# ANNUAL REVIEW of Gerontology and Geriatrics

*Volume 7, 1987*

# ANNUAL REVIEW OF GERONTOLOGY AND GERIATRICS

Volume 7, 1987

# ANNUAL REVIEW OF
# Gerontology and Geriatrics

## Volume 7, 1987


**K. Warner Schaie, Ph.D.**
*SPECIAL VOLUME EDITOR*

**Carl Eisdorfer, Ph.D., M.D.**
*EDITOR-IN-CHIEF*



SPRINGER PUBLISHING COMPANY
New York

Springer Publishing Company, Inc.
536 Broadway
New York, New York 10012

87 88 89 90 91 / 5 4 3 2 1

ISBN 0-8261-3086-0
ISSN 0198-8794

Printed in the United States of America

# Contents


*Introduction* vii
*Contributors* xi
*Forthcoming Contents*, Volume 8 xiii

Chapter 1 Research in Geriatric Psychophysiology 1
GREGORY A. MILLER, THEODORE R. BASHORE, LAWRENCE A. FARWELL, AND EMANUEL DONCHIN

Chapter 2 Sensory–Perceptual Processes and Aging 29
JOHN F. CORSO

Chapter 3 Aging and Memory 57
MARION PERLMUTTER, CYNTHIA ADAMS, JANE BERRY, MICHAEL KAPLAN, DENISE PERSON, AND FREDERICK VERDONIK

Chapter 4 Reading Comprehension and Aging 93
BONNIE J. F. MEYER

Chapter 5 Intellectual Abilities and Age 117
WALTER R. CUNNINGHAM

Chapter 6 The Role of Experience in Cognitive Aging 135
TIMOTHY A. SALTHOUSE

Chapter 7 Cognitive Training and Everyday Competence 159
SHERRY L. WILLIS

Chapter 8 Personality Development in Adulthood and Old Age: Relationships among Identity Style, Health, and Well-being 189
SUSAN KRAUSS WHITBOURNE

Chapter 9 Perceptions of Aging and the Elderly 217
WALTER H. CROCKETT AND MARY LEE HUMMERT

Chapter 10 Industrial Gerontology: The Aging Individual and Work 243
HARVEY L. STERNS AND RALPH A. ALEXANDER

Chapter 11 Applications of Structural Equation Models in Gerontological Research 265
CHRISTOPHER HERTZOG

Chapter 12 Assessment of Depression and Dementia During the Late Years 295
LARRY W. THOMPSON, VINCENT GONG, EDMUND HASKINS, AND DOLORES GALLAGHER

*Index* 325

# Introduction

This volume of the *Annual Review of Gerontology and Geriatrics* is devoted to the behavioral sciences, with particular attention given to topics in experimental and applied psychology. When planning for the volume began, it seemed almost presumptuous to attempt to come up with a great deal of new material so soon after the publication of the second edition of the *Handbook of the Psychology of Aging* (Birren & Schaie, 1985). However, it quickly became clear that a number of important basic and applied topics were either not covered or underrepresented in that handbook. Moreover, the pace of research on behavioral aspects of aging has increased at a rapid rate, as witnessed by the recent introduction of several new important research publications (e.g., the American Psychological Association's new journal, *Psychology and Aging*). The selection of topics, therefore, has been influenced by the need to cover those areas that were neglected in the recent handbook or those in which there have been particularly rapid advances that demanded early updating of the research literature.

Reviews of the literature are never entirely impartial but are driven by the reviewer's theoretical and methodological preferences. Rather than commissioning reviews that follow the traditional broad sweep of handbook chapters, the editor therefore encouraged the contributors to this volume to prepare chapters that are more concise in scope, and in virtually every case present the authors' point of view as to the state of the art. Indeed, it was my specific objective to recruit contributors who could be depended on to add their own unique flavor to what otherwise might be dry reviews of the empirical literature, regardless of whether or not their interpretations necessarily coincided with those of the editor.

Since behavioral change with age must have some physiological basis, the volume begins with a review of geriatric psychophysiology that focuses on the physiological loci of cognitive changes with age and discusses what cognitive abnormalities develop in association with common neurological disorders, as distinct from changes that accompany healthy aging. Chapter 1 by Miller, Bashore, Farwell, and Donchin also raises questions as to what can be learned from comparisons of different physiological systems that affect behavioral change with age. Closely related is a review of models, theories, and empirical data relevant to the understanding of aging in the sensory–perceptual system (Corso, Chapter 2). That chapter also considers various approaches that may compensate for sensory–perceptual problems and thereby improve the personal adjustment of the elderly.

One of the major complaints voiced by many persons as they get older is the subjective perception of increasing memory difficulties. Chapter 3, by Perlmutter and associates, provides an up-to-date conceptualization of the memory system and reviews our current knowledge of memory changes with age. The chapter calls attention to a variety of factors that may affect memory and that become of increasing importance as people age. After noting that memory problems are not necessarily irreversible, the authors then discuss strategies for the remediation of memory problems in the elderly. Since age seems to have important consequences for the efficacy of learning new materials, we next turn to a particular instance, reading comprehension (Meyer, Chapter 4). This contribution should be of particular interest for specialists in adult education, as it provides a careful review of the differential effect of various instructional techniques for the prose learning of older persons compared to young adults.

Research on cognitive functioning and age continues at an unabated pace. Three chapters are therefore devoted to this topic. Cunningham (Chapter 5) reviews some theoretical developments as well as recent empirical studies of structural differences and age changes in levels of intellectual abilities. Some studies of reaction time are also included, since response speed is so closely interwoven with the measurement of abilities. Important recent contributions to the understanding of intellectual aging have come from the study of experts in specific areas of human performance. Salthouse (Chapter 6) discusses the role of experience in the maintenance of abilities. He reviews studies of expertise in unselected populations as well as in specific occupational groupings, considers the role of practice, and examines the distinction between abilities that do or do not show marked age-related decline by contrasting novice and expert levels of performance. He also describes a useful new strategy (molar equivalence–molecular decomposition) for the study of individuals with comparable experience who differ in age, and he discusses alternative conceptualizations of the relationship between age and experience. An examination of intervention strategies that might reverse age-related cognitive deficits is provided by Willis (Chapter 7). She reviews cognitive training research that has shown to be promising in remediating experiential age deficits and discusses the relevance of the laboratory research in this area to the modification and improvement of performance in older persons in their everyday experience.

Rather than presenting an overview of the widely scattered research literature on personality, this volume's contribution (Whitbourne, Chapter 8) is designed to provide an integrated treatment of how an individual's "identity style" influences personality development during adulthood and old age. In addition to formulating an integrated model for the role of identity style, literature is reviewed that illustrates the effects of identity styles on physiological functioning, psychological well-being, and adaptation in old age. Similarly, in the area of the social psychology of aging, we elected to focus on the specific topic of perceptions of aging and the elderly (Crockett and Hummert, Chapter 9). That chapter deals with the common observation that the elderly as a group are often perceived more negatively than individual older persons, and the authors conclude that this discrepancy can be resolved as research moves away from conceptualizing the elderly as a unitary category.

In an update on the status of industrial gerontology, Sterns and Alexander (Chapter 10) deal with the psychological issues arising as a consequence of changes in the work environment due to plant closings, reductions in the work force, the introduction of new technology, and related concerns about age discrimination in employment. The chapter consequently focuses on job-related training of older workers, perceptions of age bias in industry, measurement of job performance, job attitudes, and absenteeism.

Gerontologists have long suffered from the methodological limitations common to all developmentalists: the fact that age is not an assignable variable and that much of our work must be in the nature of quasi-experiments. Over the past decade new methodological tools have been developed that have increased our ability to analyze and draw causal inferences from quasi-experiments. Structural equation models provide a particularly useful technique for this purpose. Since this approach is rapidly becoming one of the more important state-of-the-art techniques, we have included a chapter that reviews exemplary applications of such models in gerontology (Hertzog, Chapter 11).

The final contribution in this volume deals with one of the thorniest applied problems facing behavioral scientists in clinical practice: the diagnostic differentiation of depression and progressive dementia in the elderly (Thompson, Gong, Haskins, and Gallagher, Chapter 12). The chapter reviews interview techniques and self-rating scales for the assessment of depression and describes the physical examination and neuropsychological testing commonly used in the study of dementia. The different dementia symptoms are then described and are differentiated from cognitive decline seen in depression.

Although this volume is limited primarily to a review of behavioral sciences research on aging, the nature of gerontological efforts is such that much of the behavioral work is often at the interface with the biological and/or social sciences. In addition, a number of chapters summarize data that have important relevance for public policy formation. And further, a number of chapters—notably those on memory, prose learning, cognitive training, industrial gerontology, and the assessment of depression and dementia—have direct implications for clinical, educational, or industrial practice. It is my hope, then, that this stimulating material will be of broad interest to researchers and practitioners in the entire gerontological and geriatric community.

**K. Warner Schaie**
*State College, PA*
*February 15, 1987*

## REFERENCE

Birren, J. E., & Schaie, K. W. (Eds.). (1985). *Handbook of the psychology of aging* (2nd ed.). New York: Van Nostrand Reinhold.

*This page intentionally left blank*

# Contributors

**Cynthia Adams, Ph.D.**
Institute of Gerontology
University of Michigan
Ann Arbor, Michigan

**Ralph A. Alexander, Ph.D.**
Department of Psychology and Institute for Life-Span Development and Gerontology
The University of Akron
Akron, Ohio

**Theodore R. Bashore, Ph.D.**
Department of Psychiatry
Medical College of Pennsylvania
Philadelphia, Pennsylvania

**Jane Berry, Ph.D.**
Institute of Gerontology
University of Michigan
Ann Arbor, Michigan

**John F. Corso, Ph.D.**
Distinguished Professor of Psychology (Emeritus)
State University of New York
College of Arts and Science
Cortland, New York and
Visiting Research Scientist
State University of New York
Upstate Medical Center
Syracuse, New York

**Walter H. Crockett, Ph.D.**
Gerontology Center
University of Kansas
Lawrence, Kansas

**Walter R. Cunningham, Ph.D.**
Department of Psychology
University of Florida
Gainesville, Florida

**Emanuel Donchin, Ph.D.**
Cognitive Psychophysiology Laboratory
Department of Psychology
University of Illinois at Urbana-Champaign
Champaign, Illinois

**Lawrence A. Farwell, B.A.**
Cognitive Psychophysiology Laboratory
Department of Psychology
University of Illinois at Urbana-Champaign
Champaign, Illinois

**Dolores Gallagher, Ph.D.**
Geriatric Research, Education and Clinical Center (GRECC)
Veterans Administration Medical Center
Palo Alto, California and
Stanford University School of Medicine
Stanford, California

**Vincent Gong, Ph.D.**
Department of Psychiatry
University of California School of Medicine
San Francisco, California

**Edmund Haskins, Ph.D.**
Community Hospital of Indianapolis
Indianapolis, Indiana

**Christopher Hertzog, Ph.D.**
School of Psychology
Georgia Institute of Technology
Atlanta, Georgia

**Mary Lee Hummert, Ph.D.**
Department of Communication Studies
University of Kansas
Lawrence, Kansas

**Michael Kaplan, B.G.S.**
Institute of Gerontology
University of Michigan
Ann Arbor, Michigan

**Bonnie J. F. Meyer, Ph.D.**
University of Washington
Seattle, Washington

**Gregory A. Miller, Ph.D.**
Cognitive Psychophysiology Laboratory
Department of Psychology
University of Illinois at Urbana-Champaign
Champaign, Illinois

**Marion Perlmutter, Ph.D.**
Department of Psychology, Institute of Gerontology, and Center for Growth and Human Development
University of Michigan
Ann Arbor, Michigan

**Denise Person, M.A.**
Institute of Gerontology
University of Michigan
Ann Arbor, Michigan

**Timothy A. Salthouse, Ph.D.**
School of Psychology
Georgia Institute of Technology
Atlanta, Georgia

**Harvey L. Sterns, Ph.D.**
Department of Psychology and Institute for Life-Span Development and Gerontology
The University of Akron
Akron, Ohio and
Office of Geriatric Medicine and Gerontology
Northeastern Ohio Universities College of Medicine
Rootstown, Ohio

**Larry W. Thompson, Ph.D.**
Geriatric Research, Education and Clinical Center (GRECC)
Veterans Administration Medical Center
Palo Alto, California and
Stanford University School of Medicine
Stanford, California

**Frederick Verdonik, Ph.D.**
Institute of Gerontology
University of Michigan
Ann Arbor, Michigan

**Susan Krauss Whitbourne, Ph.D.**
Department of Psychology
University of Massachusetts at Amherst
Amherst, Massachusetts

**Sherry L. Willis, Ph.D.**
Department of Individual and Family Studies
The Pennsylvania State University
University Park, Pennsylvania

## FORTHCOMING

## THE ANNUAL REVIEW OF GERONTOLOGY AND GERIATRICS, Volume 8

**Aging Differently**

**George L. Maddox and M. Powell Lawton**

Guest Editors

### Section I. Orientation

Toward a Differential Gerontology
DALE DANNEFER
Societies as Natural Experiments in Aging
CHRISTINE FRY

### Section II. Differential Allocation of Societal Resources

Lifestyles and Life Chances: An Epidemiologic Perspective
LISA BERKMAN
Social Support and Well-being: Gender and Ethnic Differences
NEAL KRAUSE
Health and Health Care Utilization
FREDERIC WOLINSKY
Women and the Workplace
ANGELA O'RAND
Changing Patterns of Income and Consumption
MARILYN MOON

### Section III. Increasing Options: Differential Aging and Public Policy

Planning Long Term Care for Older Populations
KEN MANTON
Options for Insuring Long Term Care
ALICE RIVLIN AND JOSHUA WIENER
Maintaining Income of Older Adults in a Heterogeneous Population:
The Case of Social Security
YUNG-PING CHEN

*This page intentionally left blank*

CHAPTER 1

# Research in Geriatric Psychophysiology

GREGORY A. MILLER
COGNITIVE PSYCHOPHYSIOLOGY LABORATORY
DEPARTMENT OF PSYCHOLOGY
UNIVERSITY OF ILLINOIS AT URBANA-CHAMPAIGN, CHAMPAIGN, ILLINOIS

THEODORE R. BASHORE
DEPARTMENT OF PSYCHIATRY
MEDICAL COLLEGE OF PENNSYLVANIA
PHILADELPHIA, PENNSYLVANIA

LAWRENCE A. FARWELL
COGNITIVE PSYCHOPHYSIOLOGY LABORATORY
DEPARTMENT OF PSYCHOLOGY
UNIVERSITY OF ILLINOIS AT URBANA-CHAMPAIGN, CHAMPAIGN, ILLINOIS

EMANUEL DONCHIN
COGNITIVE PSYCHOPHYSIOLOGY LABORATORY
DEPARTMENT OF PSYCHOLOGY
UNIVERSITY OF ILLINOIS AT URBANA-CHAMPAIGN, CHAMPAIGN, ILLINOIS

Although psychophysiological data often bear on physiological questions, the present review will focus on what psychophysiology is able to say about the psychological aging of the individual, as distinguished (Birren & Cunningham, 1985) from biological and social aging. Much of the psychophysiological literature using elderly human subjects addresses one of two psychological questions, and this review is organized accordingly. First, what is the nature of cognitive changes with age? Second, what cognitive abnormalities develop in association with common psychiatric and neurological disorders in old age?

Work on this chapter was supported in part by AFOSR Contract #F49620-79-C-0233, Al Fregly, Project Manager. Noel K. Marshall, Ron D. Chambers, Frank Morrell, Leyla DeToledo-Morrell, and Thomas Hoeppner were collaborators during various phases of our own work with the aged, which was supported in part by NIH Grant AG03151. Kay Strayer's assistance in the execution of the project is greatly appreciated. The authors also wish to acknowledge the subjects who made the research possible.

Several emphases in this review should be noted at the outset. In terms of content, this review gives primary attention to an attempt to understand the locus of the pervasive cognitive slowing that comes with advanced age (Birren & Botwinick, 1955; Cerella, 1985; Salthouse, 1985a). This emphasis reflects the salience of the issue of slowing in the aging literature. Moreover, it is an issue that highlights the potential utility of psychophysiology for the study of aging, in that it exemplifies how psychophysiological measures can help dissect complex cognitive processes. In particular, the burgeoning literature on event-related brain potentials (ERPs) provides an impressive basis for specifying the stages of information processing that may mediate behavioral slowing, in partial disagreement with the reaction time (RT) literature.

Another emphasis will be most apparent in the discussion of psychophysiological research on psychiatric and neurological problems in the aged. As articulated elsewhere (Donchin & Bashore, in press; Donchin, Miller, & Farwell, 1986b), we suspect that the usual strategy of comparing samples of subjects recruited on the basis of clinical diagnosis places serious constraints on the richness, usefulness, and replicability of the data obtained. The present review will critique the available literature in light of this issue and will propose an alternative strategy of comparing subjects selected on the basis of psychophysiological functioning.

## NORMAL AGING: COGNITIVE CHANGES

A number of components of the ERP have attracted interest in studies of healthy elderly adults. Although brain-wave measures are not necessarily more useful for studying cognition than are other physiological systems, most of the cognitive psychophysiological literature has employed ERPs. After a brief review of progress in other areas, this section will emphasize ERP evidence for the source of cognitive slowing in the elderly.

### Electroencephalogram

The electroencephalogram (EEG) is the oldest measure of gross brain electrical activity. Whereas the ERP is recorded as a change in the ongoing EEG elicited by a specific event, the EEG has generally been recorded with subjects at rest or in some other static condition (e.g., Stage 2 sleep). EEG studies with the elderly have appeared steadily for some decades. It is well established that the dominant frequencies in the EEG decline with age (Goodin, 1985). Thus, in a state in which alpha waves (8–13 Hz) predominate, the peak frequency is likely to average around 10 Hz for young adults and 8 Hz for an older group (Obrist, 1979; but see Duffy, Albert, McAnulty, & Garvey, 1984). Attempts have been made over the years to relate this finding to a general decline in CNS arousal with advancing age. However, this picture is muddled, and the functional significance of this decline, if it exists, is not clear. These efforts have contributed little to our understanding of the aging process or of the psychological performance of the aged. Importantly, it has been suggested (Duffy et al., 1984; Katz & Horowitz, 1982) that much or all of the decline in peak alpha frequency is artifactual, reflecting the increasing prevalence of disease in elderly samples not carefully screened on health status.

In an earlier review, Marsh and Thompson (1977) suggested that there were already too many studies of EEG changes and aging, shedding too little light on fundamental issues. Their recommendations for future studies included the following: (a) assessment of the full EEG spectrum, not merely conventional EEG bands; (b) collection of longitudinal data; (c) measurement of EEG changes during specific tasks; and (d) evaluation of the contribution of CNS–ANS (autonomic nervous system) relationships to behavioral changes with age. In light of these needs, we may evaluate what has been accomplished in the decade since their review.

In general, interesting EEG research with the elderly in recent years has relied on new ways to combine and analyze data, rather than on innovations in conceptual approach. For example, Duffy et al. (1984) employed a 20-channel EEG recording array. As recommended by Marsh and Thompson (1977), they provided subjects with a series of 10 standard tasks in an attempt to characterize EEG changes with age. Their results were at variance with much of the previous literature in a number of ways, such as finding no effect of age on dominant alpha frequency and decreased rather than increased amounts of slower-frequency activity. On the other hand, many of their EEG measures correlated surprisingly well with neuropsychological measures of memory function. These investigators were also impressed with a decline in "alpha reactivity" found with increasing age. That is, alpha blocking, the difference between eyes-closed and eyes-open alpha levels, declined. In addition to the authors' suggestion that their unusual findings may result from the unusually good health of their older subjects (see also a subsequent section of the present chapter), it may be that the study's emphasis on active tasks makes comparisons with previous studies using subjects at rest inappropriate.

Dustman, LaMarche, Cohn, Shearer, and Talone (1985) recorded the EEG at rest from 40 young and 40 elderly adults. EEG power across the spectrum was less variable, as a function of recording site on the scalp, in the older sample. Furthermore, a measure of the EEG phase relationship between pairs of sites showed tighter coupling in this group. Dustman et al. (1985) interpreted their findings in terms of a decline in the functional autonomy of different brain regions with age. These data provide an interesting parallel to the increased uniformity across brain regions in the amplitude of the P300 measure, which will be discussed below.

Few other studies directly address the findings of Dustman et al. (1985). In a brief report, Giaquinto and Nolfe (1985) also noted greater consistency between brain regions in their elderly group. In contrast, Drechsler (1978) found decreased synchrony in EEGs of the elderly. Both of these papers provide a much less thorough data analysis and discussion than do Dustman et al. (1985), so it is difficult to integrate these studies. Of indirect relevance is a finding by Podlesny and Dustman (1982) that P300 amplitude, contingent negative variation (CNV) amplitude, heart rate deceleration, and reaction time were more strongly correlated in a young-adult sample than in an elderly group. Several papers have proposed that elderly subjects' slowed RT may result in part from reduced efficiency in the interaction between physiological systems (Marsh & Thompson, 1973, 1977; Thompson & Nowlin, 1973). This question of the existence and functional significance of multichannel synchrony warrants considerably more empirical attention before conclusions can be drawn because the field has not achieved consensus on how to quantify or draw conclusions about synchrony.

Increased or decreased consistency or linkage between brain areas is not necessarily problematic for the aging adult. It may be more or less appropriate, depending on the task at hand. It would be very useful, in line with Marsh and Thompson's (1977) recommendations, to repeat the Dustman et al. (1985) experiment with subjects engaged in a series of active tasks. This would be especially helpful if the tasks were chosen for an ability to foster differential regional activation of the brain, or if the tasks were known to benefit from greater or lesser regional independence. A finding of enhanced cross-regional coupling persisting in the elderly in the face of such challenges would greatly extend the data obtained at rest by Dustman et al. (1985). Such data would be important for addressing whether the increased coupling is related to a loss of functional capacity in the elderly. Duffy et al. (1984) collected appropriate data to address such questions but did not emphasize regional linkage in their analyses. Thus, such a study remains to be done.

Overall, limited progress has been made in the decade since Marsh and Thompson's (1977) recommendations. We can repeat their plea for more sophisticated experimental design. The few recent studies reviewed here are improvements over earlier papers, but more such work is needed. Furthermore, longitudinal studies are still lacking. Before additional EEG studies are pursued, however, a thoughtful reassessment of the questions to be addressed by EEG studies is sorely needed. Particularly in the absence of active task manipulations, the promise of continued EEG research appears limited. Conceptual development is also needed to guide future research; the generalized, nonspecific arousal notion that was popular in psychophysiological research decades ago has been thoroughly discredited (e.g., Davidson, 1978).

## Contingent Negative Variation (CNV)

Beginning in the early 1970s, a series of papers reported on the contingent negative variation (CNV) in the aging population. The CNV is typically recorded as a negative-going voltage at the scalp that increases in the seconds during which a subject awaits an imminent event, expected to occur at a known time. It is associated with both general anticipatory processes to evaluate the event and with motor preparation to respond to the event (Rohrbaugh & Gaillard, 1983; Simons, in press). The CNV was one of the first ERP components to be assessed (see Marsh & Thompson, 1977, for a review).

Tecce, Cattanach, Yarchik, Meinbresse, and Dessonville (1982) tested a theory-based prediction about the CNV in the elderly. Older individuals have been found to be less able than young adults to switch attentional set (Birren, 1974). Tecce (1979) had found an enhanced CNV when subjects switch from a task with distraction to one without it. Tecce et al. (1982) hypothesized that the elderly might fail to show this CNV "rebound" if they were indeed less able to switch attentional focus. Results supported the authors' hypothesis for subjects aged 70 to 85 but not for those in the 55-to-69-year-old group. This CNV rebound failure in the oldest group resembled that reported for Alzheimer's patients (Tecce, Boehner, Cattanach, Branconnier, & Cole, 1981). In addition, the oldest group in the Tecce et al. (1982) study showed a deficient early CNV over the frontal lobes, also suggesting perseveration in this group. A final note of interest in this study is that, whereas P300 amplitude and latency differentiated the young group (18–32 years) from both older groups, CNV differentiated the oldest group from the other two groups, with the oldest group showing reduced CNV amplitude. Thus, CNV and P300 effects with advancing age not only are psychologically distinct but have their impact at different developmental stages.

Michalewski and associates (1980) found equivalent reduction in CNV amplitude for young and aged subjects when a distractor task was introduced, but, like Tecce et al. (1982), they noted that frontal CNV was reduced, across conditions, for the aged group. They suggested that this site-specific effect may indicate regional differences in the aging process. On the other hand, Podlesny and Dustman (1982) reported that CNV amplitude increased with age, which they interpreted as possibly reflecting weakening inhibitory function. In sum, the picture for simple CNV effects with age is unclear. It may be that, rather than being a main effect for age on the CNV, the aging process interacts with yet-to-be-specified variables in determining changes in the CNV.

CNV research with the elderly is not widely pursued at present. However, in light of new evidence that healthy older subjects in excellent physical shape may show few of the changes believed to be inevitably age-related (see below), the CNV may yet prove to be a valuable tool in studies of movement and cognitive preparation for movement.

## P300

The P300 component of the ERP is the most frequently studied measure in recent psychophysiological studies of the elderly. This positive-going deflection of brain electrical activity occurs 300 msec or more after an event that is rare and/or task-relevant, particularly when the event requires the individual to update his or her working model of the current environment (Donchin, 1981; Donchin et al., 1986b). The increasing emphasis on the P300 is perhaps the best example of a trend noted a decade ago in a review of the aging/psychophysiology literature—"the shift from rather slowly responding parameters, such as galvanic skin response or skin temperature, to experiments that analyze rapid onset phenomena" (Storrie & Eisdorfer, 1978, p. 1489).

The appeal of the P300 lies partly in the consistency with which researchers have found its latency to increase with age and partly in its demonstrated relationship to relatively high order cognitive processes. The established cognitive significance of changes in P300 contrasts markedly with the "slowly responding parameters" originally favored, the cognitive significance of which is less richly established. Most specifically, explanations for the slowing of behavior with age that rely on peripheral processes or that implicate generalized CNS processes are challenged by data on the slowing of P300 latency with age. P300 research has now advanced to the point that it supports a significant revision in prevailing views on the basis of the slowing of behavior.

Findings from a series of studies in Arnold Starr's laboratory are generally credited with sparking the high interest in the P300 for studies of age-related changes in cognition. This early work sought to identify a scalp-recorded brain event that could contribute to the differential diagnosis of dementing disease, and this work has provided the impetus for studies of normal aged populations in which more challenging cognitive tasks have been performed. (A detailed review of this literature is available in Bashore, in press, summarized here; for earlier reviews, see Ford & Pfefferbaum, 1980, 1985; Goodin, 1985; Marsh & Thompson, 1977; Polich & Starr, 1984; Squires, Chippendale, Wrege, Goodin, & Starr, 1980; Squires, Goodin, & Starr, 1979.)

In the first study from Starr's group (Goodin, Squires, Henderson, & Starr, 1978a), neurologically normal subjects ranging in age from 6 to 76 years were tested in an auditory "oddball" task. In this task, rare tones of one pitch occur randomly in a train of tones of another pitch. A series of response components is readily distinguished in the ERPs obtained from this task, labeled according to voltage polarity and approximate latency (e.g., N100, P300). Enhanced P300s are reliably observed in response to the rare tones if the subject is asked to attend to (e.g., to count) them. Goodin et al. (1978) found systematic, linear increases in the latency of P200 (0.7 msec/year), N200 (0.8 msec/year), and P300 (1.8 msec/year) beginning at age 15, as well as concomitant reductions in the amplitude of P200 (0.2 μV/year, measured as the N100–P200 peak-to-peak value) and P300 (0.2 μV/year, measured as N200–P300). The latency of N100 was not found to change with age (N100 amplitude was not measured). Thus, age-dependent, linear changes in both amplitude and latency of components later than N100 were noted in this initial study. Moreover, the later the component, the larger the increase in latency seen with age, and the largest was for P300.

The results from this initial study have been replicated to a large degree in subsequent studies. That is, age-related increases in latency have been reported consistently in auditory oddball tasks for P200, N200, and P300 but not for N100 (e.g., Brown, Marsh, & LaRue, 1983; Donchin et al., 1986b; Ford & Pfefferbaum, 1985; Goodin, Squires, & Starr, 1978b; Picton, Stuss, Champagne, & Nelson, 1984; Syndulko et al., 1982). There have been some reports of failures to find age-related latency effects, at least in some paradigms (Michalewski, Patterson, Bowman, Litzleman, & Thompson, 1982; Picton et al., 1984; Podlesny & Dustman, 1982; Snyder & Hillyard, 1979). However, by far the majority of studies have demonstrated age-correlated slowing, and none has reported a decrease in P300 latency with age.

Amplitude reductions in P300 have also been reported in a number of studies (Brown et al., 1983; Donchin et al., 1986b; Goodin et al., 1978; Mullis, Holcomb, Diner, & Dykman, 1985; Picton et al., 1984; Podlesny & Dustman, 1982; Polich, Howard, & Starr, 1985), but this consistency is lacking for N100, P200, and N200 amplitude. Several studies also dispute the P300 amplitude decline with age (Beck, Swanson, & Dustman, 1980; Ford, Pfefferbaum, Tinklenberg, & Kopell, 1982; Pfefferbaum, Ford, Roth, & Kopell, 1980a). However, to some extent this may be an artifact of a more intriguing finding: a shift in the scalp distribution of the P300. As reported in the original paper by Goodin et al. (1978a), the amplitude appears to be reduced at the parietal lead and maintained or increased at the frontal lead with advancing age (Donchin et al., 1986b; Ford & Pfefferbaum, 1985; Mullis et al., 1985; Pfefferbaum, Ford, Roth, & Kopell, 1980b; Pfefferbaum, Ford, Wenegrat, Roth, & Kopell, 1984a; Picton et al., 1984; Smith, Michalewski, Brent, & Thompson, 1980; Tecce et al., 1982). Clear exceptions to this frontal shift have rarely been reported (e.g., Duffy et al., 1984, who used an unusual index of P300 amplitude).

Emerging from this research is some controversy about the form of the relationship between age and P300 latency. Whereas Goodin et al. (1978a) reported a linear increase in component latency, Brown et al. (1983) identified a curvilinear pattern, in which positively accelerating increases were apparent at age 45 for P200, N200, and P300, although little change was apparent in these components prior to that age. A reanalysis by these investigators of the P300 latency data from Goodin et al. (1978a), Polich et al. (1985, in preparation at the time), and Syndulko et al. (1982) identified similar age-dependent curvilinear trends in the latter two studies. Picton et al. (1984) failed, however, to find any evidence for curvilinearity in their P300 data.

