, and 20 percent of tribal councils, youth suicide

is effectively unknown. The "epidemic" of youth suicides regularly reported in the popular press is evidently not a general "First Nations" concern, but rather a tragedy suffered by some Indigenous communities and not others.

With this information in hand, the next step in our work involved identifying socio-cultural factors that distinguished communities with low as opposed to high youth suicide rates. While we might have looked anywhere, our search pattern focused primarily on community-level markers of cultural continuity—a concept that manifests itself at the level of whole Indigenous communities, and, for us at least, served as the group-level analog to self-continuity. We hypothesized, in particular, that insofar as suicide could be construed as a manifestation of failed attempts to sustain a sense of personal self-continuity, First Nations communities that fell short of rebuilding their own cultural practices would also demonstrate higher rates of suicide. Those communities, on the other hand, that evidenced success in their cultural reconstruction efforts—that is, of linking their rich heritage to a hopeful future—would effectively show zero suicides.

We began the first wave of our study (Chandler & Lalonde, 1998) by constructing an Index of Cultural Continuity made up of six marker variables expressive of the degree to which each of BC's First Nations bands had both managed to preserve ties to their heritage culture and secured some enduring control over their own as yet unrealized futures. These proxy measures focused on the degree to which each of the province's native bands had already secured: 1) some measure of self-government, 2) some control over the delivery of health, education, policing services, and cultural resources, and 3) were otherwise at work litigating for Aboriginal title to traditional lands. These measures were chosen primarily because each appeared to signal something important about a community's efforts to recover its past and secure a measure of control over its own civic future. Access to information concerning these variables for each of BC's First Nations bands made it possible to locate these communities along a six-point continuum ranging from low to high levels of Cultural Continuity. Subsequently, in a second wave of data-gathering from 1993–2000 (Chandler & Lalonde, 2009), three more predictor variables were added, including a measure of band-level knowledge of Indigenous languages, the proportion of women in band government, and control of child protection services.

Figure 19.1 concerns the six-year window of Wave 1 between 1987 and 1992, and displays the suicide rates for all of those bands credited with as many as six of our original Cultural Continuity markers. As this figure makes clear, every band characterized by all

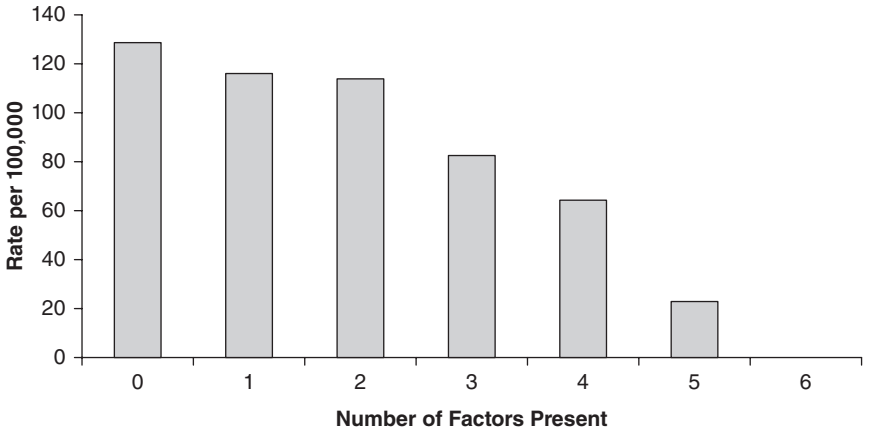

Figure 19.1 Youth suicide rate by number of cultural continuity factors present (1987–92).