The findings from these studies can be summarized as follows: Age-related increases in the latency of components beyond 100 msec poststimulus occur, covarying with component latency so that, in general, the later the component, the larger the age-related increase. However, although we can conclude with confidence that the latencies of certain components of the ERP do slow with age, whether this slowing occurs at a constant rate over time or accelerates at a certain point in the life span is unclear. In contrast to the consistency observed in component latency, changes in the amplitude of the various components are observed less consistently. Finally, there appears to be a topographic shift with age, an equalization of P300 amplitude across recording sites. Whether this shift in measured P300 amplitude is truly a change in the neural generator(s) of the classic P300 or a change in the generator(s) of some other, overlapping component remains to be determined.

A number of other P300 oddball studies have been conducted with elderly subjects in recent years, using visual stimuli (e.g., Beck et al., 1980; Donchin et al., 1986b; Picton et al., 1984; Snyder & Hillyard, 1979) and omitted stimuli (Donchin et al., 1986b; Michalewski et al., 1982; Picton et al., 1984). Some studies have added an RT requirement (e.g., Donchin et al., 1986b; Ford & Pfefferbaum, 1985; Mullis et al., 1985; Pfefferbaum et al., 1980b; Pfefferbaum et al., 1984a; Picton et al., 1984; Picton, Cerri, Champagne, Stuss, & Nelson, 1986; Podlesny & Dustman, 1982; Podlesny, Dustman, & Shearer, 1984). Conclusions to date are similar to those for the oddball studies that emphasized auditory stimuli and "count" tasks: a consistent (though not invariant) increase in P300 latency, as well as mixed evidence of amplitude decrement, with advancing age.

Two studies of P300 and RT in the elderly deserve extended review here, as they exemplify ERP research that goes beyond description of age-related changes and tests a cognitive hypothesis about aging. Ford, Duncan-Johnson, Pfefferbaum, and Kopell (1982) applied a sequential analysis to P300 amplitude, P300 latency, and RT data obtained in a two-choice RT task, to test the hypothesis that older individuals do not utilize prior information as effectively as do young individuals to anticipate subsequent stimulus events (Rabbitt & Vyas, 1980). This analysis technique had been used originally with RT data to infer the effect of expectancy on response speed (e.g., Kirby, 1976). In this analysis, the pattern of response latencies is assessed over a sequence of trials, typically five. It was commonly observed that repetitions of a stimulus produced faster RTs than did discontinuations and that, as the number of repetitions increased, RT became a bit faster. The interpretation offered has been that repetitions of stimulus events induce subjects to anticipate subsequent repetitions (i.e., establish a response set), confirmations of which produce faster RTs than do disconfirmations because the correct response has been prepared.

Squires, Wickens, Squires, and Donchin (1976) were the first to apply this analysis to ERP data. An important element of this study was its demonstration of the crucial role that subjective expectancy (rather than objective probability alone) plays in determining P300 amplitude. Squires et al. (1976) showed that a larger P300 was produced when the preceding stimulus differed from the counted stimulus; and the longer the sequence of different stimuli that preceded the counted stimulus, the larger the P300 elicited by that stimulus. Conversely, the longer the sequence of similar stimuli (i.e., those that were also counted) preceding a counted stimulus, the smaller the P300 elicited by that stimulus. Thus, the pattern of amplitude change for P300 paralleled that reported for RT. These findings have been confirmed and extended in a number of subsequent studies.

It is important to note that Ford et al. (1982) found that the effects of stimulus sequence on P300 latency and amplitude were comparable in young and elderly subjects. Thus, P300 amplitude was larger in both groups in response to stimuli that discontinued rather than continued a stimulus sequence, and both P300 latency and RT were prolonged by discontinuations of a stimulus event. Discontinuations of a stimulus sequence produced larger P300s in the young and the old subjects, but the change was more pronounced in the older subjects. This disparity in P300 amplitude effects was not apparent when expectations were confirmed. Ford et al. suggested that disconfirmations of expectancies disrupt the processing efficiency of the elderly more than they do that of the young, but that confirmations of expectancies do not benefit the elderly more than the young. These findings imply that older subjects establish expectancies for future stimulus events from earlier events in much the same way as do young subjects and that they may be even more sensitive to prior stimulus events than are young subjects, contrary to the hypothesis of Rabbitt and Vyas (1980).

Several consistent findings have emerged from the P300/RT studies:

1. P300 latency is prolonged with age, and the increase is comparable to that reported in the oddball studies (1.0–2.0 msec/year).
2. Unlike the age-related decrease in P300 amplitude observed in the oddball studies, when an overt response to an auditory stimulus is required, there is no evidence of amplitude diminution with age.
3. The scalp distribution of P300, as reported in the oddball studies, is equipotential along the midline in the old, whereas it is maximal at Pz and reduces frontally in the young.
4. This age-related variation in the topography of P300 is paralleled by a reduction in the frontal negativity of the slow wave in the elderly (recall also the reduced slow frontal negativity reported by Tecce et al., 1982).
5. The elderly utilize prior stimulus information to establish expectancies for future events in much the same way as do the young.
6. RTs are comparable among the young and the old in these reasonably uncomplicated tasks. This last finding is notable, since studies in which RT is the only dependent measure of processing speed have consistently reported a slowing of response speed with age at all levels of processing

complexity (Birren, Woods, & Williams, 1979; Cerella, 1985; Kausler, 1982; Salthouse, 1985a, b), although there is strong evidence that the age effect on RT increases for more complex tasks (Cerella, Poon, & Williams, 1980).

Comparability of response latency in old and young subjects is typically reported only when the old subjects are in very good health and keep fit through regular exercise (see below). In most of the ERP/RT studies, subjects have been screened medically; whereas in the RT-only studies, health status questionnaires were typically used to screen candidates. It has now been documented that such questionnaires probably provide unreliable information (Siegel, Nowlin, & Blumenthal, 1980). It may very well be that healthier subjects were used in these ERP studies and that this is reflected in the comparability of response latencies across age groups. Indeed, this issue of underassessed health status is emerging as a significant confound in the psychophysiological literature on the aged (see below).

## P300/RT Relationships in Memory Function

The most concrete contributions of ERP research to gerontology have emerged from five studies on memory scanning, P300 latency, and RT. Taken together, this work provides a basis for revising notions of the locus of cognitive slowing in the elderly. A sixth study suggests a specific memory deficit in those elderly individuals with a particularly small or even absent P300. In the five memory scanning studies, Sternberg's (1969) task was chosen to assess age-related declines in the speed of memory search (Ford, Roth, Mohs, Hopkins, & Kopell, 1979; Ford et al., 1982; Marsh, 1975; Pfefferbaum et al., 1980a; Strayer, Wickens, & Braune, 1987). The sixth study adapted a clinical test of memory function for use in the ERP laboratory (Donchin et al., 1986b; Farwell, Chambers, Miller, Coles, & Donchin, 1985).

In the Sternberg task, the subject is shown a list of stimuli such as the digits 1 to 9, one stimulus at a time. This list, the memory set, typically varies in length from one to six items. Following presentation of the last item in the memory set, the subject is presented a single stimulus, the test or probe item, and is required to make a choice RT response indicating whether or not the test item was in the memory set for that trial. Subjects are encouraged to place equal emphasis on speed and accuracy, and the task is designed for perfect recall (Sternberg, 1969). There are two basic versions of the task: fixed and varied set. In the former, the subject is shown the same memory set items on each trial in a block of trials. In the latter, the memory set items are different on each trial.

Sternberg (1969, 1975) and many others have shown that RT to the test item is a linear function of the number of items in the memory set and that the increase is approximately 40 msec per item in young adults. The slope of this function was hypothesized by Sternberg (1969) to reflect the time needed to compare the test item with each item held in memory, what he has labeled "serial comparison time." Negative responses typically have longer latencies, but the slopes of the two functions are parallel. According to Sternberg (1969), this process of serial comparison is exhaustive. That is, the subject is presumed to scan through the entire memory set for both positive and negative items, irrespective of the location of the positive test item in the memory set. The intercept of the regression function is hypothesized to be an aggregate time comprising stimulus encoding, binary decision, and response translation and organization times, independent of comparison time.

Sternberg's (1969) componential analysis of the regression function derives from his assumption that the four stages hypothesized to mediate memory scanning are activated sequentially. Thus, a stage is not engaged until it receives the output of the processing completed at the stage immediately prior. In this model, the value of the intercept is the sum of the processing times of the three stages it includes, and the total RT is the sum of the times required for each stage to complete its processing. This assumption of serially engaged stages of processing gave rise to Sternberg's (1969) development of the Additive Factors Method, to isolate the stages influenced by different experimental manipulations. Experimental variables are inferred to activate different stages of processing if they produce main effects (i.e., are additive) and to activate the same stage if they produce interactive effects.

Although not unchallenged (e.g., Grice, Nullmeyer, & Spiker, 1982), these theoretical and research assumptions have had a major influence on cognitive psychology (see Lachman, Lachman, & Butterfield, 1979). Investigations in which the memory scanning time of young and old subjects has been compared reveal that older subjects have longer RTs, larger intercepts, and steeper slopes than do young adults (Anders & Fozard, 1973; Anders, Fozard, & Lillyquist, 1972; Eriksen, Hamlin, & Daye, 1973; Madden, 1982; Madden & Nebes, 1980; Maniscalco & DeRosa, 1983; Salthouse & Somberg, 1982a, 1982b). These findings have led to the conclusion that memory scanning is slower at all stages of processing in older adults.

Importantly, however, a different conclusion can be drawn from the ERP studies of age-related changes in memory scanning. The five psychophysiological studies completed to date have used a varied-set version of Sternberg's task to study age-related declines in memory scanning (Ford et al., 1979, 1982b; Marsh, 1975; Pfefferbaum et al., 1980a; Strayer et al., 1987). Although there is some disagreement in the findings from these studies, sufficient consistency exists to permit the additive-factors logic of Sternberg (1969) to be applied to the P300 latency data. First, the RT data are generally consistent with those from the RT literature for both the young and the old. That is, RT increases with increases in memory set size, it is longer in the old, and the slope is steeper and the intercept of the RT-memory set size regression function larger in the old than in the young. Second, the slope of the P300 latency-memory set size regression function is comparable in the two groups, whereas the intercept of this function is larger in the old than it is in the young. Third, the interval between P300 latency and the response output is larger in the old, and the slope is steeper and the intercept is larger in the old for the RT–P300 latency difference regression function.

From these findings it is possible to partition the memory scanning process with greater precision than can be accomplished using RT measures alone. As noted above, Ford et al. (1979) were the first to do this analysis, and their paper provides an elegant example of this procedure. Their contribution was to use P300 latency as a measure of the timing of stimulus-related processing. The rationale for this was provided by the evidence that suggested the relationship between P300 latency and stimulus processing (e.g., Kutas, McCarthy, & Donchin, 1977).

In the Sternberg model, the slope of the RT-memory set size regression function is an estimate of the time taken at the serial comparison stage, and the intercept of this function is the sum of the times taken to complete stimulus encoding, to make the binary decision, and to activate the correct response. However, Ford et al. (1979) reasoned that the slope of the P300 latency-memory set size function, rather than that of the RT-memory set size function, provides an estimate of serial comparison time. They also argued that the intercept of the P300 latency function gives an estimate of the time required to encode the stimulus information. They reasoned further that the time between the peak of the P300 and the response output was a measure of the relative timing of response-related processes. The slope of this regression function was assumed to provide an estimate of binary decision time, whereas its intercept was assumed to reflect the time required to translate and organize the response.

Ford et al. (1979) found that the slope of the RT-memory set size function was steeper and the intercept larger in the old than in the young. As in the RT function, the intercept was larger in the old. Unlike the RT function, however, the slope of the P300 latency-memory set size function was comparable in the two groups. As would be expected from these data, the RT–P300 latency-memory set size function had a slope that was steeper and an intercept that was larger in the old. These findings led Ford et al. to the following conclusions: (1) Serial comparison time does not increase with age (P300 latency slope); (2) stimulus encoding processes are somewhat slower in the old than in the young (P300 latency intercept); (3) response-related processes are much slower in the old than in the young (RT–P300 latency intercept); (4) the old are less confident in their response selection decisions as task difficulty increases (RT–P300 latency slope).

Strayer et al. (1987) also fractionated memory scanning utilizing RT and P300 latency data, and they added another refinement by analyzing speed–

accuracy tradeoff functions for the RT data. Their data largely replicated those of Ford, Roth, et al. (1979). Addition of the speed–accuracy tradeoff analyses suggested that the delays in response-related processes evident in the elderly could be attributed in part to their adoption of a more conservative response criterion. Strayer et al. argued that three components contributed equally to the overall slowing of the older subjects. The first, evident in the elevation of the P300 latency intercept, was inferred to be related to stimulus encoding. The second, indexed by the steeper slope of the RT function (they did not analyze the RT–P300 latency interval), was thought to be related to slowing of response-related processes with increases in memory set size (not to serial comparison because of the comparability of the P300 latency slopes). The third, derived from the speed–accuracy analysis, was thought to be produced by shifts in the response criterion (i.e., the older subjects were more conservative).

Importantly, the results of these two studies suggest that age-related slowing in memory scanning occurs at both stimulus encoding and response-related stages of processing. *The speed of serial comparison processes appears to be maintained with age.* Response-related slowing may be contributed to by strategy differences and by changes in the speed with which responses can be selected and executed, the relative contributions of which are unknown. The work of Ford et al. (1979) and of Strayer et al. (1987) provides elegant examples of how mental processes can be articulated utilizing ERP/RT measures. In the next section, a refinement of a model of age-related slowing in the rate of mental processing will be developed, using the rationale that guided these ERP researchers.

## P300, RT, and the Slowing of Behavior

On the basis of independent analyses, both Salthouse (1985a, b) and Cerella (1985; Cerella et al., 1980) concluded that age-related slowing in response speed is multiplicative and that it is mediated by declines in the efficiency of CNS transmission. Both concluded that the decline is generalized across levels of central information processing. An assumption underlying these analyses is that RT is a reasonably pure measure of general nervous system integrity and as such can be decomposed into peripheral and central constituents using the appropriate experimental and quantitative procedures. However, our own analysis of P300 latency data (Bashore, in press) demonstrates an age-related increment in higher-order processing time that is addictive, not proportional. Since the timing of brain electrical activity provides a more direct measure of higher-order central engagement than does the timing of response output, we would argue, in agreement with Ford and Pfefferbaum (1985), that P300 latency provides a purer measure of age-related changes in higher-order CNS processes than does response latency. It follows, in contrast to the conclusions of Cerella (1985) and

Salthouse (1985a, b), that only certain elements of central information processing decline with age.

To pursue this view more fully, Bashore (in press) aggregated P300 latency and RT data from 33 studies that included 64 different experimental conditions in which age-related changes were analyzed. Importantly, the slopes of the RT and RT–P300 latency regression functions suggest that the age-related decline in mental processing speed is multiplicative, whereas that for P300 latency indicates an additive relationship. How can this difference be reconciled? Previous research has demonstrated that RT is extremely sensitive to variations in response strategy (e.g., Wickelgren, 1977), whereas P300 latency is reasonably insensitive (e.g., Kutas et al., 1977; Pfefferbaum et al., 1983; Strayer et al., 1987). There is compelling evidence that older subjects adopt more conservative response strategies than do young subjects (Salthouse, 1982; Strayer et al., 1987; but see Ford & Pfefferbaum, 1985, for a counterargument), and this conservatism may increase with increases in task complexity (Ford et al., 1979; Pfefferbaum et al., 1980a). Hence, the slope functions for these two measures may reflect changes in response strategy as processing complexity is increased; that is, nonanatomic factors contribute to the slope effect. Since P300 is generated from a neural source and its timing is not very sensitive to shifts in response strategy, we can infer that its latency reflects the engagement of central mechanisms uncontaminated by nonneural variables. In sum, rather than a generalized slowing of CNS function, the P300/RT data indicate that the "slowing of behavior" in the elderly is confined to response strategy and execution stages.

Some speculations can be offered to account for the additive linear function for P300 latency. It is conceivable that this additivity represents the sum of earlier processing times that may or may not be differentially changed with age. Since the literature indicates that N100 latency does not become prolonged with age (another ERP basis for arguing against the generalized CNS slowing hypothesis) and that its amplitude and latency vary comparably in the old and the young when a selective attention task is performed (Ford, Hink, Hopkins, Roth, Pfefferbaum, & Kopell, 1979), it is reasonable to hypothesize that components between N100 and P300 may be differentially affected by age when a rapid decision is made. Potential candidates are the Na and N200 components investigated in studies by Ritter, Vaughan, and colleagues (Ritter, Simson, Vaughan, & Friedman, 1979; Ritter, Simson, Vaughan, & Macht, 1982; Ritter, Vaughan, & Simson, 1983), which appear to reflect pattern recognition and stimulus categorization processes, respectively, engaged during the decision-making process itself. In contrast, the timing of P300 may be more closely related to the outcome of this prior processing, the function of which is to prepare for stimulus processing on future trials (e.g., Donchin, Karis, Bashore, Coles, & Gratton, 1986a). Thus, the timing of these earlier components may be more reflective of age-related declines in the speed of mental processes activated for immediate action, where the timing of the P300 may be more closely tied to the engagement of processes essential to the performance of later, memory-dependent functions such as recognition of previous stimulus events (Johnson, Pfefferbaum, & Kopell, 1985).

### P300 and Maintenance of Working Memory

Whereas the five P300 *latency* studies employing the Sternberg memory scanning task suggest a new view of the role of CNS changes in the *speed* of memory function and behavior with age, a recent study in our laboratory investigates the relationship of P300 *amplitude* to the *quality* of memory function in the elderly (Donchin et al., 1986b; Farwell et al., 1985).

Our study of P300 in the elderly included, as a first stage, the assessment of 53 healthy subjects, aged 60 to 82 years, in four variants of the oddball experiment. The results indicated that these subjects yielded an orderly data set in which rare stimuli elicited a clear and typical P300, albeit with a somewhat longer latency than we have observed in young adults. However, in about one-sixth of the sample, the P300 appeared to be absent or very small in all four tasks. This was quite surprising relative to our experience with hundreds of young adults run in similar studies.

To test the reliability of these observations, the four oddball tests were repeated with half of the original sample several months later. It turned out that the low-P300 subjects whose ERPs were consistent in lacking a P300 across tasks were also quite consistent across time. Test–retest correlations for P300 amplitude to target stimuli for the four tasks were reasonably good (.44, .51, .66, and .73).

A comparison of 19 young adults with the full elderly sample yielded findings consistent with those recorded in other laboratories, reviewed above. There was a highly significant P300 latency difference between our aged (539 msec) and young (455 msec) groups, averaged across tasks and target/nontarget. This is a slowing of 1.77 msec/year, within the range of values found by other investigators (see discussion above). As some other laboratories have reported, P300 amplitude was lower in the full elderly group, overall.

The low-P300 subjects performed the oddball task as well as the other subjects. Comparing the low-P300 group with the high-P300 group revealed no significant differences in reaction time. The groups also did not differ in P300 latency or response accuracy. Medical records were examined, data on educational background were collected, and various psychometric, sensory, and other tests were administered to the subjects. The high-P300 group was, on average, a year older than the low-P300 group and had a higher proportion of women. However, none of these differences proved statistically reliable. In consideration of our developing theory of P300 as a manifestation of an intracranial process associated with updating representations of information in working memory, it seemed possible that subjects who lack a P300 would show a deficit in performing tasks that depend on the viability of those short-term representations. For this reason, we designed a task that was intended to determine the subject's ability to maintain the status of his/her working memory, patterned after the Hebb-Corsi test used by Milner (1978) and her colleagues in evaluating the effects of severe temporal lobe damage on memory. On each trial in the task we used, the subject was presented with a digit followed by a second digit 1,000 msec later. The subject was instructed to indicate by a button press whether or not the pair had appeared previously in that trial block.

In accord with our theory, high- and low-P300 subjects differed in RT performance. Both groups were able to accomplish the task with high accuracy (88% for the "lows," and 93% for the "highs"; not significantly different). Mean RTs when reporting that a pair had been seen before were comparable for the high-P300 and low-P300 groups. The low-P300 subjects, however, were significantly slower than the high subjects when reporting that a pair of digits had not been seen before. Reaction time to nonrepeating digit pairs correlated with the P300 amplitude obtained in the original oddball study for the high and low groups combined (Spearman $r = -.49, p < .05$). We found a similar pattern of RTs in a small replication sample.

In summary, elderly subjects who lack a P300 but are otherwise normal are slower in indicating that an item is novel. We interpret this as indicating that they are slower either in searching working memory or in reporting the results of such a search when the search is unaided by cues provided by external stimuli. The specificity of this finding is underscored by the fact that the high- and low-P300 subjects were equally fast in the choice-RT oddball task, which does not require the short-term maintenance of a memory set. Thus, an exceptionally small characteristic P300 reflects a deficit specific to recall from working memory, rather than a generalized deficit so often seen in special populations. These data support the interpretation of P300 as a manifestation of the updating of working memory and suggest that it is useful to examine the deterioration of memory performance in the elderly and the demented in terms of specific properties such as the maintenance of working memory. It is becoming increasingly apparent that studies involving multiple, active tasks are needed to characterize age-related cognitive changes.

## PSYCHIATRIC AND NEUROLOGICAL DISEASE IN THE ELDERLY

Although EEG assessment has played a role in clinical diagnosis for some decades (e.g., McAdam & Robinson, 1962), its clinical utility is variable. In the diagnosis of dementia, for example, EEG assessment is of little value (Goodin, 1985). This role has been eclipsed to a significant extent by the widespread use of computed tomography (CT) X-ray techniques. It further appears that the high anatomical fidelity available with nuclear magnetic resonance imaging (NMR or MRI) will further erode reliance on the EEG. Despite this progress in anatomical diagnosis, much remains to be accomplished with electrophysiological measures of brain function. Accordingly, the greater cognitive specificity that can apparently be achieved with ERP rather than EEG measures is moving the field away from the EEG and toward ERPs collected under increasingly precise cognitive demands.

In recent years, much of the focus of the literature on clinical applications of psychophysiology has shifted to two issues. First, there has been growing concern with potential utility in differential diagnosis, particularly with ERP measures. For example, it appears that simple, stimulus-determined visual ERPs show too much overlap between healthy and diseased groups to be of clinical use for individual patients (Coben, Danziger, & Hughes, 1983). On the other hand, components of the ERP that are sensitive to higher-order cognitive function appear to be more promising, with the latency of the P300 receiving most of the attention (discussed above). Second, data are appearing that implicate general physical health, as promoted by above-average exercise regimens, in substantially moderating the psychophysiological declines once thought to be inevitable with age.

### The Specificity of P300 Changes

A group of recent studies captures well the dilemma encountered in attempts to apply ERP methodology to improve differential diagnosis in elderly samples. A number of studies have found a lengthened P300 latency associated with dementia in elderly subjects (Brown, Marsh, & LaRue, 1982; Goodin et al., 1978b; Pfefferbaum, Ford, Wenegrat, Roth, & Kopell, 1984b; Polich, Ehlers, Otis, Mandell, & Bloom, in press; Syndulko et al., 1982). Squires et al. (1980) reported considerably different distributions of P300 latency in a comparison of demented and (1) nondemented neurological patients, (2) psychiatric patients, and (3) healthy elderly subjects. Furthermore, clinician ratings of degree of cognitive impairment exam have been found to correlate with P300 latency (Lai, Brown, Marsh, & LaRue, 1983; Polich et al., in press). Thus, there is evidence that P300 holds considerable promise for the differential diagnosis of dementia. However, there is also evidence that P300 latency cannot distinguish among different types of dementia and cannot detect mild cases of dementia (Polich et al., in press).

Using a slightly more complex task, Pfefferbaum and colleagues (1984a, b) conducted an extensive study comparing 135 normal controls ranging in age from 18 to 90 with a group of demented patients, as well as with schizophrenics, depressives, and nondemented, cognitively impaired patients. Auditory and visual stimuli were employed, with both rare target (subjects responded with a button press) and rare nontarget (no response required) as well as frequent stimuli. P300s were elicited by both types of rare stimuli.

Like previous research, this study found that demented patients exhibited significantly prolonged P300 latencies when compared with normal subjects for both target and nontarget rare stimuli in both auditory and visual modalities. However, schizophrenics also showed significantly prolonged P300s. Nondemented, cognitively impaired patients and depressives seemed to exhibit somewhat longer P300 latencies than did normals but did not show as great an effect as the demented patients. Variability in P300 latency was greater in demented patients and in schizophrenics.

Amplitude effects were also observed in this study. Demented patients showed diminished P300 amplitude for almost all conditions. Schizophrenics and depressives who were not under medication appeared to show a similar but less pronounced effect. Both demented and schizophrenic patients had slower RTs than controls.

This important study illustrates the difficulties in attempting to employ ERPs to distinguish clinically defined populations. Although significant relationships were found, the lack of specificity of the effects suggests that use of ERPs in differential diagnosis is problematic at best. Moreover, not all studies have found P300 latency differences in demented patients. With 42 demented elderly patients, 29 nondemented elderly patients, and 10 healthy young controls, Slaets and Fortgens (1984) found no significant difference in P300 latency between demented and nondemented patients performing an auditory oddball counting task. It is difficult to give these results weight, however, as a number of aspects of the results are highly unusual. The authors could identify a P300 in only 37% of their controls, 19% of their demented patients, and 20% of their nondemented patients. Only 35% of the patients could perform the instructed task. Of greatest concern was that nothing was done to deal with electrooculogram (EOG) artifact.

Of course, in considering this inconsistent literature, it is necessary to note that, too often, studies viewed as putative replications of previous work differ in important respects. The pattern of ERPs one obtains in any experimental paradigm is enormously sensitive to subjects' perception of the task and the range of strategies that are employed by the subject. It is crucial, therefore, that investigators take pains to ensure that when they claim to replicate a study they have indeed done so in the formal sense of the word "replicate." Thus, for example, if an original study reports a pattern of results that was obtained when a sequence of stimuli was randomly selected, then any study that imposes constraints on the stimulus sequence is, by definition, not a replication. Failure to confirm the original results in such cases is not entirely surprising. It is in such a context that one must, for example, evaluate the implication of the failure of Pfefferbaum et al. (1984b) to replicate the work of Goodin et al. (1978b). Overall, Goodin's (1985) review of this and related studies concludes that P300 latency appears to be rather useful clinically because of what he sees as its high specificity for dementia.

**General Health and the Inevitability of CNS Decline**

The popular interest in health, exercise, and nutrition is beginning to filter into psychophysiological research on aging. A large literature has documented that individuals over 60 who have maintained aerobic fitness through systematic exercise for a number of years typically have cardiovascular and pulmonary systems that function comparably to those of young adults (Shepherd, 1978). There are no systematic studies, however, of the beneficial effects of such training on CNS functions, particularly those mediated in the brain. A handful of RT studies do suggest that mental processing speed (and presumably brain processing speed) is faster in older exercisers than it is in older nonexercisers; in some instances, it may be comparable to that of young adults (see Spirduso, 1980, 1982). A pilot study (Bashore, Heffley, & Donchin, unpublished data) assessed the relationship between age, aerobic fitness, and mental processing speed utilizing a task developed by McCarthy and Donchin (1981). We tested 10 men between 62 and 74 years of age on this task, 5 of whom jogged regularly (averaging about 20 miles a week) for at least 10 consecutive years. The ERPs of the older exercisers appeared to have a closer resemblance to those of young adults than to those of old nonexercisers. This correspondence was evident in the amplitude and latency of P300, as well as in the RT.

That this question is worthy of systematic investigation is suggested in a study completed recently by Dustman and colleagues (personal communication). They did comprehensive neuropsychological assessments, including ERP and RT measures, of old and young, exercisers and nonexercisers, and found, as we did, that older exercisers had RTs and P300 latencies that were significantly faster than their sedentary age peers and comparable to those of young adults. The suggestion from these two data sets is that the rate at which declines in brain processing efficiency occur with age may be alterable and that aerobic exercise may be one means by which this decline can be delayed well into later life.

## CONCLUSIONS

In closing, we note a set of methodological and interpretive issues yet to be faced adequately in the aging/psychophysiology literature. First, the vast majority of psychophysiological studies with elderly subjects have been limited to a single physiological response system (e.g., heart rate or ERPs), perhaps with RT also recorded. Yet the value of multiple simultaneous measurement for characterizing psychological and physiological changes with age is clear. For example, the question of age-related increases in physiological consistency or decreases in variability, noted earlier in this review for EEG power and for P300 amplitude, has emerged also in quite different studies, involving a variety of cardiovascular measures (e.g., Gintner, Hollandsworth, & Intrieri, 1986). If age-related variability changes are stable, pervasive, individual-differences phenomena, might increased consistency (decreased flexibility?) in P300 response predict sustained elevation in blood pressure? The short- and long-term implications of blood pressure changes in the elderly are particularly deserving of continuing research, given the high rate of blood pressure problems in this population. Questions about consistency across measures and across individuals within an age group deserve increased attention in future research.

As a second general issue, how does one decide that an age-related change is a "decline" in function, particularly without reference to a specific subject goal or task context? It is also crucial to determine the boundaries of an apparent functional decline. As a third and closely related issue, should increases in consistency, decreases in response amplitude, and decreases in reactivity be treated as equivalent types of "decline"? Consider the following example.

In a study of the habituation of the sweat response (skin conductance response, or SCR) and recall of slides of common and uncommon objects, elderly subjects had poorer recall performance and smaller SCRs (Plouffe & Stelmack, 1984). However, young and elderly subjects showed very similar relationships between novelty and SCR, SCR and recall performance, and habituation and other variables. Thus, while the attenuation of SCR paralleled attenuated memory function, the dynamic relationship between the experimental variables was fully intact in the elderly sample. It appears from this data set that *how* the relevant memory system and its physiological support are functioning is entirely normal in the older sample. That is, the older sample's decline in memory performance is not due to a complete loss of some capability. Rather, normal strategies are being used but with somewhat reduced success.

These results highlight a fourth issue: When two groups of subjects are found to differ on some observable measure, do we conclude that they employed different strategies, the same strategies but at different times, or the same strategies at the same time but with differing degrees of skill? It is of considerable theoretical significance whether a deviant group differs because it is incapable of pursuing a normal strategy or merely because it is capable of the normal strategy but chooses to employ a different one (Perlmutter & Mitchell, 1982). This issue is also of considerable practical significance for training and rehabilitation efforts.

Finally, more attention must be paid to the importance of showing appropriate *differential* deficits, not merely differences on one measure. This is a classic point from the testing and assessment literature in clinical psychology (e.g., Chapman & Chapman, 1973). If one group is thought to have certain generalized deficits, then demonstration of a difference with another group on a single measure may say nothing about that measure. For example, if one group is generally less able to maintain vigilance, then any task requiring vigilant attention will indicate inferior performance for that group when, in fact, there may be no specific deficit for that task. A related point is that care must be taken in matching tasks and subject groups on relevant variables. For example, a task believed to measure a certain cognitive function may do so equally well for two subject groups but may be more difficult for one group than the other for reasons having nothing to do with possible differences in that cognitive function. One group's poorer performance would then falsely suggest lower cognitive function. When multiple tasks are employed—a research strategy for which there is great need in the literature reviewed here—it is important to evaluate the tasks for their relative psychometric properties. For example, if two subject groups truly differ from each other an equal amount on two tasks, and the two tasks differ in reliability (in a test-theoretic sense), the task having the higher reliability will produce a larger group difference, purely as a statistical artifact. These issues of relative task difficulty and reliability have received essentially no attention in the aging/psychophysiology literature.