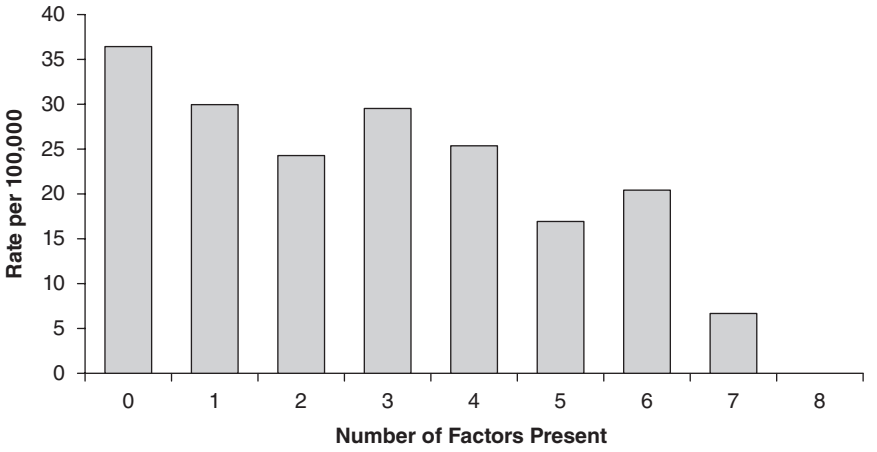

Figure 19.2 Total suicide rate by number of cultural continuity factors present (1993–2000).

of these Cultural Continuity factors experienced no youth suicides during the time period considered, whereas those communities lacking any or all of these protective factors suffered youth suicide rates often hundreds of times the national average.

These data, which were closely replicated in Wave 2 from 1993–2000 (see Figure 19.2), make a very strong case that the wellbeing of First Nations youth, as measured by community-level suicide rates, is strongly associated with the extent to which their cultural community is hard at work both rebuilding connections to its traditional past and struggling to regain control over its own future.

What these comparisons serve to make clear, we think, is that in working to promote a sense of connectedness to one's own cultural past, communities can succeed in constructing safety nets that help catch adolescents who slip through while trying to navigate those standard developmental transitions that recurrently threaten to cost every young person a sense of enduring self-continuity.

Conclusions

We began this chapter by recognizing Overton's special place as an interpretive guide within the rich theoretical landscape of our field. Overton's contributions to the history and systems of developmental psychology, in particular, have been as much about the study of history as about his making of it. We do not think it is too grandiloquent to suggest that Overton has fashioned for himself a role resembling the Olympian character, Hermes, who was regularly consulted in trying to interpret the ghosts of the past and who was said to freely transit between traditional antinomies and boundaries that divided the existence of mere mortals. Not only has Overton positioned himself in the fluid conceptual "spaces in-between" the usual antinomies of developmental science, he has also crafted, with his articulation of the *Relational Developmental Systems Metatheory*, an interpretive framework that invites all our research to inhabit a similar place. We have touched on only a small handful of the potentially many ways that Overton's views have helped to clarify the transitional spaces and categories of our work on moral character and identity. We hope, however, that our analysis of system alignments and misalignments in the psycho-social processes of adolescence is enough to show that Overton's ideas are anything but theoretic fictions. The principles of *Relational*

Developmental Systems Metatheory, when applied to our own and other current research initiatives in psychology, can lead us all to a more grounded, and productive, understanding of young people's development.

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Afterword

Developmental Science, Yesterday, Today, and Tomorrow

Willis F. Overton

I want to express my thanks and deep appreciation to the editors and chapter authors of this volume. Among you are some of my very best ex-graduate students, admired colleagues, and close friends, who have been friends for many years. I'd like each of you to know how deeply moved and humbled I feel at receiving this incredibly scholarly and forward-looking volume.

My career in developmental science has involved two areas of interest that have often dovetailed into each other. The first has been an empirical interest in cognitive development, especially the development of reasoning. The second has been a theoretical interest in the impact of often hidden assumptions (metatheoretical ones) on our theories, methods, and practical applications. I thought in this Afterword that I would sketch out the history of this second interest, and ruminate on how this interest may impact developmental science

I entered the field of psychology as an undergraduate at Boston University in the late 1950s. In those days it was difficult to be involved in either of my later interests because a radical behaviorism ruled the world of scientific psychology. In this world, "cognition" and "reasoning" were considered nonscientific terms. Furthermore, if one were interested in what was behind the psychology we practiced, the suggestion was made that, perhaps, we should become a philosophy major rather than a psychology major. At the time anything "philosophical" was as unacceptable a term in psychological science as were the words "cognition" and "reasoning."

This scientific psychological world was one encapsulated by, and only by, the confines of *S*s (stimuli) and *R*s (responses). To be scientific in this world, it was required that all the interesting actions of people be reduced to observable movements (responses) and the environmental (stimuli) or biological events (drives = stimuli) that were believed to produce them. At times, *intervening variables* were introduced (e.g., mediators), but these were necessarily ultimately defined in terms of, and only in terms of, the overt stimuli and responses that were believed to produce them.