Psychophysiology is partaking actively of the rapidly growing interest in basic research in gerontology. Important contributions are already apparent in understanding the locus of the general slowing of behavior in old age, and much promise is apparent in analyzing cognitive function. Psychophysiology at present is struggling to establish itself as useful in clinical applications: In the language of clinical medicine, the sensitivity of a variety of psychophysiological measures is fairly well established, but there is no consensus yet on the specificity. It is certainly premature to draw conclusions about whether a useful degree of specificity can be established. As a suggestion applicable to any study of special populations (Donchin & Bashore, in press; Donchin et al., 1986b), a supplement to the usual strategy of selecting subjects on the basis of clinical diagnosis and then assessing possible differences in the laboratory would be to select subjects on the basis of laboratory deficits (e.g., specific differences in cognitive function) and then to look for other laboratory differences and for systematic clinical differences.

Only in cognitive ERP research have enough programmatic psychophysiological studies been conducted with aged samples to provide a significant contribution to what is known about the aging process. A number of methodological and conceptual issues have been raised here in the context of a brief review of a rapidly growing literature. It is hoped that greater attention to these issues will allow other facets of geriatric psychophysiology to develop a solid knowledge base.

## REFERENCES

Anders, T. R., & Fozard, J. L. (1973). Effects of age upon retrieval from primary and secondary memory. *Developmental Psychology, 9*, 411–416.

Anders, T. R., Fozard, J. L., & Lillyquist, T. D. (1972). Effects of age upon retrieval from short-term memory. *Developmental Psychology, 6*, 214–217.

Bashore, T. R. (in press). Age-related changes in mental processing revealed by analyses of event-related brain potentials.

Beck, E. C., Swanson, C., & Dustman, R. E. (1980). Long latency components of the visually evoked potential in man: Effects of aging. *Experimental Aging Research, 6,* 523–545.

Birren, J. E. (1974). Translations in gerontology—from lab to life: Psychophysiology and the speed of response. *American Psychologist, 29,* 808–815.

Birren, J. E., & Botwinick, J. (1955). Speed of response as a function of perceptual difficulty and age. *Journal of Gerontology, 10,* 433–436.

Birren, J. E., & Cunningham, W. (1985). Research on the psychology of aging: Principles, concepts, and theory. In J. E. Birren & K. W. Schaie (Eds.), *Handbook of the psychology of aging (2nd ed.)* (pp. 3–34). New York: Van Nostrand Reinhold.

Birren, J. E., Woods, A. M., & Williams, M. V. (1979). Speed of behavior as an indicator of age changes and the integrity of the nervous system. In F. Hofmeister & C. Mueller (Eds.), *Brain function in old age* (pp. 10–44). Berlin: Springer-Verlag.

Brown, W. S., Marsh, J. T., & LaRue, A. (1982). Event-related potentials in psychiatry: Differentiating depression and dementia in the elderly. *Bulletin of the Los Angeles Neurological Society, 47,* 91–107.

Brown, W. S., Marsh, J. T., & LaRue, A. (1983). Exponential electrophysiological aging: P3 latency. *Electroencephalography and Clinical Neurophysiology, 55,* 277–285.

Cerella, J. (1985). Information processing rates in the elderly. *Psychological Bulletin, 98,* 67–83.

Cerella, J., Poon, L. W., & Williams, D. M. (1980). Age and the complexity hypothesis. In L. Poon (Ed.), *Aging in the 1980s: Psychological issues* (pp. 332–340). Washington, DC: American Psychological Association.

Chapman, L. J., & Chapman, J. P. (1973). *Disordered thought in schizophrenia.* New York: Appleton-Century-Crofts.

Coben, L. A., Danziger, W. L., & Hughes, C. P. (1983). Visual evoked potentials in mild senile dementia of the Alzheimer's type. *Electroencephalography and Clinical Neurophysiology, 55,* 121–130.

Davidson, R. J. (1978). Specificity and patterns in biobehavioral systems: Implications for behavior change. *American Psychologist, 33,* 430–436.

Donchin, E. (1981). Surprise! . . . Surprise?, *Psychophysiology, 18,* 493–513.

Donchin, E., & Bashore, T. (in press). Clinical versus psychophysiological paradigms in the study of event-related brain potentials. In S. Harnad (Ed.), *The behavioral and brain sciences.*

Donchin, E., Karis, D., Bashore, T. R., Coles, M. G. H., & Gratton, G. (1986a). Cognitive psychophysiology and human information processing. In M. G. H. Coles, S. W. Porges, & E.Donchin(Eds.), *Psychophysiology: Systems, processes, and applications* (pp. 244–267). New York: Guilford Press.

Donchin, E., Miller, G. A., & Farwell, L. A. (1986b). The endogenous components of the event-related potential—a diagnostic tool? In D. F. Swabb, E. Fliers, M. Mirmiram, W. A. Van Gool, & F. van Haaren (Eds.), *Progress in brain research. Vol. 70: Aging of the brain and Alzheimer's disease* (pp. 87–202). Amsterdam: Elsevier.

Drechsler, F. (1978). Quantitative analysis of neurophysiological processes of the aging CNS. *Journal of Neurology, 218,* 197–213.

Duffy, F. S., Albert, M. S., McAnulty, G., & Garvey, A. J. (1984). Age-related differences in brain electrical activity of healthy subjects. *Annuals of Neurology, 16,* 430–438.

Dustman, R. E., LaMarche, J. A., Cohn, N., Shearer, D. E., & Talone, J. M. (1985). Power spectral analysis and cortical coupling of EEG for young and old normal adults. *Neurobiology of Aging, 6,* 193–198.

Eriksen, C. W., Hamlin, R. M., & Daye, C. (1973). Aging adults and rate of memory scan. *Bulletin of the Psychonomic Society, 1,* 259–260.

Farwell, L. A., Chambers, R. D., Miller, G. A., Coles, M. G. H., & Donchin, E. (1985). A specific memory deficit in elderly subjects who lack a P300. *Psychophysiology, 22,* 589. (Abstract).

Ford, J. M., Duncan-Johnson, C. C., Pfefferbaum, A., & Kopell, B. S. (1982). Expectancy for events in old age: Stimulus sequence effects on P300 and reaction time. *Journal of Gerontology, 37,* 696–704.

Ford, J. M., Hink, R. F., Hopkins, W. F., Roth, W. T., Pfefferbaum, A., & Kopell, B. S. (1979). Age effects on event-related potentials in a selective attention task. *Journal of Gerontology, 34,* 388–395.

Ford, J. M., & Pfefferbaum, A. (1980). The utility of brain potentials in determining age-related changes in central nervous system and cognitive functioning. In L. Poon (Ed.), *Aging in the 1980s: Psychological issues* (pp. 115–124). Washington, DC: American Psychological Association.

Ford, J. M., & Pfefferbaum, A. (1985). Age-related changes in event-related potentials. In P. Ackles, R. Jennings, & M. G. H. Coles (Eds.), *Advances in psychophysiology,* Vol. 1 (pp. 301–339). Greenwich, CT: JAI Press.

Ford, J. M., Pfefferbaum, A., Tinklenberg, J. R., & Kopell, B. S. (1982). Effects of perceptual and cognitive difficulty on P3 and RT in young and old adults. *Electroencephalography and Clinical Neurophysiology, 54,* 311–321.

Ford, J. M., Roth, W. T., Mohs, R. C., Hopkins, W. F., & Kopell, B. S. (1979). Event-related potentials recorded from young and old adults during a memory retrieval task. *Electroencephalography and Clinical Neurophysiology, 47,* 450–459.

Giaquinto, S., & Nolfe, G. (1985). The EEG and cognitive tasks in the aged. *Journal of Neurology, 232,* 447.

Gintner, G. G., Hollandsworth, J. G., & Intrieri, R. C. (1986). Age differences in cardiovascular reactivity under active coping conditions. *Psychophysiology, 23,* 113–120.

Goodin, D. S. (1985). Electrophysiological evaluation of dementia. *Neurologic Clinics, 3*(3), 633.

Goodin, D., Squires, K., Henderson, B., & Starr, A. (1978a). Age related variations in evoked potentials to auditory stimuli in normal human subjects. *Electroencephalography and Clinical Neurophysiology, 44,* 447–458.

Goodin, D. S., Squires, K. C., & Starr, A. (1978b). Long latency event-related components of the auditory evoked potential in dementia. *Brain, 101,* 635–648.

Grice, G. R., Nullmeyer, R., & Spiker, V. A. (1982). Human reaction time: Toward a general theory. *Journal of Experimental Psychology: General, 111,* 135–153.

Johnson, R., Pfefferbaum, A., & Kopell, B. S. (1985). P300 and long-term memory: Latency predicts recognition performance. *Psychophysiology, 22,* 497–507.

Katz, R., & Horowitz, G. R. (1982). Electroencephalogram in the septuagenarian:

Studies in a normal geriatric population. *Journal of the American Geriatric Society, 3,* 273–275.

Kausler, D. H. (1982). *Experimental psychology and human aging.* New York: John Wiley & Sons.

Kirby, N. H. (1976). Sequential effects in two-choice reaction time: Automatic facilitation or subjective expectancy? *Journal of Experimental Psychology: Human Perception and Performance, 2,* 567–577.

Kutas, M., McCarthy, G., & Donchin, E. (1977). Augmenting mental chronometry: The P300 as a measure of stimulus evaluation time. *Science, 197,* 792–795.

Lachman, R., Lachman, J. L., & Butterfield, E. C. (1979). *Cognitive and information processing: An introduction.* Hillsdale, NJ: Erlbaum.

Lai, J., Brown, W. S., Marsh, J. T., & LaRue, A. (1983). Covariation of the P3 latency and Mini-Mental-State scores in geratric patients. *Psychophysiology, 20*(4), 455.

Madden, D. J. (1982). Age differences and similarities in the improvement of controlled search. *Experimental Aging Research, 8,* 91–98.

Madden, D. J., & Nebes, R. D. (1980). Aging and the development of automaticity in visual search. *Developmental Psychology, 16,* 377–384.

Maniscalco, C. I., & DeRosa, D. V. (1983). Memory scanning of young and old adults: The influence of rate of presentation and delay interval on recognition memory performance. *Bulletin of the Psychonomic Society, 21,* 7–10.

Marsh, G. R. (1975). Age differences in evoked potential correlates of a memory scanning process. *Experimental Aging Research, 1,* 3–16.

Marsh, G. R., & Thompson, L. W. (1973). Effects of age on the contingent negative variation in a pitch discrimination task. *Journal of Gerontology, 28,* 56–62.

Marsh, G. R., & Thompson, L. W. (1977). Psychophysiology of aging. In J. E. Birren & K. W. Schaie (Eds.), *Handbook of the psychology of aging* (pp. 219–248). New York: Van Nostrand Reinhold.

McAdam, W., & Robinson, R. A. (1962). Diagnostic and prognostic value of the electroencephalogram in geriatric psychiatry. In T. H. Blumenthal (Ed.), *Medical and Clinical Aspects of Aging* (pp. 557–564). New York: Columbia University Press.

McCarthy, G., & Donchin, E. (1981). A metric for thought: A comparison of P300 latency and reaction time. *Science, 211,* 77–80.

Michalewski, H. J., Patterson, J. V., Bowman, T. E., Litzleman, D. K., & Thompson, L. W. (1982). A comparison of the emitted late positive potential in older and young adults. *Journal of Gerontology, 37,* 52–58.

Michaelewski, H. J., Thompson, L. W., Smith, D. B. D., Patterson, J. V., Bowman, T. E., Litzelman, D., & Brent, G. (1980). Age differences in the contingent negative variation (CNV): Reduced frontal activity in the elderly. *Journal of Gerontology, 35,* 542–549.

Milner, B. (1978). Clues to the cerebral organization of memory. In P. A. Buser & A. Rougel-Buser (Eds.), *Cerebral correlates of conscious experiences: INSERM Symposium No. 6* (pp. 139–153). Amsterdam: Elsevier North-Holland.

Mullis, R. J., Holcomb, P. J., Diner, B. C., & Dykman, R. A. (1985). The effects of aging on the P3 component of the visual event-related potential. *Electroencephalography and Clinical Neurology, 62,* 141–149.

Obrist, W. D. (1979). Electroencephalographic changes in normal aging and dementia. In

F. Hoffmeister & F. Muller (Eds.), *Brain function in old age, Bayer Symposium VII* (pp. 102–111). Berlin: Springer-Verlag.

Perlmutter, M., & Mitchell, D. B. (1982). The appearance and disappearance of age differences in adult memory. In F. I. M. Craik & S. Trehub, *Aging and cognitive processes*. New York: Plenum.

Pfefferbaum, A., Ford, J., Roth, W. T., & Kopell, B. S. (1980a). Age differences in P3-reaction time associations. *Electroencephalography and Clinical Neurophysiology, 49*, 257–265.

Pfefferbaum, A., Ford, J., Roth, W. T., & Kopell, B. S. (1980b). Age-related changes in auditory event-related potentials. *Electroencephalography and Clinical Neurophysiology, 49*, 266–276.

Pfefferbaum, A., Ford, J. M., Wenegrat, B., Roth, W., & Kopell, B. (1984a). Clinical application of the P3 component of event-related potentials: I. Normal aging. *Electroencephalography & Clinical Neurophysiology, 59*, 85–103.

Pfefferbaum, A., Ford, J. M., Wenegrat, B., Roth, W., & Kopell, B. (1984b). Clinical application of the P3 component of event-related potentials: II. Dementia, depression, and schizophrenia. *Electroencephalography & Clinical Neurophysiology, 59*, 104–124.

Picton, T. W., Cerri, A. M., Champagne, S. C., Stuss, D. T., & Nelson, R. F. (1986). The effects of age and task difficulty on the late positive component of the auditory evoked potential. In W. C. McCallum, R. Zappoli, & F. Denoth (Eds.), *Cerebral psychophysiology: Studies in event-related potentials (Electroencephalography and Clinical Neurophysiology, Supplement 38)*. Amsterdam: Elsevier Science Publishers.

Picton, T. W., Stuss, D. T., Champagne, S. C., & Nelson, R. F. (1984). The effects of age on human event-related potentials. *Psychophysiology, 21*, 312–325.

Plouffe, L., & Stelmack, R. M. (1984). The electrodermal orienting response and memory: An analysis of age differences in picture recall. *Psychophysiology, 21*, 191–198.

Podlesny, J. A., & Dustman, R. E. (1982). Age effects on heart rate, sustained potential, and P3 responses during reaction-time tasks. *Neurobiology of Aging, 3*, 1–9.

Podlesny, J. A., Dustman, R. E., & Shearer, D. E. (1984). Aging and respond-withhold tasks: Effects on sustained potentials, P3 responses and late positivity. *Electroencephalography and Clinical Neurophysiology, 58*, 130–139.

Polich, J., Ehlers, C. L., Otis, S., Mandell, A. J., & Bloom, F. E. (1986). P300 latency reflects the degree of cognitive decline in dementia illness. *Electroencephalography and Clinical Neurology*.

Polich, J., Howard, L., & Starr, A. (1985). Effects of age on the P300 component of the event-related potential from auditory stimuli: Peak definition, variation, and measurement. *Journal of Gerontology, 40*, 721–726.

Polich, J., & Starr, A. (1984). Evoked potentials in aging. In M. L. Alpert (Ed.), *Clinical neurology of aging* (pp. 149–177). New York: Oxford University Press.

Rabbitt, P., & Vyas, S. M. (1980). Selective anticipation for events in old age. *Journal of Gerontology, 35*, 913–918.

Ritter, W., Simson, R., Vaughan, H. G., & Friedman, D. (1979). A brain event related to the making of a sensory decision. *Science, 203*, 1358–1361.

Ritter, W., Simson, R., Vaughan, H. G., & Macht, M. (1982). Manipulation of event-related potential manifestations of information processing stages. *Science, 218,* 909–911.

Ritter, W., Vaughan, H. G., & Simson, R. (1983). On relating event-related potential components to stages of information processing. In A. W. K. Gaillard & W. Ritter (Eds.), *Tutorials in event-related potential research* (pp. 143–158). Amsterdam: North Holland.

Rohrbaugh, J. W., & Gaillard, A. W. K. (1983). Sensory and motor aspects of the contingent negative variation. In A. W. K. Gaillard & W. Ritter (Eds.), *Tutorials in ERP research: Endogenous components.* Amsterdam: North-Holland.

Salthouse, T. A. (1982). *Adult cognition: An experimental psychology of human aging.* New York: Springer-Verlag.

Salthouse, T. A. (1985a). Speed of behavior and its implications for cognition. In J. E. Birren & K. W. Schaie (Eds.), *Handbook of the psychology of aging* (pp. 400–426). New York: Van Nostrand Reinhold.

Salthouse, T. A. (1985b). *A theory of cognitive aging.* Amsterdam: North-Holland.

Salthouse, T. A., & Somberg, B. L. (1982a). Isolating the age deficit in speeded performance. *Journal of Gerontology, 37,* 59–63.

Salthouse, T. A., & Somberg, B. L. (1982b). Skilled performance: The effects of adult age and experience on elementary processes. *Journal of Experimental Psychology: General, 111,* 176–211.

Shepherd, R. J. (1978). *Physical activity and aging.* London: Croom Helm.

Siegel, I. C., Nowlin, J. B., & Blumenthal, J. A. (1980). Health and behavior: Methodological considerations for adult development and aging. In L. Poon (Ed.), *Aging in the 1980s: Psychological issues* (pp. 599–614). Washington, DC: American Psychological Association.

Simons, R. F. (in press). Can the autonomic nervous system contribute to our understanding of event-related potentials?

Slaets, J. P. L., & Fortgens, C. (1984). On the value of P300 event-related potentials in the differential diagnosis of dementia. *British Journal of Psychiatry, 145,* 652–656.

Smith, D. B. D., Michalewski, H. J., Brent, G. A., & Thompson, L. W. (1980). Auditory averaged evoked potentials and aging: Factors of stimulus, task and topography. *Biological Psychology, 11,* 135–151.

Snyder, E., & Hillyard, S. A., (1979). Changes in event-related potentials in older persons. In F. Hoffmeister (Ed.), *Bayer-Symposium VII: Brain function in old age* (pp. 112–125). Berlin: Springer-Verlag.

Spirduso, W. W. (1980). Physical fitness, aging and psychomotor speed: A review. *Journal of Gerontology, 35,* 850–865.

Spirduso, W. W. (1982). Physical fitness in relation to motor aging. In J. A. Mortimer, F. J. Maletta, & G. J. Maletta (Eds.), *The aging motor system* (pp. 120–151). New York: Praeger.

Squires, K. C., Chippendale, T. J., Wrege, K. W., Goodin, D. W., & Starr, A. (1980). Electrophysiological assessment of mental function in aging and dementia. In L. Poon (Ed.), *Aging in the 1980s* (pp. 125–134). Washington, DC: American Psychological Association.

Squires, K., Goodin, D., & Starr, A. (1979). Event related potentials in development, aging and dementia. In D. Lehmann & E. Callaway (Eds.), *Human evoked potentials* (pp. 383–396). New York: Plenum.

Squires, K. C., Wickens, C. D., Squires, N. K., & Donchin, E. (1976). The effect of stimulus sequence on the waveform of the cortical event-related potential. *Science, 193*, 1142–1146.

Sternberg, S. (1969). The discovery of processing stages: Extensions of Donder's method. *Acta Psychologica, 30*, 276–315.

Sternberg, S. (1975). Memory scanning: New findings and current controversies. *Quarterly Journal of Experimental Psychology, 27*, 1–32.

Storrie, M. C., & Eisdorfer, C. (1978). Psychophysiological studies in aging: A ten-year review. In M. A. Lipton, A. DiMascio, & K. F. Killam (Eds.), *Psychopharmacology: A generation of progress*. New York: Raven Press.

Strayer, D. L., Wickens, C. D., & Braune, R. (1987). Adult age differences in the speed and capacity of information processing: II. An electrophysiological approach. *Psychology and Aging, 2*, 99–110.

Syndulko, K., Hansch, E. C., Cohen, S. N., Pearce, J. W., Goldberg, Z., Montan, B., Tourtellotte, W. W., & Potvin, A. R. (1982). Long-latency event-related potentials in normal aging and dementia. In J. Courjon, F. Mauguiere, & M. Revol (Eds.), *Clinical applications of evoked potentials in neurology* (pp. 279–285). New York: Raven Press.

Tecce, J. J. (1979). A CNV rebound effect. *Electroencephalography and Clinical Neurophysiology, 46*, 546–551.

Tecce, J. J., Boehner, M. B., Cattanach, L., Branconnier, R. J., & Cole, J. O. (1981). Hydergine treatment and brain functioning (CNV rebound) in Alzheimer's patients: Preliminary findings. *Psychopharmacology Bulletin, 173*, 202–206.

Tecce, J. J., Cattanach, L., Yarchik, D. A., Meinbresse, D., & Dessonville, C. L. (1982). CNV rebound and aging. *Electroencephalography and Clinical Neurophysiology, 54*, 175–186.

Thompson, L. W., & Nowlin, J. B. (1973). Relations of increased attention to central autonomic nervous system states. In L. F. Jarvik, C. Eisdorfer, & J. E. Blum (Eds.), *Intellectual functioning in adults* (pp. 107–123). New York: Springer Publishing Co.

Wickelgren, W. A. (1977). Speed-accuracy tradeoff and information processing dynamics. *Acta Psychologica, 41*, 67–85.

*This page intentionally left blank*

CHAPTER 2

# Sensory–Perceptual Processes and Aging

John F. Corso
State University of New York
College of Arts and Science
Cortland, New York
Upstate Medical Center
Syracuse, New York

This chapter is concerned with recent developments in the area of sensory–perceptual processes and aging, with primary emphasis on advances since approximately 1983. The chapter is not intended to provide an exhaustive chronology of publications in this field but to develop an intellectual framework for guiding further research on sensory–perceptual processes and aging. To accomplish this objective, selected models and theories will be identified and described in sufficient detail to demonstrate their relevance for investigating problems of aging in sensory–perceptual systems. Next, the most significant studies in this area will be reviewed, so that the reported findings will assist not only in the understanding of aging sensory–perceptual systems but in revealing the need for additional research. Furthermore, as previously stated (Corso, 1977a), disorders and deficits in sensory–perceptual systems due to aging should be viewed, ultimately, not as singular events affecting a given modality but as interrelated events that implicate the "aging person's total repertoire of behavior" (p. 535). Therefore, part of this chapter will be devoted to a consideration of various approaches that may be made to offset, in part, sensory–perceptual problems and thereby improve the personal adjustment of the elderly. Finally, some suggestions for research will be offered.

## SIGNIFICANT LITERATURE

The material referenced in this chapter has been selected primarily from a detailed search of more than 30 major national and international journals on aging research for the period 1983 through 1986. However, sources prior to this period are cited when warranted by their significance and relevance.

With the exception of Corso (1981a), textbooks devoted exclusively to sensory–perceptual processes and aging are not available. Weale (1963) published a volume on the aging eye; Hinchcliffe (1983) edited a volume on hearing and balance in the elderly; Han and Coons (1977) edited a biological assessment of the special senses in aging; and Gilchrest (1984) published a monograph on the skin and aging processes. Sensory and perceptual changes with age in relation to cognitive changes were considered by Jarvik and Cohen (1973) and extended by Hoyer and Plude (1980).

Despite these publications, relatively little research is being conducted on psychological problems involving aging sensory–perceptual systems. A bibliography of doctoral dissertations on aging from American institutions of higher learning from 1979 to 1981 listed only eight titles under the heading of sensory perception (Mueller & Longo, 1982). A similar bibliography compiled for 1981 through 1983 showed only three entries (Moore, 1985). Moreover, the Report of the National Research on Aging Planning Panel (National Institute on Aging, 1982) has stressed the need to accelerate research on sensory systems because information generated in this area would be relevant to the comfort and enjoyment of life by the elderly.

## MODELS AND THEORIES

Inasmuch as aging involves a vast array of phenomena, ranging from cellular events through physiological and psychological functions of individuals to the social action of elderly groups, it is unlikely that a single theory will suffice to explain all of these activities. Likewise, the primary attempt to understand the sensory–perceptual problems of aging through an aggregate of descriptive studies is likely to be relatively fruitless. In some areas, the study of aging processes has been hampered by the widespread use of a model with limited validity, for example, the decrement model in learning and memory. In other areas, quantitative theories often are applied inappropriately, vaguely, or in a nonquantitative manner, for example, information theory in studies of personality. Thus, there is a critical need to utilize correctly the theories available for the investigation of sensory–perceptual processes in the elderly. Ultimately, the aim is to develop theories of such scope and scientific rigor that they will be capable of explaining phenomena in this area from a life-span perspective.

## Information Theory

Information theory is a formal (mathematical) theory within which problems of aging sensory–perceptual systems may be investigated. The application of information theory requires that the behaving subject be regarded as a communication channel; the problem then becomes one of measuring the efficiency with which information in the stimulus ensemble is registered, coded, and transmitted in the channel to yield output information (responses). Corso (1977c) showed that the transmission of auditory information decreased with advancing age from 20 to 60 years for both pure tones and complex tones (Corso, 1977b).

Although information theory has been applied primarily in terms of transmission, in which it is assumed that successive responses in a given situation are independent, the assumption is at best only a first approximation. Consequently, sequential analysis of information may be applied to those situations in which serial responses exhibit internal dependencies. Computational formulas for the analysis of data in both experimental paradigms are available in various sources (e.g., Attneave, 1959; Corso, 1967).

Figure 2-1 is a hypothetical block diagram that shows the functional aspects of human behavior and illustrates the relationship of other classes of variables (genetic matrix and rehabilitation programs) to the behavioral process (Corso, 1981a). The model provides an organizational structure within which large segments of the biological and psychological literature on aging may be subsumed, including sensory–perceptual processes, learning, memory, motor performance, and affective behavior. Figure 2-1 has the heuristic value of designating "stages" in the processing of information that may be affected by advancing age and therefore are in need of investigation.

Although the experimental literature on aging contains numerous references that treat the processing of information, most studies fail to use "information" in its technical, quantitative meaning and often do not identify the particular model of information processing within which the measurements are being made. Figure 2-1 views information processing as a hierarchical sequence of functional stages; when this model is used, the specific stage under investigation should be designated. However, other information-processing models are available. In the continuous-flow model, sensory–perceptual processes are divided arbitrarily into peripheral and central components, and attempts are made to identify which components are responsible for obtained deficits due to aging. For example, Corso (1977a) has used this model with respect to issues in speech discrimination. A third model of information processing views this system as one with fixed capacity but with variable loci for the allocation of resources within the system (Navon & Gopher, 1979).

Regardless of which model of information processing is adopted, the transmission of information may be affected by the presence of noise in or acting on the communication channel. The definition of "noise," however, within the literature on aging has at least two meanings: (1) perceptual noise, that is, the presence of irrelevant internal and external stimulation (Layton, 1975); and (2) neurological noise, that is, random activity in the nervous system due to the spontaneous firing of neurons (Welford, 1977). The significance of these differences in definition should be noted because neurological noise will be continuously present (unless suppressed by pharmacological agents or other means), but age-related perceptual noise may or may not occur, depending on the particular circumstances of the behavioral situation. However, both kinds of noise may be treated experimentally within the framework of Figure 2-1.

In considering the sensory–perceptual processing of information, it is understood that other psychological processes may affect the behavioral output. For example, selective attention, that is, the ability to separate relevant from irrelevant stimuli, has been found to decline with age (Kausler & Kleim, 1978) and may be expected to alter perceptual responses. Memory processes also affect sensory–perceptual behavior, and an interactive model has been proposed by Rumelhart (1977) that encompasses the relation between sensory events and the contents of memory. The important point is that, for convenience, sensory–perceptual processes may be studied within an aging context as singular processes, but ultimately the processes must be viewed in a theoretical manner as

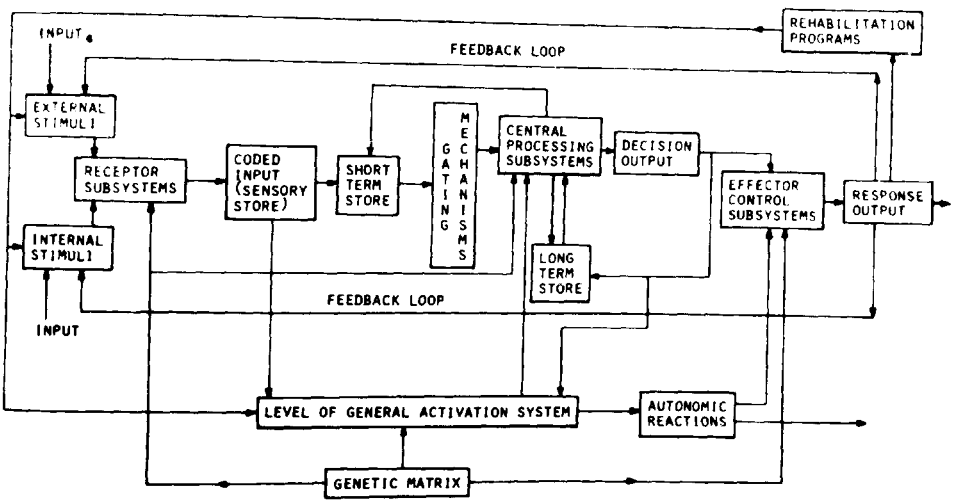


**Figure 2-1.** Hypothetical diagram of functional stages involved in human information processing (from Corso, 1981a). Reprinted by permission of Praeger Publishers.

components within a larger array of interacting processes that determine human behavior.

## Signal-Detection Theory

The processing of information may also be considered as part of a decision process. In a decision process, the informational content of a situation is available to the subject; the subject evaluates the situation according to a particular set of principles and, as a consequence, selects and executes a given response. As in the case of information transmission, perceptual noise or random neural activity may affect the behavioral sequence at any or all stages.

Signal-detection theory has been applied widely to psychophysical problems of aging in all modalities and has been used increasingly in studies of memory. The theory has two major advantages over the classical psychophysical approach: (1) it provides a measure of sensitivity ($\delta^1$ or its equivalent) that is independent of the quantitatively specified response criterion (bias) ($\beta$ or its equivalent), and (2) it provides an "ideal observer" that may be used as a mathematical standard of comparison for evaluating the effectiveness of the behavioral decisions (Corso, 1967).