The prevailing behaviorism of the day was identified with grand learning and drive theories, especially the work of Clark Hull (1943) and Kenneth Spence (1956)—known as the *Hull-Spence* theory (Spiker, 1970)—with B. F. Skinner (1953) as a relatively minor, although rapidly emerging, important contributor. In this setting, if development was ever mentioned—and it was not yet a very popular word ("child psychology" was better)—it was thought of as a long temporal string of *S*s and *R*s. Development, along with other concepts, was thought of as an issue to be ignored as a nonscientific problem until one day in the future it would find a *naturalized* solution as a strictly empirical generalization induced from the laws to be discovered in the field of stimuli and responses.

Although it was *de rigueur* at the time to deny the scientific value of any philosophical concepts, the hegemony of behaviorism was, in fact, supported by a number of philosophical positions popular at the time that operated under the general heading of *radical empiricism*.

The most important of these philosophical principles was the epistemology of radical empiricism itself, which stated that knowledge comes through pristine (i.e., interpretation-free) observations, and only pristine observations. Other supportive philosophical principles were an *atomism* and *foundationalism* (i.e., the idea that there is an ultimate fixed bedrock reality, and complex entities must be analytically reduced to this bedrock), a *physicalism* (i.e., that the physical constitutes the ultimate non-reducible "really-real" bedrock), and, finally, an *objectivism* or *scientific realism* (i.e., the assertion that objects of scientific knowledge exist independently of the minds or acts of scientists, and that scientific theories are true of that objective world).

These features of radical empiricism, in turn, formed the base for the philosophical/scientific methodology called *neopositivism*. According to the neopositivist creed, two rules defined whether a proposition (e.g., a concept, a hypothesis, a theoretical proposition, a law) was scientifically meaningful or not:

1) A proposition could be accepted as scientifically meaningful *if, and only if*, it could be *reduced* to words whose meaning could be directly observed and pointed to. The words whose meaning could be directly observed constituted a *neutral observation language*—completely objective, and free from subjective or mind-dependent interpretation. Thus, all theoretical language required reduction to pristine observations and a neutral observational language. Because not each and every proposition in the major personality and developmental theories of the day were so reducible (e.g., the theories of Jean Piaget, Heinz Werner, Jerome Bruner, Erik Erikson), these theories became prime targets as exemplars of scientific meaninglessness.
2) A proposition was acceptable as scientifically meaningful *if, and only if*, it could be shown to be a strictly *inductive generalization*, drawn directly from the pristine observations. Thus, to be scientifically meaningful, any universal proposition (e.g., hypothesis, theory, law) had to be demonstrably nothing more than a summary statement of the pristine observations. In today's vernacular, it would be said that a theory must be *data based* and only *data based* to be acceptable as scientifically meaningful. When the notion of science as a *Hypothetico-Deductive Method* was introduced by Hull (1943), nothing really changed because it was understood that the *hypothetico* was not referring to inferential or interpretative hypotheses. The *hypothetico* was referring to earlier inductively derived empirical generalizations, and the deduction was merely a formal heuristic for moving from empirical generalizations back down to pristine observations to repeat the observation–inductive generalization process.

By 1960 when I entered the Ph.D. program at Clark University, I entered a new world and my introduction to this world was primarily guided by Heinz Werner and Bernard Kaplan (see Werner, 1957; Werner & Kaplan, 1963). This was a world whose past had represented an opposition to behaviorism, radical empiricism, and neopositivism, and whose present represented the emergence of several newly respectable scientific developmental and cognitive developmental perspectives. It was, in fact, I later learned, an organismic world as compared with the mechanistic world of behaviorism.

This was a time of truly revolutionary change in psychology, and that change came to be termed the Cognitive Revolution. Few agree upon a specific date for the revolutionary shift. As I have noted elsewhere (Overton, 2012), some date it to 1956 (Miller, 2003), when Bruner, Goodnow, and Austin (1956) published their influential *A Study of Thinking*, and the year after Jean Piaget founded the International Center for Genetic Epistemology (ICGE) in Geneva, Switzerland. In 1957 a new revised edition of Werner's *Comparative*

Psychology of Mental Development was published (Werner, 1957). And the same year saw the publication of the highly influential book titled *The Concept of Development* edited by Dale Harris, which contained very non-behaviorist chapters by Harris, Werner, T. C. Schneirla, and others. Certainly the 1957 publication of *Syntactic Structures* by Chomsky, and his 1959 review of Skinner's 1957 book *Verbal Behavior*, were important dates; so too was 1960 when, at Harvard, Bruner created the Center for Cognitive Studies.

Regardless of any specific date, and regardless of any later diversions into *information processing*, and *cognitive science*, we at Clark and at other schools around this country and Europe lived the revolution the way Bruner (1990) later described it:

> That revolution was intended to bring "mind" back into the human sciences after a long cold winter of objectivism. It was . . . an all-out effort to establish meaning as the central concept of psychology—not stimuli and responses, not overtly observable behavior, not biological drives and their transformation, but meaning. . . . Its aim was to prompt psychology to join forces with its sister interpretive disciplines in the humanities and in the social sciences. We were not out to "reform" behaviorism, but to replace it.
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> (pp. 1–3)

It was in this world that I learned about Werner and Kaplan's organismic-developmental theory, as well as Jean Piaget's cognitive developmental theory. It was also in this world that, in 1963, I first read Thomas Kuhn's (1962) *Structure of Scientific Revolutions* and the discussion of scientific paradigms. Furthermore, it was in this world that I read several philosophy of science texts (e.g. Hanson, 1958; Popper, 1959, 1963; Taylor, 1964; Toulmin, 1953), as well as Steven Pepper's (1942) *World Hypotheses: A Study in Evidence*. This latter text argued that philosophical systems cluster around four core models, or "world hypotheses," drawn from common-sense metaphors. While this text was not directly about psychology, it seemed to expose the philosophical basis of many conflicts within psychology itself and it made a deep impression on me.

At this point we can skip to my first academic position at SUNY Buffalo in 1966. By this time I had given up my Clinical Psychology background and had become a full-time developmentalist. In 1968, my colleague Hayne Reese invited me to co-author a paper to be presented in 1969 at the first West Virginia University life-span developmental psychology conference. Hayne, himself, originally a long-standing dyed-in-the-wool Spence-Hull behaviorist, was, like several of his colleagues, rapidly becoming highly disenchanted with behaviorism. When Hayne invited me to co-author the paper I told him I would agree, if and only if, he read Pepper's *World Hypotheses* and found enough value in it to use it as the framework for our paper. He read it. He agreed about its value. And we wrote and presented the paper, which was published in 1970 as a chapter in the first of a long series of *Life-Span Developmental Psychology* texts (Reese & Overton, 1970).

The title of the paper was *Models of Development and Theories of Development*, and our primary thesis was then, as mine remains today, that, like other sciences, psychology in general, and developmental psychology specifically, functions within the context of a broad set of concepts that generally go unnoticed during day-to-day research and intervention activities. These *background ideas* constitute the *conceptual framework* or *conceptual context* within which day-to-day research and intervention activities operate. The particular sets of background ideas, or today what we term *metatheoretical* concepts, that we focused our analyses on were what Pepper (1942) had termed the "mechanistic" and the "organismic" worldviews and what Thomas Kuhn (1962, 1970) was terming "scientific paradigms." We chose these paradigms because at the time, in virtually all of psychology, the mechanistic worldview was seen to be the standard and the organismic its only challenger.

What happened next is that the chapter turned out to be quite successful (i.e., lots of people read and cited it), and so we wrote a few more articles and chapters along similar lines, some appearing in later volumes of the *Life-Span Developmental Psychology* series (e.g., Overton & Reese, 1973). But somewhere along the line a third, Steven Pepper-defined, worldview began to become popular as the conceptual foundation for Skinnerian operant psychologists—today's behavior analysts—and later for many life-span developmental psychologists. This worldview is called "contextualism." It would take far too long to describe contextualism here. But let me try to give a brief description. The basic metaphor that gives rise to organicism is the process of organic development of the living *system*. The basic metaphor that gives rise to contextualism is the *ongoing act in context*. Both organicism and contextualism are *holistic*, but the whole for organicism is the system and its interrelated parts, whereas the whole for contextualism is the whole overt observable act in context. Further, organicism is *integrative* in the sense of focusing on the integration of the system and making interpretative inferences about the organization and change of organization of the system. Contextualism, on the other hand, is said to be *dispersive* as ongoing acts are related to each other only when they are observed to be so related.