Since the theory provides a more viable alternative for the design of experiments and the interpretation of results than do traditional kinds of studies, the use of signal-detection theory in studying sensory–perceptual processes and aging is recommended and encouraged. Studies on aging should no longer ignore the fact that a subject's performance is dependent not only on individual sensitivity but also on response bias, which encompasses motivational and cognitive variables.

It is suggested that apparent disagreements in the literature concerning the effects of age and sex on various responses, for example, pain, are due to the confounding of organismic sensitivity and response bias. Since sensory–perceptual processes are altered by the interaction of variables inherent in other psychological processes, it is imperative that appropriate experimental paradigms be employed, as in signal detection, to eliminate artifacts and erroneous conclusions derived from confounding factors.

## Adaptation-Level Theory

Although both information theory and signal-detection theory provide quantitative measures of behavior in defined experimental situations, neither theory takes explicitly into account numerous other factors that may be operating within that context. It is now recognized that the judgments of human observers in sensory–perceptual situations are relative, that is, are made with respect to a frame of reference or adaptation level. Adaptation-level theory has been developed to account for a wide range of perceptual phenomena, from psychophysics to attitude formation and social behavior (Helson, 1964).

The frame of reference (adaptation level) is viewed as an intervening variable that is a function of all stimuli, past and present, acting on or within the individual at a particular moment. Adaptation level may be specified quantitatively by determining the value of the stimulus that elicits a neutral response. Thus, stimuli in a given class may be scaled on a bipolar continuum extending from rejection to acceptance and passing through the point of indifference, that is, adaptation level.

In a given experimental situation there are three primary determiners of adaptation level: (1) the experimental stimuli being judged, (2) the contextual stimuli forming the background for the judgments, and (3) a residual factor that represents the effects of both previous stimulation (experience) and constitutional factors. *The adaptation level of the individual comprises an adjustment to the* combined effects of these three classes of stimuli and provides a reference point for all responses.

Since adaptation-level theory provides an objective and quantifiable basis for assessing the relative contribution of the inner and outer determinants of behavior, it is applicable to psychology in general (Helson, 1964). Corso (1971a) has evaluated the theory in terms of psychophysical scaling. It would appear that the theory should be particularly relevant for studies on aging, given the varied personal experiences and wide range of motivational levels found in the elderly. Comparisons of adaptation levels for young and old subjects can be obtained relatively easily for a vast array of stimulus situations. These could include studies dealing with problems in everyday activities in order to ensure the ecological validity of age-related findings. Despite the presumed merits of adaptation-level theory within the framework of aging research, no studies have been located that utilize this approach. The theory has the potential for revealing aspects of aging behavior that lie outside information theory and signal-detection theory and therefore should be explored.

### Need for Theory-Guided Research

Consistent and meaningful progress in the understanding of aging processes depends on the availability of theories that permit quantitative measurements and require the testing of derived hypotheses. As indicated, theories are needed to relate sensory systems to each other, to other psychological processes, and to other human systems. Although research in aging is often centered on practical problems, there is no need for the research to be atheoretical. It is time for investigators in areas well researched from a descriptive-empirical perspective to devote attention to the development of appropriate and adequate theories that may serve to explain extant data and guide future research.

## RESEARCH ON SENSORY-PERCEPTUAL PROCESSES AND AGING

### Vision

*Structural Changes in the Visual System With Age.* The findings on structural changes in the visual system with age have not advanced markedly beyond those already reported (Corso, 1981a). A detailed review of changes in the morphology of the lens with advancing age has been provided by Tripathi and Tripathi (1983). The opacity, or clouding, of the crystalline lens that impairs or obstructs the passage of light to the retina remains a major problem for many over the age of 60 years. No direct cause for senile cataract has been determined.

However, Lerman (1983) has shown that over 75% of ultraviolet radiation (300–400 nm) is transmitted by human lenses under 10 years of age and drops markedly to approximately 20% by 25 years, with little further change through 82 years. The young lens has a relative lack of fluorogens (ultraviolet-absorbing chromosomes), but there is an increasing concentration as the lens ages. These pigments may be a significant factor in the development of nuclear (brown or black) cataract.

With a reasonably tractable patient, cataract surgery usually produces results that are technically excellent if there are no complications; however, in the elderly, the functional results are not so favorable. Murphy and Donderi (1980) have attempted to predict which cataract-surgery patients will make a successful recovery and which will not. The amount of activity before surgery and the ability to learn a new visual-motor coordination (path walking with a pair of 6° base-left cylindrical prisms) were correlated positively with successful recovery. Unsolicited comments revealed that 22 of 54 patients were satisfied with the surgery, and 7 (more women than men) expressed dissatisfaction. Unwarranted fears of cataract surgery can be minimized by careful prior explanations (Keeney & Keeney, 1980).

The mass electrical response of cones and rods has been studied in detail by Weleber (1981), using the ganzfeld electroretinogram. Significant age dependency was found for scotopic rod-mediated b-wave amplitude and for photopic cone-mediated b-wave amplitude, but no effect was obtained for dark-adapted cone a-wave amplitude. The clinical implication of these findings is that patients need to be evaluated on age-corrected norms for rod- and cone-mediated b-wave responses; a correction for sex would also be appropriate because women have a greater amplitude of response than men.

*Spatial Vision.* Although visual status has been evaluated most commonly by the measurement of visual acuity, the limited predictive power of acuity for visual performance in certain daily tasks, for example, postural stability, locomotion, face perception, and localization of targets, has revealed the need for a more comprehensive and sensitive measure of visual effectiveness. The contrast sensitivity function (CSF) appears to be the most widely accepted alternative. CSF describes the spatial-discrimination abilities of an observer by specifying the minimum contrast level required to detect targets of different size, that is, varied spatial frequency. Typically, the targets are gratings consisting of alternating dark and light lines, which produce a sinusoidal change in luminance. The grating is quantified on the basis of its spatial frequency, that is, the number of pairs of light and dark bars per degree of visual angle expressed in cycles per degree (c/deg). The contrast of the grating is the difference between the maximum and minimum luminances divided by their sum. The observer's sensitivity is defined as the reciprocal of the target's contrast at threshold.

Sekuler, Owsley, and Hutman (1982) obtained CSF functions on 33 subjects from 20 to over 50 years of age and 71 subjects from 60 to over 80 years of age. The mean CSF for each decade is shown in Figure 2-2. At 0.5 and 1 c/deg, there are no age differences; but beginning at about 2 c/deg, older ages show greater losses. Also, beginning at about age 60, the peak of CSF occurs at a lower frequency (2 c/deg) compared to younger adults (4 c/deg). When retinal illuminance was reduced by one-third in a subgroup of young adults by means of a neutral density filter, the age difference in CSF at the higher frequencies was reduced but not eliminated. This suggests that the remaining age differences in CSF are influenced by changes in the neural channels of the visual system or by alterations in the optical modulation transfer function of the eye.

Similar findings on CSF were reported by Kline, Schieber, Abusamra, and Coyne (1983), who also found that reaction time increased significantly as a function of increasing spatial frequency. The reaction times of older subjects were significantly longer than those of young adults. The age losses in contrast sensitivity, however, could not account fully for these differences.

When CSF is obtained with a moving grating, sensitivity is enhanced, particularly for younger adults and a faster moving rate (4.3 vs. 1.1 deg/sec for 1 c/deg grating) (Owsley, Sekuler, & Siemsen, 1983). No sex differences in contrast sensitivity were obtained at any spatial frequency tested, with or without movement.

*Vigilance.* An 18-year longitudinal replication was conducted on 33 men originally tested on the Mackworth Clock (vigilance apparatus) in 1962 to 1964 (Quilter, Giambra, & Benson, 1983). The longitudinal changes in skin-potential response latencies and reaction times replicated the earlier cross-sectional relationships: subjects 51 to 69 years of age showed faster reaction times than 70- to 88-year-olds. The latter group also detected significantly fewer targets than when they were 18 years younger. Regardless of age, as the longitudinal change in the number of detected targets decreased, the longitudinal change in mean reaction time for those targets increased. The significance of this study is that cross-sectional interindividual decrements in vigilance can be replicated (longitudinally) within individuals who mature to the given decade.

*Judgments of Lines and Figures.* The literature on geometrical illusions through approximately 1972 has been reviewed by Fozard, Wolf, Bell, McFarland, and Podolsky (1977). On the basis of empirical findings, these illusions can

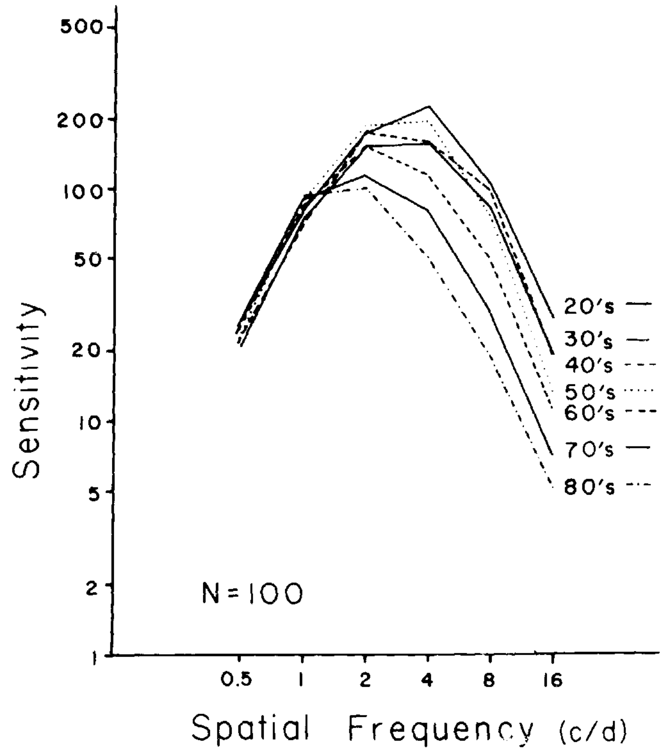


**Figure 2-2.** Mean contrast-sensitivity functions for monocular vision for each decade of age. (Observers wore their best optical correction.) From Sekuler, Owsley, & Hutman (1982). Reprinted by permission.

be grouped into three classes: Type I, which decrease steadily in magnitude through childhood; Type II, which increase in magnitude through childhood; and Type III, which increase in magnitude through childhood and then decline through adolescence to early adulthood (Piaget & Lambercier, 1944).

Recent studies have traced the effects of these three classes of visual illusions into late adulthood. Atkeson (1978), using the Type I Muller-Lyer simultaneous figure, found decreased susceptibility from the 20s through the 60s, and a nonsignificant decline for 70-year-olds. For the Type II illusion (the successive Muller-Lyer figure), there was no susceptibility through middle adulthood; but those in their 60s showed a reversed illusion, and those in their 70s showed no effect.

In a subsequent study (Lorden, Atkeson, & Pollack, 1979), it was found that the Type I (Delboeuf) illusion decreased in childhood, remained essentially stable through approximately 60 years of age, and then increased. The Type II (Usnadze) illusion increased in childhood but showed no further changes into adulthood and old age. In general, the decline in the magnitude of the illusions is hypothesized to be a function of decreased perceptual activity, that is, fewer comparisons between parts of the test figure due to the gradual deterioration of neural fibers within the visual system. An alternative hypothesis involves a decrease with age in the ability to integrate temporally separated stimuli. However, these hypotheses have not been tied to experimental tests in a rigorous manner. The continued pursuit of geometrical illusions on an empirical basis needs to be replaced by theoretical studies from which the implications of visual aging can be deduced.

Although it is informative to know that certain functions are very stable through early adulthood and appear unaffected by normal aging of the visual system, it is of greater value to select some component or functional element of the aging visual system and determine whether or not a given decrement is associated with altered behavior. Conversely, it is equally important to detect altered behavior from which psychological or neurological inferences may be drawn. For example, Van Deusen (1983) has provided normative data for elderly persons on the Schenkenberg Line Bisection Test. The use of these data will aid in the evaluation of elderly brain-damaged patients with respect to the presence and severity of unilateral neglect, that is, a condition in which there is observable lack of awareness of one side of the body or space contralateral to the site of a brain lesion.

It is well recognized that older adults perform less accurately or less rapidly on perceptual and motor tasks than do younger adults. Some of the difficulty in the perceptual tasks may be due to decreased visual sensitivity or to a slower encoding time. However, neither of these factors appears adequate to explain the difficulty of the elderly with tasks such as the identification of incomplete figures (Danziger & Salthouse, 1978). The decrement may be due to the older subjects' inability to utilize segment information when that information is most useful in aiding figure identification. It should be noted that this kind of study is an ideal candidate for the application of information theory, that is, to determine the minimal amount of stimulus information required for a correct response of identification. By applying appropriate stimuli, intermodal comparisons could be made, as well as intramodal comparisons as a function of age.

*Eye Movements.* Performance of young and old adults has been found to differ on a coincidence-anticipation task (Haywood, 1980), but factors other than reaction time have received little attention in the explanation of the poorer performance by the elderly. The task requires the subject to execute a motor response, for example, press a button, coincident with the arrival of a moving stimulus (real or apparent) at a designated target location. At stimulus speeds of 3, 5, and 7 mph, although age differences have been found to occur in the preferred patterns of visual search, the patterns did not affect task performance

(Haywood, 1982). Also, there was no stability in the preferred pattern of the elderly when retested 1 year later. Although older subjects had slower reaction times for eye movement than did younger subjects, the difference did not affect the judgment of stimulus speeds.

The characteristics of eye movements can serve both as a means of quantification in the study of the neural control of motor activity and as a useful technique for the determination of dysfunction in a variety of neurologic conditions. Abel, Troost, and Dell'Osso (1983) have provided normative data for two age groups (means, 25.7 and 72.0 years) on saccadic eye movements. There are no significant differences in saccadic velocity or duration, but the older group shows an increase in saccadic latency (means, 229.8 vs. 275.2 msec).

*Visual Masking.* Visual masking methodology has proved useful in assessing visual information processing, human cognition, and psychopathology. Visual masking utilizes two basic paradigms: (1) backward masking, in which the perception of a leading stimulus (target) is impaired by a rapidly following masking stimulus; and (2) forward masking, in which a leading (first) stimulus (masking stimulus) affects the processing of a rapidly following second stimulus (target). By observing different kinds of masks and the resulting functions in backward masking, Turvey (1973) identified separate peripheral and central processes in visual perception. The peripheral components include the retina, lateral geniculate nucleus, and the terminal connections in the striate cortex; the central components encompass the remainder of the visual pathway (retrochiasmal and cortical parts). Age differences in the speed of peripheral and central processing in favor of young adults have been well documented (e.g., Walsh, Williams, & Hertzog, 1979). However, the data from these studies do not support the hypothesis of a general mechanism that underlies the slowness of response in the elderly. Walsh (1982) has reviewed this issue and has provided a systematic treatment of visual information processing in adulthood and old age.

Braff and Saccuzzo (1985) have used a backward-masking paradigm in which the target and masking stimuli were presented to opposite cerebral hemispheres over separate peripheral pathways. Dichoptic backward masking was obtained, and the interpretation of results suggested that contralateral masking probably depends on interhemispheric communication of information across the corpus callosum.

Visual masking also can be produced by the presentation of a uniform flash of light on a sinusoidal grating. With this procedure, masking occurs in the transient visual system. The sustained–transient model of vision is now widely held, and it has been proposed that many aging phenomena in vision can be explained in terms of a relative loss in the efficiency of transient mechanisms, such that the older person becomes more dependent on sustained mechanisms or channels (Kline & Schieber, 1981). However, the adequacy of the sustained–transient model in studies on masking by light has been questioned by Green (1984), who has proposed a modified version of the dichotomy.

*Color Vision.* Studies on color vision and aging remain limited. The evidence on changes in color vision in elderly adults is mixed, with some studies reporting little or no change (e.g., Pinckers, 1980), and others reporting performance decrements (e.g., Bornstein, 1977). However, there is general agreement that sensitivity to the short-wave region of the spectrum diminishes with increasing age. Recent data (Bornstein, 1977) indicate that the kind of test used in the evaluation of color vision in the elderly has a considerable effect on the outcome.

In a study of temporal resolution in color vision (Kline, Ikeda, & Schieber, 1982), monoptic pairs of tachistoscopically presented red and green flashes were separated by six levels of interstimulus interval and were presented at two levels of luminance. Integration of the color pairs produced a report of "yellow." These reports decreased significantly with increasing interstimulus interval but occurred significantly more often among an older group (mean, 68 years) than a younger group (mean, 19 years) at the higher interstimulus intervals (30–50 msec). The difference remained even when the loss in retinal illumination with age was compensated for by increasing the luminance of the stimuli.

*Visual Indices of Biological Aging.* The concept of "biological aging" serves as a latent variable in the modeling of biological systems. Since the primary processes of biological aging are unknown, the latent variable needs to be assessed by means of functionally related and measurable variables. Sekuler and Owsley (1983) have proposed that changes in the peripheral visual system can serve in this capacity and have offered accommodative amplitude and pupillary diameter as two noninvasive markers of biological aging. Formulas for computing differences between chronological and biological age have been provided.

## Audition

*Structural Changes in the Auditory System with Age.* Reviews of the literature on structural changes in the auditory system with age have been published previously (Corso, 1977a, 1981a, 1982b). The age-related degeneration of the inner ear has been reported in detail by Johnsson and Hawkins (1979).

The effect of aging on the histology of the human eustachian tube muscles has been studied by Tomoda, Yamashita, Morii, and Kumazawa (1984). The tensor veli palatini and the levator veli palatini mediate the functioning of the eustachian tube. The muscle fibers reach their maximum growth in the 20 to 29 decade with a short diameter: tensor, 21.8 um; levator, 24.5 $\mu$m. With aging, the muscles are prone to atrophy, particularly the tensor. By the 60 to 69 decade, the tensor's diameter is reduced to 15.9 um and the levator's to 20.8 $\mu$m. These decrements suggest that the function of opening the eustachian tube also deteriorates with age, thereby possibly affecting auditory sensitivity.

Measures of the electric response from the auditory brainstem are now used widely in the diagnosis of lesions in the auditory pathways below the cortex. The latencies of the waves provide one characteristic for specifying the normalcy of the potentials (Sohmer & Feinmesser, 1974). Fowler and Noffsinger (1983) compared the auditory brainstem responses at 2,000 and 4,000 Hz for three age-matched groups (mean age, approximately 41 years). A normal group exhibited more Type I and Type II waves than did the group with cochlear lesions or the group with eighth nerve or brainstem lesions. The normal and cochlear groups exhibited more Type III and Type V waves than did the eighth nerve–brainstem group, with the latency of Type V being significantly longer in the latter (neural) group. Thus, auditory brainstem responses can be used to differentiate between cochlear and neural pathology in middle-aged adults. This line of research needs to be extended to older age groups.

*Presbycusis.* The topics of presbycusis and auditory psychophysics in older adults have been reviewed in detail (Corso, 1977a, 1981a). The simplest means for examining the age-related functions of hearing are tonal audiometric tests. However, tonal tests yield patterns that are not particularly adequate for identifying the specific characteristics of auditory deterioration due to advancing age. Consequently, Cervellera and Quaranta (1982) applied more advanced clinical techniques to study the behavior of presbycusic subjects on tests of cochlear function, retrocochlear activity, and central auditory involvement. Of seven tests administered to 64 subjects over 60 years of age, the most symptomatic tonal test of presbycusis was remote masking (RM); this showed a pathological condition in nearly all presbycusic subjects.

In the RM test, the masker was a continuous narrow-band noise centered at 3,000 Hz and delivered at 98 dB sound pressure level (SPL). RM was recorded ipsilaterally, in each ear separately, for pulsed tones of 250, 500, and 1,000 Hz with a duration of 250 msec. Signal and noise thresholds were determined separately for each ear. The noise was then introduced in one ear, and the masked thresholds for each test tone were determined. The difference in decibels (dB) between the masked and unmasked thresholds was taken as RM for each test tone. At the designated test frequencies, the RM values for normal young adults were, respectively, 26, 17.5, and 24.5 dB. Any RM value less than 21, 12, and 19 dB, respectively, was considered pathological. The RM test is considered to reflect an increase in the stiffness of the hydrodynamic system of acoustic energy transmission in the basilar membrane.

A test for masking-level difference (MLD) was administered by Novak and Anderson (1982) in an attempt to differentiate among three types of presbycusis: metabolic, sensory, and neural (Schuknecht, 1964). In determining the MLD, noise was presented in phase at the two ears; the test tone was, in one case, presented in phase and, in the other case, out of phase by some specified amount, usually 180°. The difference in decibels in detection of the tone is the MLD. The

MLD for 500 Hz was obtained both in noise and in quiet to test the hypothesis that older persons with neural presbycusis have elevated levels of internal noise. The internal noise is assumed to be generated neurologically and to be correlated between ears. Thus, the presence of elevated noise levels in neural presbycusis should be evidenced by a larger MLD in quiet than one obtained from normal listeners or in other types of presbycusis. The data supported the neural-noise hypothesis; this finding has important theoretical implications for other areas of aging.

Robinson and Sutton (1979) have provided a detailed comparative analysis of the published data on presbycusis to determine whether a synthesis might be achieved to establish an international standard on auditory aging to aid in the routine interpretation of audiograms. The studies in the analysis included those cited by Spoor (1967), but others also were considered. From the analysis, a computational formula was derived for predicting the age effect from 0.125 to 12 kHz for otologically screened men and women. In general, the derived curves conform to those previously published (Corso, 1963).

*Noise Exposure and Age Effects.* The two primary factors that produce hearing deficits are age and noise exposure. Corso (1958) stressed that for medical and legal reasons the etiological evaluation of hearing loss in occupational workers should require that the effects of noise exposure be separated quantitatively from those of aging. The issue, however, has been to determine whether the effects of the two factors are additive or multiplicative (Corso, 1976).

In a detailed analysis, Corso (1976) showed that aging and noise exposure may both produce degeneration of hair cells in the organ of Corti, but the totality of physiological evidence reveals marked differences in the loci of lesions and the extent of neural damage produced by the two factors in other portions of the auditory pathways. It was concluded that the hearing loss due to noise exposure and aging may or may not be additive, depending on the locus and extent of hair cell destruction following exposure to noise with given intensity, frequency, and temporal characteristics. Corso (1976) views the permanent effects of noise exposure as similar in certain respects to "premature presbycusis."

Based on physiological and audiometric data, Corso (1980) derived a quantitative model for computing an age-correction factor in occupational hearing loss. The model uses the concept of a variable ratio for partitioning the effects of presbycusis and noise exposure at specified audiometric frequencies and age levels. With increasing years, the hearing loss for the noise factor assumes the form of a negatively accelerated function, whereas the hearing loss for the age factor increases as a positively accelerated function. Thus, for a given point in time, a ratio can be formed from the respective values of the two functions. At a different point in time, the ratio will assume a different value. When the variable ratio generated by the two functions reaches a value of 1.0, age by itself is sufficient to account for the measured hearing level, and noise can no longer contribute to hearing loss.

Szanto and Ionescu (1983) investigated the influence of age, sex, and duration of noise exposure on hearing threshold levels of occupational workers. High-intensity noise (98 dB,A) accelerates the hearing loss process, which increases with duration of exposure. At all frequencies, the effect is more pronounced for men than for women, particularly from 2 to 6 kHz. Additional studies are in progress to evaluate Corso's (1980) model.

*Tinnitus.* High-frequency hearing loss induced by excessive noise exposure is often accompanied by tinnitus. A number of mechanisms have been suggested to explain the occurrence of tinnitus, but most have received only marginal support from neurophysiological data. However, a proposal by Penner (1980) warrants further attention. It is speculated that the loss of the cochlear suppression mechanism due to noise exposure results in an excess of spontaneous activity among the high-threshold neural units in the region of the hearing loss. Thus, an "edge" or boundary is formed between the damaged units and those neurons with normal rates of spontaneous activity; it appears that the "edge effect" is sufficient to initiate tinnitus. Salvi and Ahroon (1983), using an animal model (chinchillas), obtained data consistent with Penner's (1980) hypothesis.

Tyler and Baker (1983), through a questionnaire study, found a negative correlation between the duration of tinnitus and the number of problems experienced by older sufferers of tinnitus (mean, 63 years). Of the replies ($N$ = 72), 53% indicated associated hearing difficulties, 93% reported effects on life-style, 56% declared effects on general health, and 70% stressed emotional difficulties.

The treatment for objective tinnitus usually involves vascular or neuro-otologic surgery. Subjective tinnitus is not amenable to medical or surgical management. However, patients may be helped through psychotherapy, biofeedback conditioning, a hearing aid, or a masking-noise generator (which provides an external sound to mask the internal noise).

*Speech Intelligibility.* The influence of age on language and speech communication has been reported previously (Corso, 1977a; Emery, 1985). Speech intelligibility tests are used for several purposes: (1) evaluating the accuracy of pure-tone thresholds, (2) assessing the site of pathology, (3) establishing the degree of handicap in communication, (4) selecting an ear for hearing aid application, and (5) evaluating hearing aid performance.

On the Central Institute for the Deaf (C.I.D.) Auditory Test W-22, consisting of 200 phonetically balanced (PB) monosyllabic words, young adults tested at 78 dB sound pressure level (SPL) showed a discrimination loss of 2.3% (about 2 words wrong in 100) for monaural listening (Corso, 1957). Various investigators (e.g., Tillman & Olsen, 1973) have shown that for normal-hearing subjects an increase in intensity of speech improves intelligibility by approximately 4.5% per decibel, with maximum intelligibility at approximately 25 dB sensation level (SL). For older subjects (mean, 74 years) with mild to moderate sensorineural hearing loss (flat or falling audiograms), the slope of the intelligibility function is only about 3% per decibel (Beattie & Raffin, 1985). The slope is not affected by the magnitude of the hearing loss but by the shape of the audiogram. Large intraindividual differences obtained between test and retest may limit the usefulness of the slope index in clinical work. However, the monosyllabic threshold and maximum (PB) intelligibility are very stable measures and may be utilized effectively in applied settings.

Studies continue to be performed to determine the effects of the temporal characteristics of speech on the auditory functioning of the elderly. Schmitt (1983) investigated the effects of time compression (rate increase) and time expansion (rate decrease) for word passages and questions administered to two groups of subjects (65–74 years and 75–84 years). The "young-old" group improved in comprehension with each successive time expansion (maximum at 180%), whereas the "old-old" group improved only through a time expansion of 140%. Both groups performed poorest at 60% time compression; but of the two, the young-old group did significantly better. No differences between men and women were obtained.

However, a replication of this study with speaker-altered, rather than electronically altered, passages (Schmitt & Carroll, 1985) showed that comprehension deteriorated significantly at 60% compression and was not improved by expansion from the normal rate (175 words/min). Thus, speaking faster than normal to the elderly may be expected to reduce the comprehension of passages, but speaking slower per se will probably not improve comprehension. Furthermore, the comparison of these two studies clearly stresses the need for conducting ecologically valid research on problems of aging.

*Other Psychophysical Data.* It is now established that temporal summation in a hearing-impaired ear differs from summation in a normal ear. Temporal summation involves a reciprocal relationship between stimulus intensity and stimulus duration so that, for a given frequency, a threshold response can be maintained by decreasing one factor and increasing the other, up to some critical value of time. Corso, Wright, and Valerio (1976) showed that there was no difference in the threshold-duration function at 4 kHz for older subjects (51–57 years) with and without a history of noise exposure when compared to a young noise-exposed group (mean age, 29.5 years). However, all three groups differed significantly from a theoretical curve for a normal ear. Thus, both aging and noise exposure produce a decrease in the constant of temporal integration.

Gerken, Gunnarson, and Allen (1983) also obtained a decreased constant for temporal summation in older adults (median age, 60 years). The median time-constant was approximately 10 msec, compared to a value of approximately 199 msec for normal listeners. This represents a maximum expected threshold shift (median) of approximately 8 dB for subjects with a sensorineural hearing loss versus 15 dB for normal listeners.

The diotic summation of loudness in normal and cochlear-impaired listeners also has been investigated (Hall & Harvey, 1985). Summation is measured by having the subject adjust the SPL of a diotically presented stimulus so that it matches the loudness of a monaurally presented "standard" stimulus. Normally, the diotic stimulus is adjusted to a lower SPL than that of the monaural standard for an equal-loudness match. At 500 Hz, normal and cochlear-impaired groups showed similar diotic loudness summation (approximately 9 dB); but at 2,000 Hz, the hearing-impaired listeners showed summation of only 4 to 5 dB for a 70- or 80-dB standard. However, when the standard was raised to 90 dB SPL, the hearing-impaired showed normal summation. Thus, if high speech frequencies are presented sufficiently above threshold, cochlear-impaired ears may be expected to function normally in the diotic summation of loudness.

With age, the voice characteristics of men and women can be expected to change. Honjo and Isshiki (1980) found that for subjects ranging in age from 69 to 85 years, the fundamental frequency on phonation of (Japanese) vowels was 162 Hz for men and 165 Hz for women, compared to 120 Hz for young men and 260 Hz for young women. With age, the fundamental frequency for men was found to increase; for women, to decrease. The finding for women was confirmed by Linville and Fisher (1985).

Over a wide range, the age of men and women can be estimated reliably from tape recordings of the speakers' voices ($r$ = .93) (Ryan & Capadano, 1978). Furthermore, faster speakers are evaluated more favorably on personality and social characteristics than slower speakers (Stewart & Ryan, 1982).

*Auditory Indices of Biological Aging.* As described in a preceding section on vision, psychophysical measures have utility as indices of biological aging. For audition, Corso (1982a) evaluated the various measures that might be used for this purpose. On the basis of existing data, three indices were recommended: (1) pure-tone thresholds by air conduction; (2) speech-reception threshold; and (3) speech discrimination in quiet. As additional normative data are collected on hearing in the elderly, those psychophysical measures that were excluded should be reassessed in terms of their reliability and validity and reconsidered as appropriate indices of biological aging.

*Social Impact of Hearing Loss in the Elderly.* The inter- and intraindividual problems associated with communication disorders have been presented in another source (Corso, 1977a). The loss of hearing sensitivity as a single measure does not reflect completely the degree of handicap imposed by a hearing impairment. Consequently, several self-assessment scales have been developed to quantify the degree of hearing handicap. For noninstitutionalized subjects (mean age, 74 years), scores on the Hearing Measurement Scale were found to correlate positively with pure-tone thresholds ($r$ range = .65–.71); correlations with scores on speech discrimination were slightly lower (Weinstein & Ventry, 1983a). As measured by the Hearing Handicap Inventory for the Elderly, there is considerable variability in the emotional and social response to hearing impairment (Weinstein & Ventry, 1983b). Since audiometric data explain less than 50% of the variance in hearing handicap in the elderly, self-report techniques may be more appropriate than audiometric measures for establishing the degree of auditory impairment.