Contextualism had a great appeal to behavior analysis because the belief grew among this group that this hypothesis, with its focus on actual observed acts, was a better fit for their position than the mechanistic paradigm (see Hayes, Hayes, & Reese, 1988). This behavior-analytic enthusiasm for contextualism has not faded with the years. Although contextualism remained highly popular with behavior analysts, as time passed some took this worldview as a paradigm for life-span development and, within this context, also argued for a functional theory of development (see Baltes, Lindenberger, & Staudinger, 2006).

This conceptual development created a significant conflict for me, as I had, for years, argued from an organismic point of view that, in considering development, including life-span development, the focus of our efforts should be on the person as a dynamic (i.e., active, changing) system and that we should consider the development of this system to entail both transformational change (i.e., change in the form or structure of the system) and variational change (i.e., changes in the overt acts of the system).

Contextualism, on the other hand, limits its focus to *overt observable acts, the behavior*, and developmental changes in behavior are seen as being "driven" by "biological" and "cultural" influences. And furthermore, the notion of a dynamic system is totally discounted in this approach because *system* implies making inferences from actions rather than just staying with the observable acts, as contextualism insists must be the case.

This conundrum had to wait several years for its resolution, as I had turned my attention to developing what has evolved over the years and has come to be termed the process-relational scientific paradigm (Overton, 2015). This paradigm contrasts sharply, in terms of fundamental ontological and epistemological metatheoretical concepts, with what is now known as the Cartesian-mechanistic-split paradigm. The process component of the paradigm entails ontological commitments to holism (compared to Cartesian atomism), the inherent activity of nature (compared to Cartesian fixity), change and becoming as features of nature (compared to Cartesian stasis and being), nature as process (compared to Cartesian nature as substance), the necessary organization of nature (compared to Cartesian uniformity), and a pluralistic universe (compared to a Cartesian dualism).

The relational component of the process-relational paradigm entails epistemological metatheoretical commitments. It was in the early 1990s (e.g., Overton & Horowitz, 1991) that I began working on this component, but the specific epistemological principles were not completely articulated until between 2004 and 2006 (Overton, 2004, 2006). The primary aim of the relational position is to take fundamental concepts, which under the Cartesian-mechanistic-split paradigm are represented as flat-out contradictions and unresolvable dichotomies (e.g., nature/nurture, subject/object, mind/body, biology/culture), and, based

on logical principles, transform these concepts into indissociable complementarities. This transformation occurs through an application of the holistic principle of the *identity of opposites*. Thus, under this relational principle, for example, any act becomes 100 percent nature because it is 100 percent nurture and 100 percent nurture because it is 100 percent nature. Following the transformation of split concepts into complementarities, two further holistic epistemological principles—the *opposites of identity*, and the *synthesis of wholes*—establish standpoints, or points of view, which allow the observer to study each pole of the complementarity without sinking into a vicious circularity of reasoning. Thus, for example, the familiar double arrow of the person ⇔ context relation is an identity of opposites, but the second of the two principles permits the observer to investigate either one or the other or both points of view.

Work on the relational position entailed the discovery of several other important metatheoretical features that stand in contrast to the principles of the Cartesian paradigm. The most important insight is that metatheoretical concepts are organized in a hierarchical manner. The broadest, most abstract concepts constitute the paradigm or worldview level, and this level entails ontological and epistemological principles. However, between this level and the level of specific theories, models, and methods, there are mid-range metatheories or what Lerner (Lerner, Agans, De Souza, & Hershberg, 2014) and I (Overton, 2014) now term "metamodels."