The common stereotype of the older hearing-impaired adult as isolated and lonely has been challenged in several studies. Norris and Cunningham (1981) used three quantitative measures of social activity and failed to find significant correlations with the hearing thresholds of presbycusic adults. Weinstein and Ventry (1982) found that social isolation, as measured by subjective procedures, correlated more highly with a variety of audiologic variables than did objective measures of isolation. Thus, older adults may report being isolated due to hearing problems, and convince others of this, when in fact they are not. However, it is likely that in the older population social isolation actually may result from a confounding of hearing impairment with other factors, for example, poor health, financial stress, immobility, and marital disruptions.

## Other Sensory Modalities

Studies on other sensory modalities, as well as vision and hearing, have been reviewed and summarized (Corso, 1971b, 1981a, 1982b). Therefore, only limited citations will be entered here.

*Vibrotactile System.* Although the effect of aging on the absolute threshold for detection of a vibrotactile stimulus is frequency-selective, that is, decreased thresholds at higher frequencies (250 Hz) but not lower (25 Hz), few studies have explored suprathreshold effects. Verrillo (1982) found no difference in young and old groups tested for subjective magnitude at 25 Hz; but at 250 Hz the older group showed depressed magnitude estimates for a wide range of intensities. Also, sensory persistence was more pronounced in the older group.

*Gustatory System.* A detailed review of the normal and abnormal status of the oral cavity in aging, including the exocrine glands, sensory functions, motor functions, and disease, has been provided by Baum (1984). Weg (1980) has reported the significance of prolonged, mild nutritional deficiencies for the maintenance of health in the elderly.

Shapira and Kushnir (1985) studied information seeking and decision-making in young and old female groups in a task requiring the detection of sucrose in solutions of various concentrations. The older group had a higher detection threshold (4.8 vs. 2.2 g/liter) and required more samplings for each test solution before reaching an affirmative or negative decision. Regardless of concentration, the older group used more samplings to attain the same probability of stimulus detection as the younger group. The results of this study suggest that older individuals have higher requirements for information prior to making a decision.

When experimental procedures controlled for response criterion and age-related salivary sodium, Weiffenbach, Baum, and Burghauser (1982) failed to obtain different sucrose or citric acid thresholds in three adult age groups. However, differences were obtained for sodium chloride and quinine sulfate. A sex difference was obtained only for citric acid. The study shows clearly that detection thresholds for four test qualities undergo different changes and rates of change with age. These findings are consistent with the principle of differential onset and progression proposed by Corso (1981a). Bartoshuk, Rifkin, Marks, and Bars (1986) have shown that suprathreshold sensations for sodium chloride, sucrose, citric acid, and quinine hydrochloride in older adults are essentially similar to those of younger adults.

Recent data (Murphy, 1985) confirm previous observations that young adults perform better than do older adults on the identification of blended foods when multiple chemosensory cues are present. The results suggest that the major reason for a decline in food identification in the elderly may not be due to a gustatory decline but to reduced olfactory, trigeminal, and memory factors. Murphy (1983) showed that both the olfactory threshold and the suprathreshold intensity function (for menthol) differ in young and old age groups.

*Pain.* For a detailed review and summary of the literature on pain, reference is made to Harkins and Warner (1980). Although clinical evidence suggests that there is an increase in pain complaints in the elderly, laboratory studies on pain sensitivity are conflicting, with results ranging from no change to an increase or a decrease in pain thresholds (Harkins, Price, & Martelli, 1986). Part of the difficulty in failing to obtain consistent data may be the lack of an appropriate operational definition for pain. If progress is to be made in the understanding of pain and aging, future research will need to delineate the various components of the pain response: (1) sensory or discriminal processes, (2) motivational or affective processes, and (3) memory or evaluative processes. The operant theory of pain has received experimental support and should continue to be investigated (Linton & Gotestam, 1985).

## METHODS OF ADJUSTMENT FOR SENSORY-PERCEPTUAL DEFICITS

### Behavioral Consequences of Sensory-Perceptual Deficits

Although it is important scientifically to have experimental data and related theories to explain the functional relationships between aging and sensory-perceptual processes, it must be emphasized that, from a practical perspective, it is not the behavior of the older person in an isolated testing room or clinical setting that is significant; rather, it is the behavior of the older individual in daily activities that determines the importance or unimportance of sensory-perceptual results (Corso, 1985b). Furthermore, behavior typically is not determined by a single sensory modality; all psychological processes function concomitantly to generate effective (or ineffective) behaviors in dealing on a daily basis with the environment, both social and physical.

By using a taxonomic strategy, Scheidt and Schaie (1978) obtained four attribute dimensions that, in combination, described 16 classes of 80 common situations. The problem is to determine the degree to which the elderly are competent to deal with these situations. When the sensory–perceptual processes of the elderly are disrupted and competency is impaired, technological aids should be utilized to meet the situational "demands." Thus, effective behavioral competency may be maintained, and the years of productive activity may be extended.

## Technological Aids

An extensive review of the technological aids currently available to assist individuals with age-related deficits in vision and hearing has appeared in another volume (Corso, 1984c). Technological aids designed specifically to improve the process of communication also have been considered (Corso, 1985a). Faris (1983) has reviewed some of the technological innovations that are available in five areas of activity: (1) personal and home use, (2) personal and household security, (3) fitness and health, (4) business and finance, and (5) food and nutrition. Corso (1981b) has stressed the need for the application of human-engineering methods, principles, and data to meet the needs of the elderly.

For vision-related problems, technological aids include Grade II Braille, optical-to-tactile conversion devices, optical-to-auditory conversion devices, text-to-speech reading systems, devices for driving and personal mobility, and artificial visual components. For hearing-related problems, there are state-of-the-art communication systems, monaural and binaural hearing aids, speech–visual interactive systems, auditory-to-tactile conversion devices, frequency-modulation (FM) systems, infrared systems, audio-loop systems, "hardwire" systems, telephone devices, and auditory implants. According to Pickett and McFarland (1985), auditory implants and tactile aids provide only modest gains over lipreading. Subjects highly practiced on tactile aids perform at a speech-reception level comparable to that of better subjects with implants.

Whether or not individuals with a sensory–perceptual deficit will utilize technological aids depends on several factors. These include (1) ability to meet costs, (2) level of intelligence and language skills, (3) motivation and willingness to accept the inherent limitations of the aids, and (4) conscientiousness in pursuing a rehabilitation program.

## Environments

Research on environments that surround the elderly or are related to their daily activities is emerging slowly. Howell (1980) reviewed the literature in this area and reported that the major concerns for environments include choice of housing, residential mobility, and relocation; satisfaction and adequacy of housing and neighborhoods; and special settings and their effects. In the architectural design of structures for the elderly, there are nine specific features to be evaluated: (1) convenience, attractiveness, comfort, and effectiveness in controlling relevant stimuli; (2) providing for socializing and social activities; (3) aids to physical independence and mobility; (4) orientation aids; (5) safety features; (6) architectural alternatives; (7) availability of spaces; (8) accessibility to and from the community; and (9) facilities for the staff (Deutschman, 1982).

### Rehabilitation Programs

Corso (1984b) has stressed the need for the field of human factors to become involved in medical rehabilitation, including the design of training programs. To some degree, personal adjustment to sensory-perceptual deficits attributed to aging or other circumstances can be achieved through participation in an effective program of rehabilitation.

## SUGGESTIONS FOR RESEARCH

Research needs in aging and visual perception have been delineated by Sekuler, Kline, Dismukes, and Adams (1983) in a report prepared for the National Institute on Aging. The general areas for study include visual function and human performance, posture stabilization and locomotion, visual and cognitive interactions, theory construction, and methodology for visual science.

A report on significant problems for age-related research on auditory processes, also prepared for the National Institute on Aging, has been published by Corso (1984a). The problems delineated include anatomical and physiological changes in the auditory system, particularly beyond the cochlear level; etiological factors in presbycusis; normative values for speech reception and speech discrimination; standardization of testing materials and procedures; speech intelligibility under adverse listening conditions; the relationship of aging and noise exposure; the etiology, incidence, and characteristics of tinnitus and technological remedies; the effects of aging on the auditory brainstem response; the further refinement of high-frequency audiometry; and the design and development of improved technological aids for hearing deficits.

A broader set of issues for research on biobehavioral processes and aging, including sensory–perceptual processes, has been presented in *A National Plan for Research on Aging* (National Institute on Aging, 1982).

## REFERENCES

Abel, L. A., Troost, B. T., & Dell'Osso, L. F. (1983). The effects of age on normal saccadic characteristics and their variability. *Vision Research, 23,* 33–37.

Atkeson, B. M. (1978). Differences in the magnitude of the simultaneous and successive Muller-Lyer illusions from age 20 to 79 years. *Experimental Aging Research, 4,* 55–66.

Attneave, F. (1959). *Applications of information theory in psychology.* New York: Holt, Rinehart, and Winston.

Bartoshuk, L. M., Rifkin, B., Marks, L. E., & Bars, P. (1986). Taste and aging. *Journal of Gerontology, 41,* 51–57.

Baum, B. J. (1984). Normal and abnormal oral status in aging. In C. Eisdorfer (Ed.), *Annual review of gerontology and geriatrics,* Vol. 4 (pp. 87–105). New York: Springer Publishing Co.

Beattie, R. C., & Raffin, M. J. M. (1985). Reliability of threshold, slope, and PB Max for monosyllabic words. *Journal of Speech and Hearing Disorders, 50,* 166–178.

Beattie, R. C., & Warren, V. (1983). Slope characteristics of CID W-22 word functions in elderly hearing-impaired listeners. *Journal of Speech and Hearing Disorders, 48,* 119–127.

Borstein, M. H. (1977). Developmental pseudocyanapsia: Ontogenetic changes in human color vision. *American Journal of Optometry and Physicological Optics, 54,* 464–469.

Braff, D. L., & Saccuzzo, D. P. (1985). Interhemispheric visual masking. *Perceptual and Motor Skills, 60,* 495–502.

Cervellera, G., & Quaranta, A. (1982). Audiologic findings in presbycusis. *Journal of Auditory Research, 22,* 161–171.

Corso, J. F. (1957). Confirmation of normal discrimination loss for speech on C.I.D. Auditory Test W-22. *Laryngoscope, 67,* 365–370.

Corso, J. F. (1958). Proposed laboratory standard of normal hearing. *Journal of the Acoustical Society of America, 30,* 14–23.

Corso, J. F. (1963). Age and sex differences in pure-tone thresholds. *Archives of Otolaryngology, 77,* 385–405.

Corso, J. F. (1967). *The experimental psychology of sensory behavior.* New York: Holt, Rinehart, and Winston.

Corso, J. F. (1971a). Adaptation-level theory and psychophysical scaling. In M. H. Appley (Ed.), *Adaptation-level theory: A symposium.* New York: Academic Press.

Corso, J. F. (1971b). Sensory processes and age effects in normal adults. *Journal of Gerontology, 26,* 90–105.

Corso, J. F. (1976). Presbycusis as a complicating factor in evaluating noise-induced hearing loss. In D. Henderson, R. P. Hamernik, D. S. Dasanjh, & J. H. Mills (Eds.), *Effects of noise on hearing.* New York: Raven Press.

Corso, J. F. (1977a). Auditory perception and communication. In J. E. Birren & K. W. Schaie (Eds.), *Handbook of the psychology of aging.* New York: Van Nostrand Reinhold.

Corso, J. F. (1977b). Information processing for complex tones in older adults. *Journal of the Acoustical Society of America, 62,* S 3. (Abstract).

Corso, J. F. (1977c). Information processing for pure tones in older adults. *Journal of the Acoustical Society of America, 61,* S 87. (Abstract).

Corso, J. F. (1980). Age correction factor in noise-induced hearing loss: A quantitative model. *Audiology, 19,* 221–232.

Corso, J. F. (1981a). *Aging sensory systems and perception.* New York: Praeger.

Corso, J. F. (1981b). Human engineering for the elderly. *Academic Psychology Bulletin, 3,* 197–201.

Corso, J. F. (1982a). Auditory clinical markers of aging. In M. E. Reff & E. L. Schneider (Eds.), *Biological markers of aging* (NIH Publication No. 82-2221). Washington, DC: National Institutes of Health.

Corso, J. F. (1982b). Sensory processes and perception in aging. In A. Viidick (Ed.), *Lectures on gerontology, Vol. 1: On biology of aging.* London: Academic Press.

Corso, J. F. (1984a). Auditory processes and aging: Significant problems for research. *Experimental Aging Research, 10,* 171–174.

Corso, J. F. (1984b). Human factors in medical rehabilitation: Some major problem areas. In *Proceedings of the Human Factors Society* (pp. 649–652). Santa Monica, CA: Human Factors Society.

Corso, J. F. (1984c). Technological interventions for changes in hearing and vision incurred through aging. In P. K. Robinson, J. Livingston, & J. E. Birren (Eds.), *Aging and technological advances.* New York: Plenum Press.

Corso, J. F. (1985a). Communication, presbycusis, and technological aids. In H. K. Ulatowska (Ed.), *The aging brain: Communication in the elderly.* San Diego, CA: College Hill Press.

Corso, J. F. (1985b). Visual and auditory changes with age and selected correlates with other bodily processes. *Book of Abstracts, XIIIth International Congress of Gerontology* (p. 112), New York.

Corso, J. F., Wright, H. N., & Valerio, M. (1976). Auditory temporal summation in presbycusis and noise exposure. *Journal of Gerontology, 31,* 58–63.

Danziger, W. L., & Salthouse, T. A. (1978). Age and the perception of incomplete figures. *Experimental Aging Research, 4,* 67–80.

Deutschman, M. (1982). Environmental settings and environmental competence. *Gerontology & Geriatrics Education, 2,* 237–242.

Emery, O. B. (1985). Language and aging. *Experimental Aging Research, 11,* 3–12.

Faris, J. B. (1983). Technology promises increased convenience and challenges to the nation's elderly. *Aging, 339,* 12–17.

Fozard, J. L., Wolf, E., Bell, B., McFarland, R. A., & Podolsky, S. (1977). Visual perception and communication. In J. E. Birren & K. W. Schaie (Eds.), *Handbook of the psychology of aging.* New York: Van Nostrand Reinhold.

Fowler, C. G., & Noffsinger, D. (1983). Effects of stimulus repetitive rate and frequency on the auditory brainstem response in normal, cochlear-impaired, and VIII nerve/brainstem-impaired subjects. *Journal of Speech and Hearing Research, 26,* 560–567.

Gerken, G. M., Gunnarson, A. D., & Allen, C. M. (1983). Three models of temporal summation evaluated using normal-hearing and hearing-impaired subjects. *Journal of Speech and Hearing Research, 26,* 256–262.

Gilchrest, B. A. (1984). *Skin and aging processes.* Boca Raton, FL: CRC Press.

Green, M. (1984). Masking by light and the sustained-transient dichotomy. *Perception and Psychophysics, 35,* 519–535.

Hall, J. W., & Harvey, A. D. G. (1985). Diotic loudness summation in normal and impaired hearing. *Journal of Speech and Hearing Research, 28,* 445–448.

Han, S. S., & Coons, D. H. (Eds.) (1977). *Special senses in aging: A current biological assessment.* Ann Arbor, MI: The Institute on Gerontology at the University of Michigan.

Harkins, S. W., Price, D. D., & Martelli, M. (1986). Effects of age on pain perception: Thermonociception. *Journal of Gerontology, 41,* 58–63.

Harkins, S. W., & Warner, M. H. (1980). Age and pain. In C. Eisdorfer (Ed.), *Annual review of gerontology and geriatrics,* Vol. 1 (pp. 121–131). New York: Springer Publishing Co.

Haywood, K. M. (1980). Coincidence-anticipation accuracy across the life span. *Experimental Aging Research, 6,* 451–462.

Haywood, K. M. (1982). Eye movement pattern and accuracy during perceptual-motor performance in young and old adults. *Experimental Aging Research, 8,* 153–157.

Helson, H. (1964). *Adaptative-level theory: An experimental and systematic approach to behavior.* New York: Harper.

Hinchcliffe, R. (Ed.). (1983). *Hearing and balance in the elderly.* London: Churchill Livingstone.

Honjo, I., & Isshiki, N. (1980). Laryngoscopic and voice characteristics of aged persons. *Archives of Otolaryngology, 106,* 149–150.

Howell, S. C. (1980). Environments and aging. In *Annual review of gerontology and geriatrics,* Vol. 1 (pp. 237–260). New York: Springer Publishing Co.

Hoyer, W. J., & Plude, D. J. (1980). Attentional and perceptual processes in the study of cognitive aging. In L. W. Poon (Ed.), *Aging in the 1980's.* Washington, DC: American Psychological Association.

Jarvik, L. K., & Cohen, D. (1973). A biobehavioral approach to intellectual changes with aging. In C. Eisdorfer & M. P. Lawton (Eds.), *The psychology of adult development and aging.* Washington, DC: American Psychological Association.

Johnsson, L. G., & Hawkins, J. E., Jr. (1979). Age-related degeneration of the inner ear. In S. S. Hahn & D. E. Coons (Eds.), *Special senses in aging: A current biological assessment.* Ann Arbor, MI: University of Michigan.

Kausler, D. H., & Kleim, D. M. (1978). Age differences in processing relevant versus irrelevant stimuli in multiple-item recognition learning. *Journal of Gerontology, 33,* 87–93.

Keeney, A. H., & Keeney, V. T. (1980). A guide to examining the aging eye. *Geriatrics,* Feb., 81–91.

Kline, D. W., Ikeda, D. M., & Schieber, F. J. (1982). Age and temporal resolution in color vision: When do red and green make yellow? *Journal of Gerontology, 37,* 705–709.

Kline, D. W., & Schieber, F. (1981). Visual aging: A transient/sustained shift? *Perception and Psychophysics, 29,* 181–182.

Kline, D. W., Schieber, F., Abusamra, L. C., & Coyne, A. C. (1983). Age, the eye, and the visual channels: Contrast sensitivity and response speed. *Journal of Gerontology, 38,* 211–216.

Layton, B. (1975). Perceptual noise and aging. *Psychological Bulletin, 82,* 875–883.

Lerman, S. (1983). An experimental and clinical evaluation of lens transparency and aging. *Journal of Gerontology, 38,* 293–301.

Linton, S. J., & Gotestam, K. G. (1985). Controlling pain reports through operant conditioning: A laboratory demonstration. *Perceptual and Motor Skills, 60,* 427–437.

Linville, S. E., & Fisher, H. B. (1985). Acoustic characteristics of women's voices with advancing age. *Journal of Gerontology, 40,* 324–330.

Lorden, R., Atkeson, B. M., & Pollack, R. H. (1979). Differences in the magnitude of the Delboeuf illusion and Usnadze effect during adulthood. *Journal of Gerontology, 34,* 229–233.

Moore, J. L. (1985). A bibliography of doctoral dissertations on aging from American institutions of higher learning, 1981–1983. *Journal of Gerontology, 40,* 509–519.

Mueller, J. E., & Longo, M. K. (1982). A bibliography of dictoral dissertations on aging from American institutions of higher learning. *Journal of Gerontology, 37,* 496–512.

Murphy, C. (1983). Age-related effects on the threshold, psychophysical function, and pleasantness of menthol. *Journal of Gerontology, 38,* 217–222.

Murphy, C. (1985). Cognitive and chemosensory influences on age-related changes in the ability to identify blended foods. *Journal of Gerontology, 40,* 47–52.

Murphy, S. B., & Donderi, D. C. (1980). Predicting the success of cataract surgery. *Journal of Behavioral Medicine, 3,* 1–14.

National Institute on Aging (1982). *A national plan for research on aging;* Report of the National Research on Aging Planning Panel (NIH Publication No. 82-2453). Washington, DC: Government Printing Office.

Navon, D., & Gopher, D. (1979). On the economy of the human-processing system. *Psychological Review, 86,* 214–255.

Norris, M. L., & Cunningham, D. R. (1981). Social impact of hearing loss in the aged. *Journal of Gerontology, 36,* 727–729.

Novak, R. E., & Anderson, C. V. (1982). Differentiation of types of presbycusis using the masking-level difference. *Journal of Speech and Hearing Research, 25,* 504–508.

Owsley, C., Sekuler, R., & Siemsen, D. (1983). Contrast sensitivity throughout adulthood. *Vision Research, 23,* 689–699.

Penner, M. J. (1980). Two-tone forward masking patterns and tinnitus. *Journal of Speech and Hearing Research, 23,* 779–786.

Piaget, J., & Lambercier, M. (1944). Recherches sur le developpment des perceptions: V. Essai sur un effet d' "Einstellung" suvenant au cours de perceptions visuelles, successives (effet Usnadze). *Archives de Psychologie, 30,* 139–196.

Pickett, J. M., & McFarland, W. (1985). Auditory implants and tactile aids for the profoundly deaf. *Journal of Speech and Hearing Research, 28,* 134–150.

Pinckers, A. (1980). Color vision and age. *Ophthalmologica, 181,* 23–30.

Quilter, R. E., Giambra, L. M., & Benson, P. E. (1983). Longitudinal age changes in vigilance after an eighteen year interval. *Journal of Gerontology, 38,* 51–54.

Robinson, D. W., & Sutton, G. J. (1979). Age effect in hearing—a comparative analysis of published threshold data. *Audiology, 18,* 320–334.

Rumelhart, D. E. (1977). *Toward an interactive model of reading.* In S. Dornic (Ed.), *Attention and performance,* Vol. 6 (pp. 573–603). Hillsdale, NJ: Erlbaum.

Ryan, E. B., & Capadano, H. L. (1978). Age perceptions and evaluative reactions toward adult speakers. *Journal of Gerontology, 33,* 98–102.

Salvi, R. J., & Ahroon, W. A. (1983). Tinnitus and neural activity. *Journal of Speech and Hearing Research, 26,* 629–632.

Scheidt, R. J., & Schaie, K. W. (1978). A taxonomy of situations for an elderly population: Generating situational criteria. *Journal of Gerontology, 33,* 848–857.

Schmitt, J. F. (1983). The effects of time compression and time expansion on passage comprehension by elderly listeners. *Journal of Speech and Hearing Research, 26,* 373–377.

Schmitt, J. F., & Carroll, M. R. (1985). Older listeners' ability to comprehend speaker-generated rate alteration of passages. *Journal of Speech and Hearing Research, 28,* 309–312.

Schuknecht, H. F. (1964). Further observations on the pathology of presbycusis. *Archives of Otolaryngology, 80,* 369–382.

Sekuler, R., Kline, D., Dismukes, K., & Adams, A. J. (1983). Some research needs in aging and visual perception. *Vision Research, 23,* 213–216.

Sekuler, R., & Owsley, C. (1983). Visual manifestations of biological aging. *Experimental Aging Research, 9,* 253–255.

Sekuler, R., Owsley, C., & Hutman, L. (1982). Assessing spatial vision of older people. *American Journal of Optometry & Physiological Optics, 59,* 961–968.

Shapira, N., & Kushnir, T. (1985). Aging and information seeking: Patterns of sampling of sucrose solutions. *International Journal of Aging and Human Development, 20,* 103–112.

Sohmer, H., & Feinmesser, M. (1974). Electrocochleography in clinical-audiological diagnosis. *Archives of Oto-Rhino-Laryngology, 206,* 91–102.

Spoor, A. (1967). Presbyacusis values in relation to noise induced hearing loss. *International Audiology, 6,* 48–57.

Stanford, T., & Pollack, R. H. (1984). Configuration color vision tests: The interaction between aging and the complexity of figure-ground segregation. *Journal of Gerontology, 39,* 568–571.

Stewart, M. A., & Ryan, E. B. (1982). Attitudes toward younger and older adult speakers: Effects of varying speech rates. *Journal of Language and Social Psychology, 1,* 91–109.

Szanto, C., & Ionescu, M. (1983). Influence of age and sex on hearing threshold levels in workers exposed to different intensity levels of occupational noise. *Audiology, 22,* 339–356.

Tillman, T. W., & Olsen, W. O. (1973). Speech audiometry. In J. F. Jerger (Ed.), *Modern developments in audiology* (2nd ed.) (pp. 37–74). New York: Academic Press.

Tomoda, K., Yamashita, T., Morii, S., & Kumazawa, T. (1984). Histology of human Eustachian tube muscles: Effects of aging. *Annals of Otology, Rhinology, & Laryngology, 93,* 17–24.

Tripathi, R. C., & Tripathi, B. J. (1983). Lens morphology, aging, and cataract. *Journal of Gerontology, 38,* 258–270.

Turvey, M. (1973). On peripheral and central processes in vision: Inferences from an information-processing analysis of masking with patterned stimuli. *Psychological Review, 80,* 1–52.

Tyler, R. S., & Baker, L. J. (1983). Difficulties experienced by tinnitus sufferers. *Journal of Speech and Hearing Disorders, 48,* 150–154.

Van Deusen, J. (1983). Normative data for ninety-three elderly persons with Schenkenberg Line Bisection Test. *Physical & Occupational Therapy in Geriatrics, 3,* 49–54.

Vernon, M., Griffen, D. H., & Yoken, C. (1981). Hearing loss. *Journal of Family Medicine, 12,* 1053–1058.

Verrillo, R. T. (1982). Effects of aging on the suprathreshold responses to vibration. *Perception and Psychophysics*, *32*, 61–68.

Walsh, D. A. (1982). The development of visual information processing in adulthood and old age. In F. I. M. Craik & S. Trehub (Eds.), *Aging and cognitive processes*. New York: Plenum Publishing Co.

Walsh, D. A., Williams, M. V., & Hertzog, C. K. (1979). Age-related differences in two stages of central perceptual processes: The effects of short duration targets and criterion differences. *Journal of Gerontology*, *34*, 234–241.

Weale, R. A. (1963). *The aging eye*. London: H. K. Lewis.

Weg, R. B. (1980). Prolonged mild nutritional deficiencies: Significance for health maintenance. *Journal of Nutrition for the Elderly*, *1*, 3–22.

Weiffenbach, J. M., Baum, B. J., & Burghauser, R. (1982). Taste thresholds: Quality specific variation with human aging. *Journal of Gerontology*, *37*, 372–377.

Weinstein, B. E., & Ventry, I. M. (1982). Hearing impairment and social isolation in the elderly. *Journal of Speech and Hearing Research*, *25*, 593–599.

Weinstein, B. E., & Ventry, I. M. (1983a). Audiologic correlates of hearing handicap in the elderly. *Journal of Speech and Hearing Research*, *26*, 148–151.

Weinstein, B. E., & Ventry, I. M. (1983b). Audiometric correlates of the hearing handicap inventory for the elderly. *Journal of Speech and Hearing Disorders*, *48*, 379–384.

Weleber, R. G. (1981). The effect of age on human cone and rod ganzfeld electroretinograms. *Investigative Ophthalmology and Visual Science*, *20*, 392–399.

Welford, A. T. (1977). Motor performance. In J. E. Birren & K. W. Schaie (Eds.), *Handbook of the psychology of aging*. New York: Van Nostrand Reinhold.

*This page intentionally left blank*

CHAPTER 3

# Aging and Memory

MARION PERLMUTTER
DEPARTMENT OF PSYCHOLOGY,
INSTITUTE OF GERONTOLOGY, AND
CENTER FOR GROWTH AND HUMAN DEVELOPMENT

CYNTHIA ADAMS, JANE BERRY,
MICHAEL KAPLAN, DENISE PERSON,
FREDERICK VERDONIK
INSTITUTE OF GERONTOLOGY

UNIVERSITY OF MICHIGAN
ANN ARBOR, MICHIGAN

Memory involves the capacity to retain information about the past. It keeps track of events that have occurred in different times and distant places, thus expanding experience beyond the here and now. In addition, in humans memory is used to follow through on plans and projections about the future, thus enhancing effectiveness of action. Shared memories, which are the substance of relationships and communication, constitute the social systems that mediate everyday human life. In a very major sense, then, memory is critical to both individual and societal well-being.

Not surprisingly, throughout time memory has been of interest to diverse scholars, and within psychology the study of memory consistently has been one of the most vital areas of research. This high level of activity has existed in experimental psychology (cf. Cofer, 1976; Estes, 1979), as well as in child psychology (cf. Brown, Bransford, Ferra, & Campione, 1983; Kail & Hagen, 1977; Weinert & Perlmutter, in press) and gerontology (cf. Burke & Light, in press; Craik, 1977; Poon, 1985). In each of these subfields, there has been a

The writing of this chapter was carried out with support from the Brookdale Foundation and the National Institute of Aging (Grants 1 R01 AG06156-01, 5 T32 AG00114-02, and 1 F32 AG05402-01). Junior authors are listed alphabetically.

continued and strong interest in understanding the workings and limits of memory, and in developmental research attention has focused on how memory changes with age.

This chapter reviews psychological research on memory in adulthood. Although there is also a considerable body of research on the biology of memory, that work is beyond the scope of this chapter. The goal of the present review is to gain perspective about the cognitive and behavioral manifestations of changes in everyday memory that occur in late life. Special attention is given to three questions:

1. How general within individuals, and representative within the population, are age-related changes in memory?
2. What are the possible causes of age-related changes in memory?
3. What can be done to ameliorate problematic age-related changes in memory?

A major theme developed in this chapter is that age-related decline in memory is not as general, representative, or severe as previously had been thought. Moreover, many of the memory problems observed in later life may be at least partially caused by factors that tend to be correlated with age but are not inevitable consequences of aging (e.g., depression, inactivity). Furthermore, there are techniques for reducing some of the difficulties that many older adults experience with everyday memory.

## CONCEPTUALIZATION OF THE MEMORY SYSTEM

Much recent research on memory aging has been carried out in experimental psychological laboratories. In general, researchers have adopted the methods and theoretical perspectives of contemporary cognitive psychology. That is, memory studies have involved single experimental tasks assumed to require the use of specified processes of memory. In the past several decades such work has been dominated by an information processing perspective (e.g., Anderson & Bower, 1973; Loftus & Loftus, 1976). This perspective uses the computer as a metaphor for human cognition. It assumes that information is first sensed, perceived, encoded, and then stored in memory. At some later time, it may be retrieved and thus reexperienced or remembered. Memory is studied by examining this experience of recollection for diverse kinds of stimuli, under a wide range of encoding and retrieval conditions.

*Storage structures* and *transfer processes* are respectively the *hardware* and *software* of the memory system (see Atkinson & Shiffrin, 1968). These capacities and skills allow an individual to record, retain, and retrieve information (data). Most research on memory has focused on these aspects of memory.

The short-term store is conceptualized as a limited-capacity working memory, perhaps analogous to the display on a computer. It occupies awareness and in many ways may be viewed simply as consciousness. The long-term store, in contrast, is probably an unlimited-capacity memory that does not occupy awareness. It may be conceived of as the holding space of the cognitive system, and as such might be compared to the backup storage of a computer system.

Encoding and retrieval processes move information in and out of the storage structures. Encoding processes may be viewed as forward-moving. They are involved in early processing. Some operate on information as it is initially received into the short-term store, and others later facilitate the movement of information into the long-term store. Attention, analysis, and elaboration are examples of encoding operations (Craik & Tulving, 1975; Shiffrin & Schneider, 1977). Retrieval processes might be viewed as backward-moving. They are involved in later processing. They move information from an unaware state in the long-term store to an aware state in the short-term store. Search and generation are examples of retrieval operations (Rabbitt, 1982). Although experimentalists attempt to examine encoding and retrieval processes independently, it should be noted that in everyday memory these two types of processes are interdependent (see Gillund & Perlmutter, in press). That is, information cannot be retrieved unless it has been encoded, and evidence of encoding typically involves retrieval.

*Memory contents* are the *data* in the memory system. With few exceptions (e.g., Fitzgerald, 1980; Neisser, 1982; Perlmutter, 1980), research on memory has not focused directly on contents of memory. The relative paucity of research on memory contents may be attributable to a lack of organizational frameworks for guiding inquiry. Satisfactory frameworks for addressing memory contents may be especially difficult to develop because this aspect of memory is so diverse and so individualistic. Nevertheless, several general distinctions have been useful in considering kinds of information contained in memory.

For the present purposes, memory contents are distinguished in three ways (see Perlmutter, 1986). Autobiographical memory refers to specific, time-based information about events one has experienced personally, that is, the accumulated record of one's experience. Conceptual memory refers to generalized information about the world and about oneself that is not tied to single specific experiences but is learned through multiple experiences or instruction (e.g., by another person or from a book or other external information source). Metacognitive knowledge refers to conceptual memory that pertains specifically to the cognitive system, for example, knowledge about how memory operates or how much effort may be required to solve a problem. Other terms, including episodic and semantic memory (see Tulving, 1972), declarative and procedural knowledge (see Mandler, 1983), and figurative and operative knowing (see Piaget & Inhelder, 1973) have been applied to similar distinctions but will not be used here.

## REVIEW OF KNOWLEDGE ABOUT MEMORY CHANGE WITH AGE

### Stereotypes about Memory Aging

In America's youth-oriented society, the prevalent view of the older adult has been of an infirm, incompetent invalid (see Butler & Lewis, 1982; Henig, 1982; Palmore, 1982; Rodin & Langer, 1980). Indeed, stereotypic images of forgetful, rambling, senile older adults are familiar and accepted, whereas images of vital, creative, and insightful seniors are rare. Recently, the acceptance of negative stereotypes about the elderly has been challenged (cf. Kalish, 1979; Schonfield, 1982). Research findings dispelling the stereotypes are becoming available (cf. Perlmutter, 1986), and there seems to be some shift in attitude such that older adults are being viewed more favorably by younger adults (Austin, 1985; Tibbitts, 1979). Nevertheless, many negative attitudes about aging probably still exist in the general population and continue to be portrayed in the media as well (see Gerber, Gross, Signorielli, & Morgan, 1980; Passuth & Cook, 1985).

As will be suggested in later sections on the relationship between memory performance, expectations, and self-efficacy, negative stereotypes about aging can be more than simply inaccurate; they can be detrimental because they can lead to social conditions and personal attitudes that limit performance (Rodin & Langer, 1980; see also Kuypers & Bengtson, 1973). When a person expects to lose clarity and become unproductive, he or she may avoid challenge and fall into routine unstimulating circumstances that promote atrophy of both physical and mental capacities (Bandura, 1981, 1986; Suls & Mullen, 1982).

### Questionnaire Data about Memory Aging

A number of self-report questionnaire studies have been carried out to assess perceptions of memory functioning and age-related change in memory (Cavanaugh, Grady, & Perlmutter, 1983; Chaffin & Herrmann, 1983; Dixon & Hultsch, 1983a; Perlmutter, 1978; Williams, Denney, & Schadler, 1983; Zelinski, Gilewski, & Thompson, 1980). Two important issues addressed by these studies are (1) What kinds of memory problems do younger and older adults experience? and (2) how do they view these problems? In general, older adults report more problems than younger adults (Cavanaugh, et al., 1983; Perlmutter, 1978; White & Cunningham, 1984; Zelinski et al., 1980). For example, Roberts (1983) found that 6%, 12%, and 46%, respectively, of young, middle-aged, and older subjects participating in laboratory studies reported experiencing memory problems. These findings have been corroborated by a recent large survey study (Herzog & Rodgers, 1986) in which older participants reported more memory difficulties than did younger participants.

Age differences in reports about memory have not been entirely consistent. However, there appear to be age differences in knowledge about basic memory processes and capacities, perception of stability of memory ability, and perception of personal control over memory (Dixon & Hultsch, 1983a). Older adults perceive that there are changes in their memory abilities (Zarit, 1982) and apparently are more upset by memory failures than are younger adults (Cavanaugh et al., 1983). Williams et al. (1983) found that none of the 65- and 75-year-old individuals they studied expected memory to improve with age, and Perlmutter (1978) found that adults over 60 expected their memories to decline more than adults in their 20s. Williams et al. (1983) also found that older adults believe age-related memory decline is related to expectations, less use of memory skills, and decreases in activity and contact with information to be remembered.

Questionnaire studies suggest that there tends to be selectivity in the aspects of memory that are perceived to decline. For example, memory capacity generally is thought to decline more than memory strategies (Dixon & Hultsch, 1983a), and name retrieval seems to be especially troublesome in later years (Zarit, 1982). Problems in remembering conversations and people are also commonly reported by older adults (White & Cunningham, 1984), although memory for errands and places is perceived to remain relatively stable (White & Cunningham, 1984).

## Behavioral Data about Memory Aging

*Memory Capacity.* The prevalent view is that aging produces decline in memory capacity. Although it is virtually impossible to assess memory capacity independently of other components of memory, several converging sources of data can be used to draw qualified conclusions about the developmental trajectory of memory capacity. First, the consistent finding that older adults perform somewhat worse than do younger adults on almost all tests of memory for new information (see Craik, 1977; Poon, 1985) is perhaps most parsimoniously explained by a decline in memory capacities. In addition, data from tasks in which variables have been manipulated in such a way as to optimize the likelihood of obtaining relatively pure indices of memory capacity also are consistent with a decline in memory capacity on account of aging (see Baltes & Kliegel, 1986).

*Transfer Processes.* Most experimental studies of memory have been directed at assessing the locus of age-related processing deficits (see Salthouse, 1980; Smith, 1980). In general, laboratory studies of memory have indicated that older adults are both less efficient at encoding (e.g., Craik & Simon, 1980; Perlmutter, 1978; Smith, 1980) and less effective at retrieving (e.g., Burke &

Light, 1981) information presented than are younger adults. However, particularly in the case of encoding, part of the observed age-related deficit may be due to a lack of spontaneous use of the most effective strategies available, rather than to an inability to process information more efficiently (e.g., Perlmutter, 1978). This lack of use of the most effective strategies has been referred to as a production deficiency (Flavell, 1970) and is different from a mediation deficiency (Reese, 1962), in which case potentially effective strategies are not operable. An important implication of age-related production deficiencies in processing is that performance may be amenable to remediation. For example, through modest teaching or training of memory strategies much improved performance can be achieved (e.g., Baltes & Willis, 1982; Denney, 1982; Scogin, Storandt, & Lott, 1985).

*Memory Contents.* There have been a number of investigations of adults' memory for a variety of memory contents, including people, schooling, parenting, medical histories, stressful life events, criminal acts, prose, and historical events (Gruneberg, Morris, & Sykes, 1978; Harris & Morris, 1984; Neisser, 1982). In general, these studies have not compared young and old. However, they suggest that much specific information that individuals believe they remember veridically probably is recollected on the basis of some information that is only remotely tied to the information originally acquired in memory. Something like a schema about the experience probably develops. With each new encounter information is encoded or organized in terms of what is already known. At the same time, the schema itself is modified in light of new input. Thus, recollection does not draw directly on the original memory content about an event but rather on a schema of the experience that is a transformation of the original content.

There are some data available about age patterns in memory for particular kinds of world knowledge (see Botwinick & Storandt, 1974; Lachman & Lachman, 1980; Perlmutter, 1978). For example, psychometric tests of intelligence suggest that crystallized intelligence, which reflects accumulated world knowledge, remains stable or increases somewhat through most of adulthood (e.g., Baltes & Brim, 1984; Horn, 1982; Schaie, 1979). Measures of vocabulary, which provide an index of a fairly specific sort of accumulated knowledge, also show stability or modest increases throughout adulthood (e.g., Riegel, 1968). Thus, although there is probably a decrease in rate of increase of memory content through adulthood, or a decrease in efficiency of encoding and retrieving information in memory, the healthy memory system seems able to retain old information and acquire new information throughout life. In general, then, with age one should expect to have a larger knowledge base (see Perlmutter, 1986).

Information about possible age-related changes in metacognitive knowledge is of special interest because this type of memory content is thought to play a special role in cognitive performance. That is, the cognitive system is largely susceptible to personal control and regulation, so that an individual's effort and deliberate actions have an important impact on what information is remembered and what problems are solved. Although intent is one factor that contributes to the effectiveness of the cognitive system (e.g., Adams & Rebok, 1982), knowledge about how the system operates is also important. For example, if one does not particularly care whether or not a set of names is remembered, no special cognitive action need be taken. However, if one is intent on remembering some names, special techniques can be employed to increase the probability that the names will be recalled. Of course, metacognitive knowledge of mnemonic techniques for remembering names would be essential, and the more refined such knowledge is, the more useful it will be. For example, in the case of trying to remember names, the individual who knows that rehearsal increases the likelihood that information is remembered may use this strategy and be more effective in remembering the names than the individual who did not know about this technique. Still, the rehearser would probably not remember the names as well as an individual who knew that imaging and associating are even more effective memory strategies than is rehearsal.

Presumably, metacognitive knowledge increases throughout life. However, research results have not been entirely consistent with this view. In some research little or no age differences are detected (e.g., Bruce, Coyne, & Botwinick, 1982; Lachman, Lachman & Thronesbery, 1979; Perlmutter, 1978; Rabinowitz, Ackerman, Craik, & Hinchley, 1982). However, in other research, age differences have been obtained (e.g., Dixon & Hultsch, 1983b; Murphy, Sanders, Gabriesheski, & Schmitt, 1981). At least part of this inconsistent pattern probably results from the fact that metacognition is still a fairly new concept that is not yet well articulated (see Cavanaugh & Perlmutter, 1982), and instrument development is still at a relatively early stage (see Cavanaugh & Perlmutter, 1982; Dixon & Hertzog, in press). In addition, the very idea of metacognitive knowledge implies a life relevance that probably has not been characteristic of many past assessments, and the life irrelevance of memory and metamemory tests undoubtedly has been more severe for older than younger adults.

*Summary.* Behavioral research on memory in younger and older adults suggests that there is some decline in memory capacities with age. Still, in all but very ill adults, memory contents can continue to increase throughout the adult years. Moreover, the memory system utilizes memory contents about past experience to process and remember new experience. Thus, some of the limitations in the memory system that occur at all ages can be compensated for by knowledge-based strategies that extend memory capacities. The degree to which declining memory impedes performance of older adults is determined by the degree to which tasks deviate from tasks and situations that the memory system has come to remember. The increase in conceptual and metacognitive memory content that accrues through adulthood can be used to overcome many declines in memory capacity, but such compensation will not be possible in all situations or on all tasks. Despite some inconvenience, in all likelihood many age changes in memory are adaptive and advantageous in most important life situations. For example, it would be confusing to remember all of the locations that one previously used when parking in a particular parking lot.

## AGE-CORRELATED FACTORS THAT AFFECT MEMORY

It is likely that some changes in memory functioning are experienced by most people during their middle and later adult years. However, the onset and subsequent perception of memory changes is likely to occur gradually, and in many instances (e.g., active, cognitively challenged, and healthy life-styles) as nonthreatening and with little or no negative effect. The mentally and physically healthy adult should adapt to cognitive changes and experience only minor disruption of everyday functioning. Relatively healthy adults should not become preoccupied with occasional instances of forgetting or memory failures. It is likely that younger adults also experience memory failures but are less concerned than older adults by them.

In contrast to the relatively minor memory loss that seems typical in older adults, consistent and abundant memory complaints have been noted by practitioners, service providers, and researchers (Kahn, Zarit, Hilbert, & Niederehe, 1975; Kra, 1986; Lowenthal et al., 1967; Popkin, Gallagher, Thompson, & Moore, 1982; West, 1986). Indeed, it appears that failing memory is a prevalent stereotype and concern about aging (Zarit, Cole, & Guider, 1981). This stereotype may result in an unwarranted fear and preoccupation with otherwise normal instances of everyday forgetting. For example, older adults report greater concern when they experience memory failures than do younger adults (Cavanaugh et al., 1983).

In this section, some explanations for the memory problems experienced by older adults are discussed. It may be useful, first, to distinguish between three sets of factors that contribute to memory impairment. Although these factors can affect memory performance at any age, they tend to be correlated with age and therefore become more important in later adulthood. The first set of factors relates to *psychological state*. Poor adaptation to the aging process may result in a psychological state that impairs memory performance. Many of these states have been found to be relatively transitional and/or susceptible to intervention.

The second set of factors reflects *transitory physical states*. These states often result from problematic health conditions that become more prevalent as people get older (Ford, 1986). It should be noted, however, that although acute health problems are more common in older people, they do not necessarily reflect inevitable consequences of aging. The effects of these types of influences on memory performance also are susceptible to remediation when properly diagnosed and treated.

The third set of factors reflects *chronic physical states*. They result from physiologic impairments that are not yet known to be reversible. They may range in severity from relatively modest sensory or perceptual impairment to complete loss of hearing or sight, loss of mobility, or various stages of degenerative brain diseases (e.g., dementia of the Alzheimer's type; see Thompson, Gong, Haskins, & Gallagher, this volume). These severe physical problems often impede memory, but they are beyond the scope of this chapter.

The following sections describe some psychological factors, transitory physical factors, and less severe chronic physical factors that influence memory. Each factor is introduced with research on its relationship to memory or more general cognitive functioning. Some evidence linking these factors to chronological age is then reviewed, with the intent to challenge the notion that memory deficits observed in older individuals are due predominantly to age per se. Rather, the position taken is that these extraneous factors are often correlated with age and may be amenable to remediation. Thus, memory functioning in older adults may be optimized when the effects of such mediating variables are modified.

## Psychological Expectations

Memory functioning does not occur in a vacuum; psychological factors such as mood, perception, motivation, self-esteem, and attitude contribute to memory performance. *Expectations* are the beliefs or judgments one holds about one's abilities regarding potential performance (Campbell & Fairey, 1985). These cognitions include the relative degree of expected success or failure on a given task and the causes attributed to such outcomes. Across behavioral domains (e.g., intellectual, interpersonal, athletic), performance expectations have been found to have a positive relationship with actual performance (Anderson, 1983; Bandura & Schunk, 1981; Weinberg, Gould, & Jackson, 1979; Weinberg, Yukelson, & Jackson, 1980). That is, positive expectations are predictive of successful outcomes and negative expectations are predictive of failure. Implied here is the notion that expectations or subjective evaluations are not necessarily accurate representations of the abilities or skills in question. In fact, the goal of cognitive psychotherapies (Beck, 1976; Ellis & Grieger, 1978; Meichenbaum, 1977) has been to modify self-appraisal so that it more accurately matches ability. Moreover, research has demonstrated that negative expectations can be raised or changed in such a way as to enhance performance (Anderson, 1983; Dweck, 1975).

Research on expectations has been extensive and diverse. Different processes may contribute directly or indirectly to the development of negative expectations or may serve to lower existing levels of expectations. For example, studies of *learned helplessness* (the expectation of inability to produce or control desired outcomes) suggest that expectations of helplessness are related to cognitive, motivational, and behavioral deficits (Abramson, Seligman, & Teasdale, 1978; see also Garber & Seligman, 1980, for a review of human helplessness). A closely related construct is *perceived locus of control* (Shupe, 1985). Research has shown that people's beliefs about whether personal events are due to factors such as luck, chance, fate, and powerful others (i.e., external locus of control) are associated with depressed cognitive functioning (Lefcourt, 1976). A third body of literature on expectations documents effects of *self-efficacy* on performance. Self-efficacy expectations refer to judgments regarding one's ability to perform in a stressful situation. It has been proposed that such expectations have two distinct behavioral manifestations: (1) approach and avoidance of task, and (2) amount of effort and persistence devoted to task mastery. Studies of self-efficacy have illustrated that negative expectations can inhibit performance (Bandura, 1986; Bandura, Adams, Hardy & Howells, 1980; Bandura, Reese & Adams, 1982; Bandura & Schunk, 1981; Condiotte & Lichtenstein, 1981; Schunk, 1981).

Learned helplessness, locus of control, and self-efficacy represent variables that influence expectations, and in turn they may influence memory functioning. Moreover, these variables may be related to age and thereby contribute to lowered memory functioning in older adults. This perspective is increasingly evident in research on aging and memory (Hertzog, Dixon, Schulenberg, & Hultsch, in press; Scogin et al., 1985; West, Berry, & Powlishta, 1986; West, Boatwright, & Schleser, 1984; Zarit, Cole, & Guider, 1981). Specifically, it has been hypothesized that older adults are more likely to view their memory abilities negatively, due possibly to internalization of popular stereotypes of aging (Rodin & Langer, 1980) and greater awareness of changes in cognition (Cavanaugh et al., 1983). For example, West et al. (1986) found that older adults who complained of memory problems had lower self-efficacy than younger adults. Moreover, the ways in which negative views (and other memory-related beliefs; see Cavanaugh & Perlmutter, 1982; Dixon & Hertzog, in press, for reviews of the metamemory in adulthood literature) affect actual memory functioning are beginning to be understood (Berry, 1986; Cavanaugh & Poon, 1985; Coyne, 1985; West et al., 1984, 1986). For example, it appears that low self-efficacy may produce decreased effort and persistence, a sort of "why bother?" attitude, perpetuated by the view that memory failure is inevitable and beyond one's control. If personal responsibility is taken for memory functioning, and occasional memory failure is viewed as the consequence of inadequate effort (e.g., Berry, 1986; Dweck, 1975; Murphy et al., 1981), then functioning may be improved. A goal, then, is to change inaccurate beliefs that interfere with memory behavior. By assuming control over component memory skills and task effort, performance expectations may be raised and the probability of satisfactory memory functioning enhanced.

## Mental Health

A number of psychological disorders may predispose individuals to distorted thought processes, resulting in suboptimal cognitive functioning. Two of the more common types of these disorders, depression and anxiety, have been researched extensively (see Paykel, 1982). Depression and anxiety are affective states that may be characterized respectively as feelings of hopelessness and helplessness. Moreover, anxiety is also considered a symptom of depression (Klerman, 1983) and is correlated with depression in college students (Gotlib, 1984). The negative effect of depressed affect and anxiety on memory functioning has been hypothesized to account for some memory deficits observed in older adults. That is, older adults' memory problems may be due in part to age-related change in affective mood states rather than to aging per se.

*Depression,* a persistent dysphoric mood state characterized by psychological and somatic symptoms (see DSM-III, 1980, for diagnostic criteria), has been called the common cold of mental disorders (Goodstein, 1985). Its prevalence in the general population is relatively high (George, Blazer, Winfield-Laird, Leaf, & Fischbach, 1986) and varies as a function of method of assessment, age, and sex (see Blazer, 1983; George et al., in press; Gurland, 1976; Zarit, 1980). The hypothesized causes of depression range from biochemical factors to distorted and negative self-concept and unresolved inner conflicts. The influence of depressed mood on memory and task performance has been demonstrated empirically (Bower, 1981; Strack, Blaney, Ganellen, & Coyne, 1985; Stromgren, 1977), and clinical models describe the impact of depression on cognition and behavior in everyday life (Beck, 1967, 1976; Garber & Seligman, 1980). This work suggests that the common mechanisms by which depression influences behavior include the development of negative expectancies, decreased concentration, and attentional deficits (Goodstein, 1985; Strack et al., 1985).

There is also evidence that *anxiety* influences cognitive functioning (see Lazarus & Folkman, 1984; Sarason, 1980). Anxiety is characterized as inner distress accompanied by physiological arousal and vague fears. As proposed by Hebb (1955), the arousal component of anxiety operates in a curvilinear manner where both under- and overarousal lead to behavioral deficits. More recent studies of anxiety and cognitive performance argue for an attentional (versus arousal) interpretation; that is, anxiety inhibits performance through excessive self-focusing and "worrying" (Paulman & Kennelly, 1984; Strack et al., 1985; Wine, 1971).

Increasingly, affective variables such as anxiety (Cavanaugh & Murphy, 1986; West et al., 1984; Yesavage, Rose, & Spiegel, 1982) and especially depression (Cavanaugh & Poon, 1985; Kahn et al., 1975; Kennelly, Hayslip, & Richardson, 1985; Neiderehe & Camp, 1985; Zarit, 1982) have been examined in relation to memory and aging. The poorer performance of older adults on memory tasks may be the consequence of the anxiety and/or depression prevalent in this age group. It is often assumed that these variables may be manifested differentially at different ages. For example, Eisdorfer, Nowlin, & Wilkie (1970) reported increased levels of autonomic arousal (which may indicate state anxiety) in older adults performing in laboratory settings. It is also believed that depression is more common in older adults (Butler & Lewis, 1982; Zarit, 1980); Goodstein (1985) suggests that one in four older adults is depressed. It should be noted, however, that anxiety as a personality characteristic (i.e., neurotic trait anxiety) appears stable across the life span (Costa & McCrae, 1980; Costa et al., 1986). In addition, the relationship obtained between depression and age may depend on method of assessment. The diagnosis of clinical depression is more likely in younger adults, whereas frequency of depressive symptoms is greater in older adults (Gurland, 1976). Such measurement issues must be considered in the assessment of anxiety and depressed affect, with conclusions tempered accordingly.

Evidence suggests that affective components contribute to the observed age differences in memory performance. Yesavage and his colleagues (Yesavage & Jacob, 1984; Yesavage et al., 1982) have reported decreases in memory deficits following anxiety reduction in older adults. Likewise, improvements in memory have been reported following treatments aimed at decreasing depression (Popkin et al., 1982; Zarit, Gallagher, & Kramer, 1981), although the data are not unequivocal (Scogin et al., 1985). The discrepant results may be a function of severity of depression and type of treatment (see O'Hara, Henricks, Kohout, Wallace, & Lemice, 1986). Regardless, it is plausible that memory deficits reflect underlying affective symptoms that could be remediated to improve functioning in at least some older adults.

A variable related to affective status is *memory complaint*, or the concerns expressed by older adults regarding their memory abilities and failures. This variable has received increased attention in studies of aging and memory self-assessment (Berry, 1986; Cavanaugh et al., 1983; Kahn et al., 1975; O'Hara et al., 1986; Scogin et al., 1985; West et al., 1984, 1986). The memory complaints of older adults seem to be associated more with affective distress than actual memory ability (Cavanaugh & Poon, 1985; O'Hara et al., 1986; Zarit, Cole, & Guider, 1981). Thus, the influence of complaints on memory performance may operate indirectly. A persistent question that will need to be addressed in future studies is whether depressed or anxious affect or poor performance is antecedent to the high level of memory complaints reported by older adults (Lowenthal et al., 1967; Roberts, 1983; Rodin & Langer, 1980).

A comprehensive evaluation of memory functioning in older adults should include measures of current subjective mood state as well as a mental health history. Complaints of memory functioning should be explored rather than dismissed as "normal" concomitants of aging, with the intent to (1) rule out possibly accurate appraisals of more serious memory problems such as those experienced in early stages of Alzheimer's disease, and (2) identify potential affective disorders. If an affective disorder is indicated, both drug (Plotkin, Mintz, & Jarvik, 1985) and nonpharmacologic (Yesavage, 1985) therapies may be effective in alleviating symptoms and enhancing memory.

### Physical Fitness

It is well established that physical exercise has a positive influence on physical health throughout the life span. Indeed, research over the last two decades has shown that vigorous physical conditioning can even partially reverse some of the functional losses that typically accompany normal aging (for review see deVries, 1983). For example, significant improvements have been observed in the cardiovascular (e.g., Ninimaa & Shepard, 1978) and respiratory systems (e.g., deVries, 1983) of older adults as a function of exercise. Since optimal cognitive functioning is, at least partially, dependent on cerebrovascular circulation and aerobic capacity, it is reasonable to suggest that the physiological improvements resulting from an exercise program could contribute to improvements in mental functioning as well (see Wiswell, 1980). Thus, *physical fitness* may be another important factor to take into account when evaluating the memory performance of older adults.

Physical fitness refers technically to an individual's physical work capacity, which is defined as the maximum level of physical work of which the individual is capable. Physical work capacity is reported in terms of oxygen consumption per kilogram of body weight per minute. This index decreases as physical activity or exercise decreases. To the extent that a link exists between physical work capacity and mental status, chronic inactivity could have a deleterious impact on everyday cognitive functioning.

The relationship between physical fitness and mental functioning recently has begun to receive serious scientific attention. Two research approaches characterize this literature. In one, comparisons between individuals in different categories of physical fitness (e.g., fit versus unfit) are made on performance variables. In the other, the effect of physical training on cognitive functioning in both humans and animals is tested. Although few studies have focused on physical fitness and memory, several studies have included a number of performance variables that may be related to everyday memory. In particular, the role of physical fitness and/or exercise in fluid intelligence and short-term memory has been investigated.

Fluid intelligence is thought to be tied directly to neurological functioning and, moreover, is assumed to underlie learning of new information. Thus, the potential modifiability of fluid functioning has implications for memory performance. In both comparison and training studies, physical fitness has been observed to be related to fluid ability scores. For example, in a study of 71 men ranging in age from 34 to 75 years, Powell and Pohndorf (1971) observed that physical fitness was related positively to fluid ability measures. A later training study by Powell (1974) demonstrated improved fluid performance of geriatric mental patients following an exercise therapy program. In a more recent study, Elsayed, Ismail, and Young (1980) observed that regardless of age (young versus old), "high-fit" subjects performed better on tests of fluid intelligence than did "low-fit" subjects. The young subjects, however, scored higher than the old subjects. In addition to these group comparisons, performances for all four groups (high-fit young, high-fit old, low-fit young, low-fit old) improved after a vigorous 4-month physical fitness program, thus confirming the results of Powell's earlier studies.

In a few studies, the role of physical exercise in memory performance has been investigated more directly. Davey (1973), for example, reported significant improvements in short-term memory for young adults after exercise on a bicycle ergometer. With an older adult sample, Dustman et al. (1984) observed that aerobic exercise improved digit-span memory. And in Powell's (1974) study with geriatric patients, WAIS scores improved significantly for an exercise therapy group compared to social therapy and control groups. Finally, in a recent study with middle-aged and older mice, exercise was shown to significantly improve memory (Samorajski et al., 1985).

Taken together, these studies suggest that physical fitness may indeed be an important mediating factor of memory performance in old age. However, because of a number of methodological problems, these studies must be interpreted with caution. For example, there are sampling problems in the comparison studies in that subjects are self-selected as "active." Such individuals are likely to differ from "inactive" subjects on variables other than physical fitness (see Welford, 1984). Moreover, the causal relationship between physical fitness and cognitive function is suspect because variables such as health may mediate both activity level and cognitive functioning. Finally, there remains the potential problem of practice effects when pre- and posttest scores are used to evaluate training effects.

There is clearly a need to investigate further the role of physical fitness in older adults' memory performance. Because the old are not likely to engage in regular exercise (see Wiswell, 1980), they are especially vulnerable to the deleterious effects that may be a consequence of chronic inactivity. Therefore, observed memory deficits may be at least partially due to poor physical fitness, a transient state that is potentially reversible through exercise therapy.

## Nutritional Status

The importance of diet and nutrition for the maintenance of health and well-being is widely accepted. It is reasonable, therefore, to suggest that nutritional factors also may be related to mental functioning, including memory performance.

Because elderly adults comprise a population that may be especially vulnerable to nutritional deficiencies (see Fanelli & Kaufman, 1985; Rao, 1973), *nutritional status* could be an important variable to consider when their memory performance is evaluated.

Nutritional status is an indicator of how well nutritional requirements are met in a given individual (Barrows & Kokkonen, 1984). There are various ways to assess nutritional status. These include the use of food intake records and biochemical measurements. Food intake records provide information about the adequacy of dietary intake relative to a standard (e.g., 1980 Recommended Dietary Allowances), whereas biochemical assessments provide information about blood and urine levels of specific nutrients. Biochemical information makes it possible to determine whether consumed nutrients are absorbed and metabolized (Schlenker, 1984).

Unfortunately, because the role of nutritional status in mental functioning has received very little scientific attention to date (Goodwin, Goodwin, & Garry, 1983), it is not yet clear what impact nutritional deficiencies may have on everyday cognitive functioning. Nevertheless, data that are available suggest that certain nutrient deficiencies may be functionally related to poor memory performance. For example, a number of specific vitamin deficiencies have been associated with reversible memory disorders. Thiamine has been implicated in memory failures in humans (e.g., "beriberi anemia," Cherkin, 1984) and in laboratory rats (Yoshimura et al., 1976). Likewise, niacin and $B_{12}$ deficiencies have been linked to diseases (e.g., pellagra and pernicious amnesia, respectively) in which memory failure is a major symptom (see Rosenthal & Goodwin, 1985), and $B_{12}$ deficiencies unrelated to anemia are also associated with impaired mental functioning (e.g., Roos & Willanger, 1977). Several other vitamin deficiencies have been linked to cognitive impairments, although the associations are not yet clearly understood. These include folate, vitamin C, and multiple vitamin deficiencies (for review, see Rosenthal & Goodwin, 1985).

Interest in evaluating the nutritional status of the elderly population in the United States has emerged only in the past two decades. In this period, data from a number of early government-sponsored nutritional surveys [e.g., *Ten-State Nutrition Survey* (CDC, 1972); Health and Nutrition Examination Survey I (DHEW, 1974)] indicated an age-related decline in caloric intake and in the intake of a number of essential nutrients including calcium, iron, vitamin A, and vitamin C (for review, see O'Hanlon & Kohrs, 1978). Although more recent surveys have indicated improvement in the nutritional status of older Americans (e.g., Health and Nutrition Examination Survey II, in Fanelli & Kaufman, 1985), it is estimated that anywhere from 15% to over 50% of older Americans are suffering from some form of nutritional deficiency (Eckholm, 1985; Kohrs & Czajka-Narins, 1986).

There are few published reports that specifically link vitamin deficiencies to mental functioning in the elderly. The available data, however, suggest that such a relationship may exist. In a recent study of healthy elderly, low blood levels of vitamins C and $B_{12}$ were found to be associated with poor performance on the Wechsler Memory Scale (Goodwin et al., 1983). This relationship was significant even when age, gender, income level, and educational level were controlled statistically. However, a 2-year study on placebo versus vitamin C supplementation failed to demonstrate improvements in paired-associate learning in a community-dwelling elderly sample (Burr, Hurley, & Sweetnam, 1975).