As a metamodel, the relational developmental system (RDS) is the most inclusive of several middle-range metatheories that are contextualized by the process-relational paradigm, and all of the middle-range metatheories within the process-relational paradigm incorporate systems concepts (Overton, 2015). RDS itself represents an extension and modification, made by Richard Lerner and myself (Lerner, 2006; Lerner & Overton, 2008, 2014; Overton, 2006; Overton & Lerner, 2014), of the original "developmental systems theory" described by Ford and Lerner (1992). The extension and modification made by Lerner and myself was motivated primarily by an increasing recognition of the centrality of the process-relational worldview in conceptualizing the developmental system. Today, some have affiliated themselves with developmental systems while casting the system into a Cartesian framework (see, for example, Del Giudice & Ellis, 2016). This recasting cannot occur when the system is identified as a holistic relational developmental system. A second motivation for the extension and modification was that it became clear that the system is a metatheory, not a theory. There is no RDS theory. However, there may be theories or models that are contextualized by the RDS metatheory, and so we often speak of RDS *theories*.

RDS characterizes the living organism as an *inherently active, self-creating (autopoetic, enactive), self-organizing, and self-regulating, relatively plastic, nonlinear complex adaptive system*. The system's development takes place through its own *embodied activities and actions* operating *coactively* in a lived world of physical and sociocultural objects, according to the principle of *probabilistic epigenesis* (Gottlieb, 1992). This development leads, through positive and negative feedback loops created by the system's embodied action, to increasing system differentiation, integration, and complexity, directed toward adaptive ends.

The construction and elaboration of the process-relational paradigm and the RDS metamodel represent the current status of my collaborative work in this area. This work has been done with the goal of promoting a future-looking developmental science shorn of its archaic, outmoded Cartesian moorings. This new developmental science aims at a truly holistic approach to describing, explaining, and optimizing intraindividual (within-person) development and interindividual (between-persons) differences across the life span, and at all levels of functioning from the biological, to the psychological, to the cultural. There have already been significant empirical and methodological advances that have been contextualized by this novel paradigm and metamodel (see, e.g., the chapters in Overton & Molenaar, 2015). Of course, my hope is that these advances will continue and grow.

As somewhat of an addendum, I can now briefly return to the conundrum of whether life-span development is better represented by an organismic or a contextualist approach. Pepper

had himself claimed that this had to be an either/or determination because organicism's integrative approach and contextualism's dispersive approach represented a flat-out contradiction and, thus, any combining of the two would result in a confusing eclecticism. Lerner and Kauffman (1985) had worked out an approach to how organicism and contextualism might be integrated. Their developmental-contextualism has many positive features to recommend it. However, I came to believe that there were deeper epistemological issues that had to be addressed in any possible integration. Thus, after I had worked out the principles of the relational approach, I went back to re-read Pepper and came to recognize that the "flat-out contradiction" between organicism and contextualism was readily transformed into an indissociable complementarity, a relation. *Integrative* refers to the *organization of the dynamic system*; dispersive refers to the *differentiated variable actions* of this system.

What Pepper had done, in fact, was to split structure (system, organization) and function (activity). But from a relational and process perspective, structure and function are indissociable. There can never be structure without function, nor can there be function without structure. In other words, *structures function* (i.e., systems are active) and *functions have structure* (i.e., acts emerge from some organization). When this point is recognized as an identity of opposites, the next step is to recognize that organicism (system, structure, integration) represents one point of view (opposite of identity), while contextualism (action, variability, diffusion, differentiation) represents another point of view of the whole that is development. To make this idea more concrete, when a mental structure (organicism) functions (acts), its aim is to achieve a goal (e.g., sucking on the breast to attain nourishment). If the act immediately achieves the goal then nothing new occurs. However, most acts are only partially successful. This being the case, there is variation in the act (contextualism) and there may be a number of subsequent acts until the goal is achieved. However, the variable acts feed back to the system and the system absorbs these and changes (i.e., the system develops). In 2007, my student Michelle Ennis and I, operating from this base, were able to construct a principled integration of an organismic theory (Piaget) and a neo-Skinnerian behavior-analytic theory (Overton & Ennis, 2007). More recently I (Overton, 2015) have elaborated on the detailed principles entailed in the synthesis of organicism and contextualism. The surprising outcome of this synthesis is that it in itself represents the process-relational paradigm.

Thus, again, in closing, my hope for the future is that further conceptual elaborations, research programs, empirical data, and innovative methodologies will continue to facilitate progress in a developmental science freed of the strictures of the Cartesian paradigm. As Kuhn (1962) once pointed out, it is not possible to give up a paradigm, regardless of its shortcomings, unless a viable alternative paradigm is available. The process-relational paradigm and the RDS metamodel constitute, I believe, just such an alternative.

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