Choline deficiencies also have been implicated in memory dysfunction. In particular, disruption of acetylcholine transmission in the brain has been shown to be related to learning and memory disorders (for reviews, see Bartus, Dean, Beer, & Lippa, 1982; Drachman & Leavitt, 1974). Because the nutrient choline is known to be a precursor to acetylcholine formation, low choline levels have been causally implicated in the impairment of acetylcholine transmission.

The selective depletion of acetylcholine levels has been observed consistently in the brains of Alzheimer's patients who suffer from severe memory loss (Bartus, Dean, Pontecorro, & Flicker, 1985). Researchers have thus reasoned that modulation of acetylcholine levels in the brain may improve the cognitive functioning of Alzheimer's patients and may even enhance the memory performance of nondemented elderly. Because the consumption of choline-rich foods (e.g., cauliflower, cabbage) and lecithin-rich foods (e.g., eggs, soybeans, liver) has been shown to elevate plasma choline levels (see Wurtman & Zeisel, 1982), the facilitative effects of choline and lecithin (a dietary source of choline) on memory have been studied in both human clinical trial studies and animal experiments.

The results of human clinical trial studies have been disappointing thus far (for review, see Bartus, Dean, & Bear, 1984). In most of the studies with humans, the administration of either choline or lecithin has failed to improve memory in normal (i.e., nondemented) elderly (e.g., Domino, Monor, Duff, Tait, & Gerson, 1982; Sanchez, Hooper, Garry, Goodwin, & Goodwin, 1984), or in subjects with Alzheimer's disease (e.g., Sullivan, Shedlack, Corkin, & Growdon, 1982; Thal, Rosen, Sharpless, & Crystal, 1981). In one study, however, learning and memory were reported to improve in patients with early-stage Alzheimer's disease following administration of these drugs (Signoret, Whitely, & Lhermitte, 1978).

The data from the studies just described do not alone disconfirm the relationship between acetylcholine and memory. Indeed, supportive evidence has been garnered from studies in which a number of other methodological approaches have been applied to the problem. For example, reliable improvements in memory have been observed in clinical trials using the anticholinesterase physostigmine (for review see Bartus et al., 1984). Thus, although the cholinergic system appears to be involved in learning and memory, dietary choline deficiencies may not be an important source of memory problems in old age (see Bartus et al., 1984). Moreover, although certain vitamin deficiencies (e.g., thiamine, niacin, vitamin $B_{12}$) have been linked strongly with memory disorders, the role of vitamin deficiencies in geriatric memory is as yet unclear because research examining the relationship between nutrition and memory is only beginning. In light of older adults' vulnerability to malnutrition and the memory deficits typically associated with aging, future research should address the question of how nutritional status influences mental functioning.

## Alcohol

Most studies on the effects of alcohol intake on cognitive performance show a negative linear relationship between amount of alcohol consumed on a single occasion and performance on cognitive and memory tasks (see Ryback, 1971, for a review). The alcohol-related declines in memory performances may be independent of age (Parker & Noble, 1977), although some research suggests that older adults may be more "sensitive" to the effects of alcohol than are younger adults (Zarit, 1980). Hence, it is important to consider both the immediate and the possible long-term cumulative effects of alcohol intake on memory functioning of older adults. Furthermore, it is useful to think about alcohol intake as varying along a continuum that ranges from low to high amounts on any single occasion or multiple occasions (Parker & Noble, 1977; Ryback, 1971).

Alcohol is the most widely used drug in the United States. Nearly 70% of the population take a drink at some time during any given year, and approximately 58% drink at least once a month (Abelson, Fishburne, & Cisin, 1977). Moreover, the average daily consumption of alcohol appears to peak after age 74 (Malin, Wilson, Williams, & Aitken, 1986). Still, negative effects of alcohol on memory are not restricted to alcohol abuse. Research on middle-aged moderate drinkers suggests that low levels of intoxication can have negative effects on different aspects of the memory system.

With few exceptions (e.g., Jones, 1973), most research indicates that alcohol produces no negative effects on immediate memory (Davis, Gibbs, Davis, Jetter, & Trowbridge, 1941; Hutchinson, Tutchie, Gray, & Steinberg, 1964; Talland, Mendelson, & Ryack, 1964). Likewise, research indicates that small doses of alcohol do not interfere with long-term memory. In contrast, several studies (Hutchinson et al., 1964; Jones, 1973; Muller, Tarpey, Giorgi, Mirone, & Rouke, 1964) show that relatively small doses of alcohol (e.g., 0.01 to 0.21 oz) can adversely affect short-term memory (Jones, 1973; see Loftus, 1980, for a review). In general, then, it appears that modest alcohol use interferes primarily with short-term memory.

Most definitions of alcohol abuse are based on functional criteria. That is, alcohol abuse has been defined as consumption of alcohol that interferes with health, personal relationships, work, and social functioning. Findings from a nationwide survey of alcohol abuse in the United States indicate that across all age groups at least 10% of respondents can be classified as alcoholics. Alcoholism seems to peak to about 10% of adults between the ages of 35 and 50. It is estimated that 2% to 10% of adults over age 55 are alcoholic, although estimates of alcoholism may be underestimated (Schuckit & Miller, 1976). Indeed, records from general hospitals and psychiatric hospitals showed alcoholism among older adults as high as 60% (cited in Schuckit & Miller, 1976). Thus, the extent of alcohol abuse among the elderly may be greater than indicated by present surveys.

Memory losses due to long-term or severe alcoholism seem to take two forms: "grayouts" and blackouts. A grayout generally refers to memory loss for some events that occur while drinking alcohol. If a grayout occurs, memories are experienced as fuzzy, vague, and fragmented; however, the person remembers some aspects of the events. In contrast, a blackout typically refers to a total loss of memory for events that occur while drinking alcohol (see Goodwin, 1977, for a review of terminology and research). If a blackout occurs, it is likely that a person's immediate and long-term memory will not be affected. Rather, research indicates that memory loss may be restricted to short-term memory (Goodwin, Othmer, Halikus, & Freemon, 1970).

High doses of alcohol over prolonged periods of time may also have long-term effects on memory performance. Specifically, significant negative correlations have been found between a history of high alcohol intake and performance on laboratory memory tests (Parker & Noble, 1977). These findings imply a negative "carry over" effect of heavy drinking on memory performance when a person is not drinking or intoxicated.

Research on alcohol intervention in middle-aged adults (e.g., detoxification) suggests that after initial phases of physical withdrawal, improvement is possible (Goodwin & Hill, 1975; Parsons & Prigatano, 1977). Moreover, improvements in cognitive performance occur with little residual decrements after 1 year (Long & McLachlan, 1974). Thus, under some conditions the effects of alcoholism on memory performance are potentially reversible. Although older adults have not been the target population of these intervention studies, benefits of intervention on memory of older adults may be expected.

In addition to the direct effects of alcohol on memory performance, there are indirect effects that may result from psychological and physiological states produced by drinking. For example, alcohol is a depressant that slows the rate of neuronal firing (Mishara & Kastenbaum, 1980). Insofar as decreased alertness and sensory functioning are associated with decreases in memory functioning (see "Sensory Functioning," below), alcohol intake may indirectly decrease memory functioning. Also, nutritional status often declines with heavy drinking because alcohol provides energy (calories) without nutritional contents. Alcohol-related deficiencies of vitamin B can result in Korsakoff's syndrome (Mishara & Kastenbaum, 1980), a chronic organic brain disorder; and as indicated earlier, deficits of vitamin $B_{12}$ appear to be associated with impaired mental functioning (Rosenthal & Goodwin, 1985).

## Drugs

Research on memory loss due to prescription and over-the-counter drugs is particularly important because of the widespread use of medications by older adults. In the United States, the proportional use of medications of all kinds is higher for adults over 65. For example, psychoactive drugs (e.g., neuroleptics) are commonly used by older adults in nursing homes, and over-the-counter drug use (e.g., sleeping pills and pain relievers) is higher for community-dwelling older adults than for younger adults. As noted by Avorn (1983), "this cohort, which comprises only 11% of the United States population, consumes 25% of all prescription drugs" (p. 138).

Diazepam (i.e., Valium®), a sedative commonly used by older adults, has been found to impair memory performance (Block, DeVoe, Stanley, Stanley, & Pomara, 1985). For example, 10mg doses significantly reduce recall, and the side effects of a variety of doses (2.5 to 10mg) are similar to symptoms of memory loss associated with Alzheimer's disease. Moreover, older adults are more sensitive to the side effects than younger adults.

The side effects of medications on memory require further attention. Older adults commonly take many medications that may not be metabolized in the same way that they are by younger adults. Moreover, the possible interactive effects of multiple medications are not yet adequately understood. Until the relationship between drugs and memory is better understood, assessment of memory in older adults may overestimate or misdiagnose problems (Avorn, 1983). In addition, continued use of drugs such as psychoactive medications may have long-term negative effects on memory that may hasten and amplify memory loss.

## Sensory Functioning

The senses receive information and structure perceptions of the world. Much research suggests that age-related declines in sensory functioning are correlated with declines in cognitive functioning (Birren, Botwinick, Weiss, & Morrisson, 1963; Ohta, Carlin, & Harman, 1981; Sklar & Edwards, 1962). The auditory system's relation to memory function probably has been most widely researched. Age-related declines in auditory reception are very common, especially for high frequencies (Weiss, 1959). For example, it has been estimated that approximately 15% of the population is deaf by age 75 and a considerably larger proportion has some form of hearing impairment (Rockstein & Susserman, 1979). In fact, statistics indicate that hearing impairments are the second most common chronic condition of older adults (Corso, 1977, 1984), and the severity of hearing impairments tends to increase with age (Rapp, 1970; Rockstein & Susserman, 1979). The ramification of this age change in audition is that some information is simply not encoded and subsequently is unavailable for storage and retrieval (Thomas et al., 1983). In some conditions, failures to hear are not obvious, and in others the extent of hearing loss may be intentionally hidden by older adults. Yet failures by older adults to produce veridical information on requests to remember may be mistakenly attributed to decline of memory abilities or symptoms of dementia.

Auditory deficits have implications for memory functioning that go beyond failure to pick up information. For example, prebycusis, a progressive age-related loss in the ability to hear high-frequency sounds, may lead to distortions of information. In particular, because high-frequency consonants (e.g., *s*, *z*, *t*, and *g*) are less audible, the normal flow of a conversation may be disrupted (Corso, 1977, 1984), and older adults may strain to follow a conversation (Corso, 1977). Indeed, some research indicates that by the age of 80 a person can miss up to 25% of the words in a conversation (Feldman & Reger, 1967). As a result, older adults may incorrectly infer the content of a discussion. Such inaccuracies may create an illusion of cognitive and memory incompetency.

The older adult with hearing difficulties may feel embarrassed, inferior, and anxious in conversations (Corso, 1977; Hull, 1978; Weinstein & Ventry, 1982). Moreover, stress experienced by older hearing-impaired adults may be compounded during formal interactions such as speaking with professionals (e.g., doctor, lawyer, or social worker). In fact, under such potentially evaluative conditions, an older adult may experience levels of stress that further impair his or her ability to understand speech (cf. Corso, 1977), and, as discussed earlier, anxiety may also contribute to memory problems.

## REMEDIATION OF MEMORY PROBLEMS

The high incidence of memory complaints by the aged that was discussed previously has resulted in the proliferation of geriatric memory screening and training programs (e.g., Kahn et al., 1975) and a sizable body of research on cognitive training (e.g., Poon, Fozard, & Treat, 1978; Poon, Walsh-Sweeney, & Fozard, 1980; Smith, 1980; Yesavage, 1984; Zarit, Gallagher, & Cramer, 1981). In the sections that follow, issues relevant to memory training are discussed. First, a brief review of strategies that can be used to aid memory performance is presented; then factors considered important for the development of better intervention programs are suggested.

## Strategies

The notion that memory skills can be developed in much the same way as athletic skills has led to the publication of a number of self-help books on memory (Cermak, 1975; Loisette, 1899; Lorayne & Lucas, 1974; Montgomery, 1972; Roth, 1918; West, 1986; Wood, 1937), as well as reports about memory experts (e.g., Luria, 1968; Yates, 1966). Three major methods of improving memory (see Harris, 1980) are (1) physical treatments (e.g., drugs), (2) external aids (e.g., diaries, notebooks, and electronic gadgets); and (3) internal aids (e.g., rehearsal and imaging). In addition, because some memory problems of older adults probably are attributable to high anxiety and/or poor concentration (see previous discussion), strategies to increase attention (e.g., Zarit, Gallagher, & Cramer, 1981) or reduce anxiety (e.g., Yesavage, 1984) might be helpful to older adults.

*Memory Aids.* *External memory aids* are objects such as diaries, address books, calendars, note pads, pill boxes, digital watches, timers, microcomputers, and electronic devices commonly used to support memory in everyday situations (Cavanaugh et al., 1983; Harris, 1980). Some external memory aids involve the use of externals to aid storage of information, and the others involve the use of externals to cue action. An example of externally aiding storage is writing down intermediate results during mental calculations. An example of externally cuing action is writing notes in a diary to remember to acknowledge a special occasion. Harris (1980) suggests that for cues to be effective they should (1) be given close to the time that action is required, (2) be active rather than passive, and (3) be specific to the particular action. In addition, he suggests that external memory aids should (1) be portable, (2) fit a wide range of situations, (3) store many cues for long periods of time, (4) be easy to use, and (5) not require a pen or pencil.

*Internal memory aids* are mental strategies that can enhance learning and later recall of information (Bellezza, 1981). In general, they supply meaning and order to information; that is, they embellish what is being learned (Morris, 1979). Examples of such embellishing strategies are letter identification, rhyming, story relating, peg or hook methods, place or loci methods, turning numbers into letters, face–name association, mental retracing, and search through the alphabet (for detailed descriptions and discussions of schemes, see Higbee, 1977; Lorayne & Lucas, 1974; Morris, 1979). According to Harris (1978), two internal aids, mental retracing and alphabetical searching, are used most frequently in everyday life. They are different from most internal aids in that they require no special encoding effort to use.

*Attention Enhancement and Anxiety Reduction.* It has been suggested that the aged suffer from impairments of concentration and attention that may limit memory (e.g., Yesavage & Rose, 1983; Zarit et al., 1981). Because relaxation training often enhances attention, a number of investigators concerned with memory problems of older adults have attempted to teach them to use relaxation techniques. Yesavage (1984) found that relaxation training reduced anxiety and improved recall of older adults. It is interesting that the improvement seen in Yesavage's (1984) study was of similar magnitude to the age-related deficits typically observed in studies of memory. This pattern supports the view that relaxation treatments could have practical benefits for the elderly. It is important to note, however, that relaxation training (Yesavage, 1984; Yesavage et al., 1982) has not yet been shown to have long-term positive effects on memory. As in studies of test anxiety in college students, general anxiety is not reduced without additional training in required learning skills (Eisdorfer, 1968).

## Memory Training Programs

Future research on memory training should focus on the discovery of more effective mnemonic techniques, attend to individual differences, and aim at the development of better diagnostic procedures.

*Discovery of More Effective Mnemonic Techniques.* Because research has demonstrated age-related declines in both acquisition and retrieval processes, memory training for the elderly should include techniques to aid both acquisition and retrieval. Unfortunately, most cognitive-skills training focuses only on acquisition. Moreover, training typically involves a broad-spectrum or multi-faceted approach of undemonstrated utility. More effective techniques need to be discovered before memory training can be expected to be optimally valuable for the elderly (Winograd & Simon, 1980).

*Attention to Individual Differences.* The elderly are a heterogeneous population. For example, they vary considerably in number of years of formal schooling and occupational experience. Treat, Poon, Fozard, and Popkin (1978) argued that these factors should be considered in designing training programs for the elderly. They cite a study by Belbin and Belbin (1968) demonstrating that individuals who participated in almost any kind of formal course work after leaving school benefited more from skills training than did age peers who had not had such experiences. Individual differences in temperament, cognitive style, and other personality characteristics also are likely to affect cognitive functioning (Cavanaugh & Murphy, 1986; Treat et al., 1978), as in depression (Kahn et al., 1975), anxiety (Eisdorfer, 1968), and attention (Treat et al., 1978). Training will be most effective when changes in affective status (Popkin, et al., 1982; Yesavage et al., 1982) and underlying belief systems (Berry, 1986; Cavanaugh & Murphy, 1986; Lachman, Steinberg, & Trotter, 1986) are goals of the program. Likewise, training will be more effective when individual differences in cognitive style are considered. For example, some people may benefit from mental imagery, whereas others may benefit more from verbal elaboration (Winograd & Simon, 1980). Training programs should be designed with these and other individual differences in mind (Yesavage & Rose, 1983).

*Development of Better Diagnostic Procedures.* Adequate instruments to differentiate memory problems due to mild and/or moderate cases of gradual-onset organic brain syndrome from those due to normal age-related encoding difficulties, transient affective states, or noxious environments are not available at the present time. Poon et al. (1978) argued that although short and portable assessment questionnaires are preferred by clinicians, these instruments do not provide enough information to evaluate more subtle changes in specific types of memory functions. In addition, to obtain a more comprehensive description and understanding of the impact of complaints among the aged, instruments that aid the individual in subjectively articulating complaints need to be developed. These instruments would provide detailed information concerning individuals' self-perceptions of their memory and related problems. That information, along with objective measures of memory performance, should add to understanding about why some younger adults have poor memory, whereas some older adults retain good memory throughout their later years.

## SUMMARY AND CONCLUSIONS

Although some age-related decline in memory probably occurs, most memory changes that result from normal aging are not as extensive within individuals or as representative within the population as previously had been believed (Zarit et al., 1981). Still, when older adults become aware of memory problems, they typically become quite alarmed (see Poon et al., 1980). One reason for this alarm is that memory loss has been found to be a reliable early sign of organic brain disease. Despite the sadness and severity of problems experienced by these patients and their families, the actual incidence of organic brain disease in older adults remains quite low. Unfortunately, it is possible that older adults' concern about less significant memory loss may compound or magnify problems that do exist. Therefore, when working with relatively healthy older adults, it is important first to consider possible transitory, nonmemory factors that could be contributing to memory problems and then to provide the clients with some perspective on their memory failures.

## REFERENCES

Abelson, H., Fishburne, P., & Cisin, I. (1977). *National survey of drug abuse,* Vol. 1. (DHEW Publication No. ADM 78-618). Washington, DC: U.S. Government Printing Office.

Abramson, L. Y., Seligman, M. E. P., & Teasdale, J. D. (1978). Learned helplessness in humans: Critique and reformulation. *Journal of Abnormal Psychology, 87,* 49–74.

Adams, C., & Rebok, G. W. (1982). Planfulness and problem-solving in older adults. *International Journal of Aging and Human Development, 16*(4), 271–282.

Anderson, C. A. (1983). Motivational and performance deficits in interpersonal settings: The effects of attributional style. *Journal of Personality and Social Psychology, 45,* 1136–1147.

Anderson, J. R., & Bower, G. H. (1973). *Human associative memory.* New York: Wiley.

Atkinson, R. C., & Shiffrin, R. M. (1968). Human memory: A proposed system and its control processes. In K. W. Spence & J. T. Spence (Eds.), *The psychology of learning and motivation,* Vol. 2 (pp. 80–105). New York: Academic Press.

Austin, D. R. (1985). Attitudes toward old age: A hierarchical study. *The Gerontologist, 25,* 431–434.

Avorn, J. (1983). Biomedical and social determinants of cognitive impairments in the elderly. *Journal of the American Geriatrics Society, 31*(3), 137–143.

Baltes, P. B., & Brim, O. G. (1984). *Life-span development and behavior,* Vol. 6. New York: Academic Press.

Baltes, P. B., & Kliegel, R. (1986). On the dynamics between growth and decline in the aging of intelligence and memory. In K. Poeck, H. J. Freund, & H. Ganshirt (Eds.), *Neurology* (pp. 1–33). Heidelberg: Springer-Verlag.

Baltes, P. B., & Willis, S. (1982). Plasticity and enhancement of intellectual functioning in old age. In F. I. M. Craik & S. Trehub (Eds.), *Aging and cognitive processes.* New York: Plenum Press.

Bandura, A. (1981). Self-referent thought: A developmental analysis of self-efficacy. In J. H. Flavell & L. Ross (Eds.), *Social cognitive development: Frontiers and possible futures* (pp. 200–289). Cambridge: Cambridge University Press.

Bandura, A. (1986). *Social foundations of thought and action: A social cognitive theory.* Englewood Cliffs, NJ: Prentice-Hall.

Bandura, A., Adams, N. E., Hardy, A. B., & Howells, G. N. (1980). Tests of the generality of self-efficacy theory. *Cognitive Therapy and Research, 4,* 39–66.

Bandura, A., Reese, L., & Adams, N. E. (1982). Microanalysis of action and fear arousal as a function of differential levels of perceived self-efficacy. *Journal of Personality and Social Psychology, 43,* 5–21.

Bandura, A., & Schunk, D. H. (1981). Cultivating competence, self-efficacy, and intrinsic interest through proximal self-efficacy, and intrinsic interest. *Journal of Personality and Social Psychology, 41,* 586–598.

Barrows, C. H., & Kokkonen, G. C. (1984). Nutrition and aging: Human and animal laboratory studies. In J. M. Ordy, D. Harman, & R. B. Alfin-Slater (Eds.), *Aging,* Vol. 26: *Nutrition in gerontology* (pp. 279–322). New York: Raven Press.

Bartus, R. T., Dean, R. L., & Beer, B. (1980). Memory deficits in aged cebus monkeys and facilitation with central cholinomimetrics. *Neurobiology of aging, 1,* 145–152.

Bartus, R. T., Dean, R. L., & Beer, B. (1984). Cholinergic precursor therapy for geriatric cognition: Its past, its present, and a question of its future. In J. M. Ordy, D. Harman, & R. Alfin-Slater (Eds.), *Nutrition in gerontology* (pp. 191–225). New York: Raven Press.

Bartus, R. T., Dean, R. L., Beer, B., & Lippa, A. S. (1982). The cholinergic hypothesis of geriatric memory dysfunction. *Science, 217,* 408–417.

Bartus, R. T., Dean, R. L., Gons, J. A., & Lippa, A. S. (1980). Age-related changes in passive-avoidance retention: Modulation with dietary choline. *Science, 209,* 301–303.

Bartus, R. T., Dean, R. L., Pontecorro, M. J., & Flicker, C. (1985). The cholinergic hypothesis: A historical overview, current perspective, and future directions. In D. S.

Olton, E. Gamzu, & S. Corkin (Eds.), *Memory dysfunction: An integration of animal and human research from preclinical and clinical perspectives* (pp. 332–358). New York: The New York Academy of Sciences.

Bartus, R. T., Dean, R. L., Sherman, K. A., Friedman, E., & Beer, B. (1981). Profound effects of combining choline and piracetam on memory enhancement and cholinergic function in aged rats. *Neurobiology of Aging, 2,* 105–111.

Beck, A. T. (1967). *Depression: Clinical, experimental, and theoretical aspects.* New York: Harper & Row.

Beck, A. T. (1976). *Cognitive therapy and the emotional disorders.* New York: International Universities Press.

Belbin, E., & Belbin, R. M. (1968). New careers in middle age. *Experimental Aging Research, 4,* 235–253.

Bellezza, F. S. (1981). Mnemonic devices: Classification, characteristics, and criteria. *Review of Educational Research, 51,* 247–275.

Berry, J. M. (1986). *Memory complaints and performance in older women: A self-efficacy and causal attribution model.* Unpublished doctoral dissertation, Washington University, St. Louis.

Birren, J., Botwinick, J., Weiss, A., & Morrisson, D. (1963). Interrelations of mental and perceptual tests given to healthy elderly men. In J. Birren, R. Butler, S. Greenhouse, L. Sokoloff, & M. Yorrow (Eds.), *Human aging* (DHEW, PHS Publication No. HSM 71-9051). Washington, DC: U.S. Government Printing Office.

Blazer, D. (1983). The epidemiology of depression in late life. In L. D. Breslau & M. R. Haug (Eds.), *Depression and aging* (pp. 30–50). New York: Springer Publishing Co.

Block, R., DeVoe, M., Stanley, B., Stanley, M., and Pomara, N. (1985). Memory performance in individuals with primary degenerative dementia: Its similarity to diazepam-induced impairments. *Experimental Aging Research, 11*(3), 151–155.

Botwinick, J., & Storandt, M. (1974). Cardiovascular status, depressive affect, and other factors in reaction time. *Journal of Gerontology, 29,* 543–548.

Bower, G. H. (1981). Mood and memory. *American Psychologist, 36,* 129–148.

Braithwaite, V. A. (1986). Old age stereotypes: Reconciling contradictions. *Journal of Gerontology, 41,* 353–360.

Braithwaite, V. A., Gibson, D., & Holman, J. (1985–86). Age stereotyping: Are we oversimplifying the phenomenon? *International Journal of Aging and Human Development, 22,* 315–325.

Brown, A. L., Branford, J. D., Ferrara, R. A., & Campione, J. C. (1983). Learning, remembering, and understanding. *Mussen's handbook of child psychology,* Vol. 3 (pp. 77–167). New York: Wiley.

Bruce, P. R., Coyne, A. C., & Botwinick, J. (1982). Adult age differences in metamemory. *Journal of Gerontology, 37,* 354–357.

Burke, D. M., & Light, L. L. (1981). Memory and aging: The role of retrieval processes. *Psychological Bulletin, 90,* 513–546.

Burke, D. M., & Light, L. L. (Eds.) (in press). *Language, memory, and aging.* New York: Cambridge University Press.

Burr, M. L., Hurley, R. J., & Sweetnam, P. M. (1975). Vitamin C supplementation of old people with low blood levels. *Gerontologica Clinica, 17,* 236–243.

Butler, R. N., & Lewis, M. I. (1982). *Aging and mental health* (3rd ed.). St. Louis: C. V. Mosby.

Campbell, J. D., & Fairey, P. J. (1985). Effects of self-esteem, hypothetical explanations, and verbalization of expectancies on future performance. *Journal of Personality and Social Psychology, 48,* 1097–1111.

Cavanaugh, J. C., Grady, J. G., & Perlmutter, M. (1983). Forgetting and use of memory aids in 20 to 70 year olds everyday life. *International Journal of Aging and Human Development, 17,* 113–122.

Cavanaugh, J. C., & Murphy, N. Z. (1986). Personality and metamemory correlates of memory performance in younger and older adults. *Educational Gerontology, 12,* 385–394.

Cavanaugh, J. C., & Perlmutter, M. (1982). Metamemory: A critical examination. *Child Development, 53,* 11–28.

Cavanaugh, J. C., & Poon, L. W. (1985, August). *Patterns of individual differences in secondary and tertiary memory performances.* Paper presented at the meeting of the American Psychological Association, Los Angeles.

Centers for Disease Control. (1972). *Ten state nutrition survey 1968–70* (DHEW Publication No. HSM 72-8133). Washington, DC: U.S. Government Printing Office.

Cermak, L. S. (1975). *Improving your memory.* New York: McGraw-Hill.

Chaffin, R., & Herrmann, D. J. (1983). Self reports of memory abilities by old and young adults. *Human Learning, 2,* 17–28.

Cherkin, A. (1984). Effects of nutritional factors on memory function. In H. J. Armbrecht, J. M. Prendergast, & R. M. Coe (Eds.), *Nutritional intervention in the aging process* (pp. 229–249). New York: Springer-Verlag.

Cofer, C. N. (1976). *The structure of human memory.* San Francisco: Freeman.

Condiotte, M. M., & Lichtenstein, E. (1981). Self-efficacy and relapse in smoking cessation programs. *Journal of Consulting and Clinical Psychology, 49,* 648–658.

Corso, J. (1977). Auditory perception and communication. In J. Birren & K. Schaie (Eds.), *Handbook of the psychology of aging* (pp. 535–553). New York: Van Nostrand Reinhold.

Corso, J. (1984). Auditory processes and aging: Significant problems for research. *Experimental Aging Research, 10*(3), 171–174.

Costa, P. T., & McCrae, R. R. (1980). Still stable after all these years: Personality as a key to some issues in adulthood and old age. In P. B. Baltes & O. G. Brim, Jr. (Eds.), *Life-span development and behavior,* Vol. 3 (pp. 65–102). New York: Academic Press.

Costa, P. T., Jr., McCrae, R. R., Zonderman, A. B., Barbano, H. E., Lebowitz, B., & Larson, D. M. (1986). Cross-sectional studies of personality in a national sample: 2. Stability in neuroticism, extraversion, and openness. *Psychology and Aging, 1*(2), 144–149.

Coyne, A. C. (1985). Adult age, presentation time, and memory performance. *Experimental Aging Research, 11,* 147–149.

Craik, F. I. M. (1977). Age differences in human memory. In J. E. Birren & K. W. Schaie (Eds.), *Handbook of the psychology of aging* (pp. 384–420). New York: Van Nostrand Reinhold.

Craik, F. I. M., & Simon, E. (1980). Age differences in memory: The roles of attention and depth of processing. In L. W. Poon, J. L. Fozard, L. S. Cermack, D. Arenberg, & L. W. Thompson (Eds.), *New directions in memory and aging: Proceedings of the George A. Talland Memorial Conference* (pp. 95–112). Hillsdale, NJ: Erlbaum.

Craik, F. I. M., & Tulving, E. (1975). Depth of processing and the retention of words in episodic memory. *Journal of Experimental Psychology: General, 104*, 268–294.

Crowder, R. G. (1976). *Principles of learning and memory*. Hillsdale, NJ: Erlbaum.

Davey, C. P. (1973). Physical exertion and mental performance. *Ergonomics, 16*, 595–599.

Davis, P. A., Gibbs, F. A., Davis, H., Jetter, W. W., & Trowbridge, L. S. (1941). The effects of alcohol upon the electroencephalogram (brain waves). *Quarterly Journal of Studies on Alcohol, 1*, 326–337.

Denney, N. W. (1982). Aging and cognitive changes. In B. Wolman (Ed.), *Handbook of developmental psychology* (pp. 807–827). Englewood Cliffs, NJ: Prentice-Hall.

deVries, H. A. (1983). Physiology of exercise and aging. In D. S. Woodruff & J. E. Birren (Eds.), *Aging: Scientific perspectives and social issues* (2nd ed.) (pp. 285–304). Monterey, CA: Brooks/Cole.

Dillon, K. M., & Jones, B. S. (1981). Attitudes toward aging portrayed by birthday cards. *International Journal of Aging and Human Development, 13*(1), 79–84.

Dixon, R. A., & Hertzog, C. (in press). Functional approach to memory and metamemory development in adulthood. In F. Weinert & M. Perlmutter (Eds.), *Memory development: Universal changes and individual differences*. Hillsdale, NJ: Erlbaum.

Dixon, R. A., & Hultsch, D. F. (1983a). Metamemory and memory for text relationships in adulthood: A cross validation study. *Journal of Gerontology, 38*, 689–694.

Dixon, R. A., & Hultsch, D. F. (1983b). Structure and development of metamemory in adulthood. *Journal of Gerontology, 38*, 682–688.

Domino, E. F., Monor, L., Duff, I. F., Tait, S., & Gerson, S. (1982). Effects of oral lecithin on blood choline levels and memory tests in geriatric volunteers. In S. Corkin, K. L. Davis, J. H. Growdon, E. Usdin, & R. J. Wurtman (Eds.), *Aging, Vol. 19: Alzheimer's disease: A report of progress* (pp. 393–397). New York: Raven Press.

Drachman, D. A. (1977). Memory and cognitive function in man: Does the cholinergic system have a specific role? *Neurology, 27*, 783–790.

Drachman, D. A., & Leavitt, J. (1974). Human memory and the cholinergic system. *Archives of Neurology, 30*, 113–121.

Dustman, R. E., Ruhling, E. M., Russell, D. E., Shearer, H. W., Bonekat, J. W., Shigeoka, J. S., Wood, J. S., & Bradford, D. C. (1984). Aerobic exercise training and improved neuropsychological function of older individuals. *Neurobiology of Aging, 5*, 35–42.

Dweck, C. S. (1975). The role of expectations and attributions in the alleviation of learned helplessness. *Journal of Personality and Social Psychology, 31*, 674–685.

Eckholm, E. (1985, August 13). Malnutrition in elderly: Widespread health threat. *The New York Times*, pp. 19, 20.

Eisdorfer, C. (1968). Arousal and performance: Experiments in verbal learning and tentative theory. In G. A. Talland (Ed.), *Human aging and behavior* (pp. 189–216). New York: Academic Press.

Eisdorfer, C., Nowlin, J., & Wilkie, F. (1970). Improvement of learning in the aged by modification of autonomic nervous system activity. *Science, 170*, 1327–1329.

Ellis, A., & Grieger, R. (Eds.) (1978). *Handbook of rational-emotive therapy*. New York: Springer Publishing Co.

Elsayed, M., Ismail, A. H., & Young, R. J. (1980). Intellectual differences of adult men related to age and physical fitness before and after an exercise program. *Journal of Gerontology*, 35(3), 383–387.

Estes, W. K. (1979). On the descriptive and explanatory functions of theories of memory. In L-G Nilsson (Ed.), *Perspectives on memory research: Essays in honor of Uppsala University's 500th anniversary* (pp. 35–60). Hillsdale, NJ: Erlbaum.

Fanelli, M. T., & Kaufman, M. (1985). Nutrition and older adults. In H. T. Phillips & S. A. Gaylord (Eds.), *Aging and public health* (pp. 70–100). New York: Springer Publishing Co.

Feldman, R., & Reger, S. (1967). Relations among hearing, reaction time, and age. *Journal of Speech and Hearing Research, 10*, 479–495.

Fitzgerald, J. M. (1980). Sampling autobiographical memory reports in adolescents. *Developmental Psychology, 16*, 675–676.

Fitzgerald, J. M., & Lawrence, R. (1984). Autobiographical memory across the lifespan. *Journal of Gerontology, 39*(6), 692–698.

Flavell, J. H. (1970). Developmental studies of mediated memory. In H. W. Reese & L. P. Lipsitt (Eds.), *Advances in child development and behavior* (pp. 181–211). New York: Academic Press.

Ford, G. G. (1986). Illness behavior in the elderly. In K. Dean, T. Hickey, & B. E. Holstein (Eds.), *Self-care and health in old age* (pp. 130–166). Worchester, MA: Billing & Sons.

Garber, J., & Seligman, M. E. P. (Eds.) (1980). *Human helplessness: Theory and application*. New York: Academic Press.

George, L. K., Blazer, D. G., Winfield-Laird, I., Leaf, P. J., & Fischbach, R. L. (in press). Psychiatric disorders and mental health service use in later life: Evidence from the epidemiologic catchment area program. In J. Brody & G. L. Maddox (Eds.), *Epidemiology and aging*. New York: Springer Publishing Co.

Gerbner, G., Gross, L., Signorielli, N., & Morgan, M. (1980). Aging with television: Images in television drama and conceptions of social reality. *Journal of Communication, 30*, 37–47.

Gillund, G., & Perlmutter, M. (in press). Episodic memory and knowledge interactions across adulthood. In D. M. Burke & L. L. Light (Eds.), *Language, memory, and aging*. New York: Springer Publishing Co.

Golczewski, J. A., Hiramoto, R. N., & Ghanta, V. K. (1982). Enchancement of maze learning in old C57BL/6 mice by dietary lecithin. *Neurobiology of Aging, 3*, 223–226.

Goodstein, R. K. (1985). Common clinical problems in the elderly: Camouflaged by ageism and atypical presentation. *Psychiatric Annals, 15*, 299–312.

Goodwin, D. (1977). The alcoholic blackout and how to prevent it. In I. Birnbaum & E. Parker (Eds.), *Alcohol and human memory* (pp. 177–184). Hillsdale, NJ: Erlbaum.

Goodwin, D., & Hill, S. (1975). Chronic effects of alcohol and other psychoactive drugs on intellect, learning and memory. In J. Rankin (Ed.), *Alcohol, drugs and brain damage. Proceedings of a symposium on cerebral function* (pp. 59–69). Toronto: Addiction Research Foundation of Ontario.

Goodwin, D., Othmer, E., Halikus, & Freemon, F. (1970). Loss of short-term memory as a predictor of the alcoholic "blackout." *Nature, 227*, 201–202.

Goodwin, J. S., Goodwin, J. M., & Garry, P. J. (1983). Association between nutritional status and cognitive functioning in a healthy elderly population. *Journal of the American Medical Association, 249*(21), 2917–2921.

Gotlib, I. H. (1984). Depression and general psychopathy in university students. *Journal of Abnormal Psychology, 93,* 19–30.

Granick, S., Kleban, M., & Weiss, A. (1976). Relationships between hearing loss and cognition in normally hearing aged persons. *Journal of Gerontology, 31,* 434–440.

Gruneberg, M. M., Morris, P. E., & Sykes, R. N. (Eds.) (1978). *Practical aspects of memory.* New York: Academic Press.

Gurland, B. J. (1976). The comparative frequency of depression in various adult age groups. *Journal of Gerontology, 31,* 283–292.

Harris, J. E. (1978). External memory aids. In M. M. Gruneberg, P. E. Morris, & R. N. Sykes (Eds.), *Practical aspects of memory* (pp. 172–179). London: Academic Press.

Harris, J. E. (1980). Memory aids people use: Two interview studies. *Memory and cognition, 8,* 31–38.

Harris, J. E., & Morris, P. E. (1984). *Everyday memory, actions and absent-mindedness.* New York: Academic Press.

Hebb, D. O. (1955). Drives and the CNS. *Psychological Review, 62,* 243–253.

Henig, R. M. (1982). *The myth of senility: Misconceptions about the brain and aging.* New York: Anchor.

Herzog, A. R., & Rodgers, W. L. (1986). *Memory performance assessed in a sample survey.* Unpublished manuscript.

Hertzog, C., Dixon, R. A., Schulenberg, J., & Hultsch, D. F. (in press). On the differentiation of memory knowledge: The factor structure of the metamemory in adulthood scale. *Journal of Aging Research.*

Hickey, T., Bragg, S., Rakowski, W., & Hultsch, D. F. (1978–1979). Attitude instrument analysis: An examination of factor consistency across two samples. *International Journal of Aging and Human Development, 9*(4), 359–375.

Higbee, K. L. (1977). *Your memory: How it works and how to improve it.* Englewood Cliffs, NJ: Prentice-Hall.

Horn, J. L. (1982). The theory of fluid and crystallized intelligence in relation to concepts of cognitive psychology and aging in adulthood. In F. I. M. Craik & E. E. Trehub (Eds.), *Aging and cognitive processes* (pp. 237–278). New York: Plenum Press.

Hull, R. (1978). Hearing evaluation of the elderly. In J. Katz (Ed.), *Handbook of clinical audiology.* Baltimore: Williams & Wilkins.

Hutchinson, H., Tutchie, M., Gray, K., & Steinberg, D. (1964). A study of the effects of alcohol on mental functions. *Canadian Psychiatric Association Journal, 9,* 33–42.

Jones, B. M. (1973). Memory impairment on the ascending and descending limbs of the blood alcohol curve. *Journal of Abnormal Psychology, 82*(1), 24–32.

Kahn, R. L., Zarit, S. H., Hilbert, N. M., & Niederehe, M. A. (1975). Memory complaint and impairment in the aged: The effect of depression and altered brain function. *Archives of General Psychiatry, 32,* 1569–1573.

Kail, R. V., & Hagen, J. W. (1977). *Perspective on the development of memory and cognition.* Hillsdale, NJ: Erlbaum.

Kalish, R. A. (1979). The new ageism and the failure models: A polemic. *The Gerontologist, 19,* 398–402.

Kennelly, K. J., Hayslip, B., Jr., & Richardson, S. K. (1985). Depression and helplessness-induced cognitive deficits in the aged. *Experimental Aging Research, 11,* 169–173.

Kleinknecht, R., & Goldstein, S. (1972). Neurophysiological deficits associated with alcoholism: A review and discussion. *Quarterly Journal of Studies on Alcoholism, 33,* 999–1019.

Klerman, G. L. (1983). Problems in the definition and diagnosis of depression in the elderly. In L. D. Breslau & M. R. Haug (Eds.), *Depression and aging* (pp. 3–19). New York: Springer Publishing Co.

Kline, D., & Szafrau, J. (1975). Age differences in backward monoptic visual noise mashing. *Journal of Gerontology, 30,* 307–311.

Klisz, D., & Parsons, O. (1976). *Hypothesis testing in chronic alcoholics.* Unpublished manuscript.

Kohrs, M. B., & Czajka-Narins, D. M. (1986). Assessing the nutritional status of the elderly. In E. A. Young (Ed.), *Nutrition, aging, and health* (pp. 25–59). New York: Alan R. Liss.

Kra, S. (1986). *Aging myths: Reversible causes of mind and memory loss.* New York: McGraw-Hill.

Kuypers, J. A., & Bengtson, V. L. (1973). Social breakdown and competence: A model of normal aging. *Human Development, 16,* 181–201.

Labouvie-Vief, G., & Schell, D. A. (1982). Learning and memory in later life. In B. Wolman & G. Strickler (Eds.), *Handbook of developmental psychology* (pp. 828–846). Englewood Cliffs, NJ: Prentice-Hall.

Lachman, J. L., & Lachman, R. (1980). Age and the actualization of world knowledge. In L. W. Poon, J. L. Fozard, L. S. Cermack, D. Arenberg, & L. W. Thompson (Eds.), *New directions in memory and aging: Proceedings of the George A. Talland Memorial Conference* (pp. 285–311). Hillsdale, NJ: Erlbaum.

Lachman, J. L., Lachman, R., & Thronesbery, C. (1979). Metamemory through the adult lifespan. *Developmental Psychology, 15,* 543–551.

Lachman, M. E., Steinberg, E. S., & Trotter, S. D. (1986, November). *The effects of control believes and attributions on memory self-assessments and performance.* Paper presented at the 39th annual meeting of the Gerontological Society of America, Chicago.

Lazarus, R. S., & Folkman, S. (1984). *Stress, appraisal, and coping.* New York: Springer Publishing Co.

Lefcourt, H. M. (1976). *Locus of control: Current trends in theory and research.* Hillsdale, NJ: Erlbaum.

Light, L. L., & Anderson, P. A. (1985). Working-memory capacity, age, and memory for discourse. *Journal of Gerontology, 40*(6), 737–747.

Lippa, A. S., Pelham, R. W., Beer, B., Critchett, D. J., Dean, R. L., & Bartus, R. T. (1980). Brain cholinergic function and memory in aged rats. *Neurobiology of Aging, 1,* 10–16.

Loftus, E. (1980). *Memory.* Reading, MA: Addison-Wesley.

Loftus, G. R., & Loftus, E. F. (1976). *Human memory: The processing of information.* Hillsdale, NJ: Erlbaum.

Loisette, A. (1899). *Assimilative memory or how to attend and never forget.* New York: Funk & Wagnalls.

Long, J., & McLachlan, J. (1974). Abstract reasoning and perceptual-motor efficiency in alcoholics impairment and versibility. *Quarterly Journal of Studies on Alcohol, 35*(4), 1220–1229.

Lorayne, H., & Lucas, J. (1974). *The memory book*. New York: Ballantine Books.

Lowenthal, M. F., Berkman, P. L., Brissette, G. G., Buehler, J. A., Pierce, R. C., Robinson, B. C., & Trier, M. L. (1967). *Aging and mental disorder in San Francisco: A social psychiatric study*. San Francisco: Jossey-Bass.

Luria, A. R. (1968). *The mind of a mnemonist*. New York: Basic Books.

Malin, H., Wilson, R., Williams, G., & Aitken, S. (1986). *Alcohol World, Health and Research, 10*(2), 48–50.

Mandler, G. (1983). Consciousness: Its function and construction (Technical Report No. 117). San Diego, CA: University of California, Center for Human Information Processing.

Meichenbaum, D. H. (1977). *Cognitive-behavior modification: An integrative approach*. New York: Plenum.

Mishara, B., & Kastenbaum, R. (1980). *Alcohol and old age*. New York: Grune & Stratton.

Mitra, M. L. (1971). Confusional states in relation to vitamin deficiencies in the elderly. *Journal of the American Geriatric Society, 19*, 536.

Montgomery, R. (1972). *Memory made easy*. New York: Amacom.

Morris, P. E. (1979). Strategies for learning and recall. In M. M. Gruneberg & P. E. Morris (Eds.), *Applied problems in memory* (pp. 25–57). London: Academic Press.

Muller, B., Tarpey, R., Giorgi, A., Mirong, L., & Rouke, F. (1964). Effects of alcohol and mephenoxalone on psychophysiological test performance. *Diseases of the Nervous System, 25*, 373–375.

Murphy, M. D., Sanders, R. E., Gabriesheski, A. S., & Schmitt, F. A. (1981). Metamemory in the aged. *Journal of Gerontology, 36*, 185–193.

Neiderehe, G., & Camp, C. J. (1985). Signal detection analysis of recognition memory in depressed elderly. *Experimental Aging Research, 10*, 207–213.

Neisser, U. (1976). *Cognition and reality*. San Francisco: W. H. Freeman.

Neisser, U. (1982). *Memory observed: Remembering in natural contexts*. San Francisco: W. H. Freeman.

Nesselroade, J. R. (1986). Selection and generalization in investigations of interrelationships among variables: Some commentary on aging research. *Educational Gerontology, 12*, 395–402.

Ninimaa, V., & Shepard, R. J. (1978). Training and oxygen conductance in the elderly. II. The cardiovascular system. *Journal of Gerontology, 33*(3), 362–367.

Norman, D. A., & Bobrow, D. G. (1975). *Representation and understanding: Studies in cognitive science*. New York: Academic Press.

Norman, D. A., & Bobrow, D. G. (1976). On the role of active memory processes in perception and cognition. In C. N. Cofer (Ed.), *The structure of human memory* (pp. 114–132). San Francisco: W. H. Freeman.

O'Hanlon, P., & Kohrs, M. B. (1978). Dietary studies of older Americans. *The American Journal of Clinical Nutrition, 31*, 1257–1269.

O'Hara, M. W., Henricks, J. V., Kohout, F. J., Wallace, R. B., & Lemke, J. H. (1986). Memory complaint and memory performance in the depressed elderly. *Psychology and Aging, 1*, 208–214.

Ohta, R., Carlin, M., & Harman, B. (1981). Auditory acuity and performance on the Mental Status Questionnaire in the elderly. *Journal of American Geriatrics Society, 29*, 476–478.

Palmore, E. B. (1982). Attitudes toward the aged: What we know and need to know. *Research on Aging, 4,* 333–348.

Parker, E., & Noble, E. (1977). Alcohol consumption and cognitive functioning in social drinkers. *Journal of Studies on Alcohol, 38,* 1224–1232.

Parsons, O. A., & Prigatano, G. P. (1977). Memory functioning in alcoholics. In I. M. Birnbaum & E. S. Parker (Eds.), *Alcohol and human memory* (pp. 185–194). Hillsdale, NJ: Erlbaum.

Passuth, P. M., & Cook, F. L. (1985). Effects of television viewing on knowledge and attitudes about older adults: A critical reexamination. *The Gerontologist, 25*(1), 69–77.

Paulman, R. G., & Kennelly, K. J. (1984). Test anxiety and ineffective test taking: Different names, same construct? *Journal of Educational Psychology, 76,* 279–288.

Paykel, E. S. (Ed.) (1982). *Handbook of affective disorders.* New York: Guilford Press.

Perlmutter, M. (1978). What is memory aging the aging of? *Developmental Psychology, 14,* 330–345.

Perlmutter, M. (1980). An apparent paradox about memory aging. In L. W. Poon, J. L. Fozard, L. S. Cermack, D. Arenberg, & L. W. Thompson (Eds.), *New directions in memory and aging: Proceedings of the George A. Talland Memorial Conference* (pp. 345–353). Hillsdale, NJ: Erlbaum.

Perlmutter, M. (1986). A life span view of memory. In P. B. Baltes, D. Featherman, & R. Learner (Eds.), *Advances in lifespan development and behavior,* Vol. 7 (pp. 272–313). Hillsdale, NJ: Erlbaum.

Perlmutter, M., & Hall, E. (1985). *Adult development and aging.* New York: Wiley.

Piaget, J., & Inhelder, B. (1973). *Memory and intelligence.* New York: Basic Books.

Plotkin, D. A., Mintz, J., & Jarvik, L. F. (1985). Subjective memory complaints in geriatric depression. *American Journal of Psychiatry, 142*(9), 1103–1105.

Poon, L. W. (1985). Differences in human memory with aging: Nature, causes and clinical implications. In J. E. Birren & K. W. Schaie (Eds.), *Handbook of the psychology of aging* (2nd ed.) (pp. 427–462). New York: Van Nostrand Reinhold.

Poon, L. W., Fozard, J. L., & Treat, N. J. (1978). From clinical and research findings on memory to intervention programs. *Experimental Aging Research, 4,* 235–253.

Poon, L. W., Walsh-Sweeney, L., & Fozard, J. L. (1980). Memory skill training for the elderly: Salient issues on the use of imagery mnemonics. In L. W. Poon, J. L. Fozard, L. S. Cermak, D. Arenberg, & L. W. Thompson (Eds.), *New directions in memory and aging: Proceedings of the George A. Talland Memorial Conference* (pp. 461–484). Hillsdale, NJ: Erlbaum.

Popkin, S. T., Gallagher, D., Thompson, L. W., & Moore, M. (1982). Memory complaint and performance in normal and depressed older adults. *Experimental Aging Research, 8,* 141–145.

Posner, M. T. (1978). *Chronometric explorations of mind.* Hillsdale, NJ: Erlbaum.

Powell, R. R. (1974). Psychological effects of exercise therapy upon institutionalized geriatric mental patients. *Journal of Gerontology, 29*(2), 157–161.

Powell, R. R., & Pohndorf, R. H. (1971). Comparison of adult exercisers and non-exercisers on fluid intelligence and selected physiological variables. *Research Quarterly, 42,* 70–77.

Rabbitt, P. M. A. (1982). How do old people know what to do next? In F. I. M. Craik & S. Trehub (Eds.), *Advances in the study of communication and affect, vol. 8: Aging and cognitive processes* (pp. 78–98). New York: Plenum.

Rabinowitz, J. C., Ackerman, B. P., Craik, F. I. M., & Hinchley, J. L. (1982). Aging and metamemory: The roles of relatedness and imagery. *Journal of Gerontology, 37,* 688–695.

Rao, D. B. (1973). Problems of nutrition in the aged. *Journal of American Geriatrics, 21,* 362–367.

Rapp, R. (1970). Understanding the problems of presbycusis. *Geriatrics, 25,* 100–107.

Reese, H. W. (1962). Verbal mediation as a function of age level. *Psychological Bulletin, 59,* 502–509.

Riegel, K. F. (1968). Changes in psycholinguistic performances with age. In G. A. Talland (Ed.), *Human aging and behavior* (pp. 239–280). New York: Academic Press.

Roberts, P. (1983). Memory strategy instruction with the elderly: What should memory training be the training of? In M. Pressley & J. R. Levin (Eds.), *Cognitive strategy research: Psychological foundations.* New York: Springer-Verlag.

Rockstein, M., & Susserman, M. (1979). *Biology of aging.* San Francisco: Wadsworth.

Rodin, J., & Langer, E. (1980). Aging labels: The decline of control and the fall of self-esteem. *Journal of Social Issues, 36,* 12–29.

Roos, D., & Willanger, R. (1977). Various degrees of dementia in a selected group of gastrectomized patients with low serum B12. *Acta Neurologica Scandinavica, 55,* 363.

Rosenthal, M. J., & Goodwin, J. S. (1985). Cognitive effects of nutritional deficiency. In H. H. Draper (Ed.), *Advances in nutritional research,* Vol. 7 (pp. 71–100). New York: Plenum Press.

Roth, D. M. (1918). *Roth memory course: A simple and scientific method of improving the memory and increasing mental power.* New York: Black.

Ryback, S. (1971). The continuum of specificity of the effects of alcohol on memory: A review. *Quarterly Journal of Studies on Alcohol, 32,* 995–1016.

Salthouse, T. A. (1980). Age and memory: Strategies for localizing the loss. In L. W. Poon, J. L. Fozard, L. S. Cermak, D. Arenberg, & L. W. Thompson (Eds.), *New directions in memory and aging* (pp. 47–65). Hillsdale, NJ: Erlbaum.

Salthouse, T. (1982). *Adult cognition: An experimental psychology of human aging.* New York: Springer-Verlag.

Samorajski, T., Delaney, C., Durham, L., Ordy, J. M., Johnson, J. S., & Dunlap, W. P. (1985). Effect of exercise on longevity, body weight, locomotor performance, and passive-avoidance memory of C57BL/6J mice. *Neurobiology of Aging, 6,* 17–24.

Sanchez, C. J., Hooper, E., Garry, P. J., Goodwin, J. M., & Goodwin, J. S. (1984). The relationship between dietary intake of choline, choline serum levels, and cognitive function in health elderly persons. *Journal of the American Geriatrics Society, 32,* 208–212.

Sarason, I. G. (Ed.) (1980). *Test anxiety: Theory, research, and applications.* Hillsdale, NJ: Erlbaum.

Schaie, K. W. (1979). The primary mental abilities in adulthood: An exploration in the development of psychometric intelligence. In P. B. Baltes & O. G. Brim (Eds.), *Life-span development and behavior,* Vol. 2 (pp. 67–115). New York: Academic Press.

Schlenker, E. D. (1984). *Nutrition in aging.* St. Louis: Times Mirror/Mosby.

Schmidt, D. F., & Boland, S. M. (1986). Structure of perceptions of older adults: Evidence for multiple stereotypes. *Psychology and Aging, 1,* 255–260.

Schonfield, D. (1982). Who is stereotyping whom and why? *The Gerontologist, 22,* 267–272.

Schorah, C. J., Newill, A , Scott, D. L., & Morgan, D. B. (1979). Clinical effects of vitamin C in elderly inpatients with low blood-vitamin C levels. *Lancet, 1* (Feb. 24), 403–406.

Schuckit, M., & Miller, P. (1976). Alcoholism in elderly men: A survey of a general medical word. *Annals of the New York Academy of Sciences, 273,* 558–571.

Schunk, D. H. (1981). Modeling and attributional effects on children's achievement: A self-efficacy analysis. *Journal of Educational Psychology, 73,* 93–105.

Scogin, F. R., Storandt, M., & Lott, C. L. (1985). The relationship of memory complaint to memory evaluation, affective status, and memory performance in older adults. *Journal of Gerontology, 40,* 562–568.

Shiffrin, R. M., & Schneider, W. (1977). Controlled and automatic human information processing: Perceptual learning, automatic attending and a general theory. *Psychological Review, 84,* 127–190.

Shupe, D. R. (1985). Perceived control, helplessness, and choice. In J. E. Birren & J. Livingston (Eds.), *Cognition, stress and aging* (pp. 174–197). Englewood Cliffs, NJ: Prentice-Hall.

Signoret, J. L., Whitely, A., & Lhermitte, F. (1978). Influence of choline on amnesia in early Alzheimer's disease. *Lancet, 2,* 837.

Sklar, M., & Edwards, A. (1962). Presbycusis: A factor analysis of hearing and psychological characteristics of men over 65 years old. *Journal of Auditory Research, 2,* 194–207.

Smith, A. D. (1980). Age differences in encoding, storage, and retrieval. In L. W. Poon, J. L. Fozard, L. S. Cermak, D. Arenberg, & L. W. Thompson (Eds.), *New directions in memory and aging: Proceedings of the George A. Talland Memorial Conference* (pp. 23–46). Hillsdale, NJ: Erlbaum.

Strack, S., Blaney, P. H., Ganellen, R. J., & Coyne, J. C. (1985). Pessimistic self-preoccupation, performance deficits, and depression. *Journal of Personality and Social Psychology, 49,* 1076–1085.

Stromgren, L. S. (1977). The influence of depression on memory. *Acta Psychiatria Scandinavica, 56,* 109–128.

Sullivan, E. V., Shedlack, K. J., Corkin, S., & Growdon, J. H. (1982). Physostigmine and lecithin in Alzheimer's disease. In S. Corkin, K. L. Davis, J. H. Growdon, E. Usdin, & R. J. Wurtman (Eds.), *Aging, Vol. 19: Alzheimer's disease: A report of progress* (pp. 361–367). New York: Raven Press.

Suls, J., & Mullen, B. (1982). From the cradle to the grave: Comparison and self-evaluation across the life-span. In J. Suls (Ed.), *Psychological perspectives on the self* (pp. 97–125). Hillsdale, NJ: Erlbaum.

Talland, G., Mendelson, J., & Ryach, P. (1964). Experimentally induced chronic intoxication and withdrawal in alcoholics. *Quarterly Journal of Studies on Alcohol (Supplement), 2,* 74–86.

Thal, L. J., Rosen, W., Sharpless, N. S., & Crystal, H. (1981). Choline chloride fails to improve cognition in Alzheimer's disease. *Neurobiology of Aging, 2,* 205–208.

Thomas, P., Hunt, W., Garry, P., Hood, R., Goodwin, J. M., & Goodwin, J. S. (1983). Hearing acuity in a health elderly population: Effects on emotional, cognitive, & social status. *Journal of Gerontology, 38*(3), 321–325.

Tibbitts, C. W. (1979). Can we invalidate negative stereotypes of aging? *The Gerontologist, 19,* 10–19.
Treat, N. J., Poon, L. W., Fozard, J. L., & Popkin, S. J. (1978). Toward applying cognitive skill training to memory problems. *Experimental Aging Research, 4,* 305–319.
Tulving, E. (1972). Episodic and semantic memory. In E. Tulving & W. Donaldson (Eds.), *Organization of memory* (pp. 381–403). New York: Academic Press.
U.S. Department of Health, Education and Welfare. (1974). *Preliminary findings of the first health and nutrition examination survey, United States 1971–1972: Dietary intake and biochemical findings.* (HRA 74-1219-1). Washington, DC: U.S. Government Printing Office.
Wallgren, H., & Barry, H. (1970). *Actions of alcoholism. Vol I: Biochemical, physiological and psychological aspects.* Amsterdam: Elsevier North-Holland.
Weinberg, R. S., Gould, D., & Jackson, A. (1979). Expectations and performance: An empirical test of Bandura's self-efficacy theory. *Journal of Sport Psychology, 1,* 320–331.
Weinberg, R. S., Yukelson, S., & Jackson, A. (1980). Effect of public and private efficacy expectations on competitive performance. *Journal of Sport Psychology, 2,* 340–349.
Weinert, F., & Perlmutter, M. (Eds.). (in press). *Memory development: Universal changes and individual differences.* Hillsdale, NJ: Erlbaum.
Weinstein, B., & Ventry, I. (1982). Hearing impairment and social isolation in the elderly. *Journal of Speech and Hearing Research, 25,* 593–599.
Weiss, A. (1959). Sensory functions. In J. Birren (Ed.), *Handbook of aging and the individual* (pp. 503–542). Chicago: University of Chicago Press.
Welford, A. T. (1984). Psychomotor performance. In C. Eisdorfer (Ed.), *Annual review of gerontology and geratrics,* Vol. 4 (pp. 237–273). New York: Springer Publishing Co.
West, R. L. (1986). *Memory fitness over 40.* Gainesville, FL: Triad.
West, R. W., Berry, J. M., & Powlishta, K. K. (1986). *Self-efficacy and performance on laboratory and everyday memory tasks.* Manuscript submitted for publication.
West, R. L., Boatwright, L. K., & Schleser, R. (1984). The link between memory performance, self-assessment, and affective status. *Experimental Aging Research, 10,* 197–200.
White, N., & Cunningham, W. R. (1984, November). *The relationships among memory complaint, memory performance, and depression in young and elderly adults.* Paper presented at the Gerontological Society of American meetings, San Antonio, TX.
Williams, S. A., Denney, N. W., & Schadler, M. (1983). Elderly adults' perception of their own cognitive development during the adult years. *International Journal of Aging and Human Development, 16,* 147–158.
Wine, J. (1971). Test anxiety and direction of attention. *Psychological Bulletin, 76,* 92–104.
Winograd, E., & Simon, E. W. (1980). Visual memory and imagery in the aged. In L. Poon, J. Fozard, L. Cermak, D. Gruneberg, & L. Thompson (Eds.), *New directions in memory and aging* (pp. 485–506). Hillsdale, NJ: Erlbaum.
Wiswell, R. A. (1980). Relaxation, exercise, and aging. In J. E. Birren & R. B. Sloane (Eds.), *Handbook of mental health and aging* (pp. 943–958). Englewood Cliffs, NJ: Prentice-Hall.

Wood, E. (1937). *Mind and memory training*. London: Sir Isaac Pitman & Sons.

Wurtman, R. J., & Zeisel, S. H. (1982). Brain choline: Its sources and effects on the synthesis and release of acetylcholine. In S. Corkin, K. L. Davis, J. H. Growden, E. Usdin, & R. J. Wurtman (Eds.), *Alzheimer's disease: A report of progress in research* (pp. 303–313). New York: Raven Press.

Yates, F. A. (1966). *The art of memory*. Middlesex, England: Penguin.

Yesavage, J. A. (1984). Relaxation and memory training in 39 elderly patients. *American Journal of Psychiatry, 141*(6), 778–781.

Yesavage, J. A. (1985). Nonpharmacologic treatments for memory losses with normal aging. *American Journal of Psychiatry, 142,* 600–605.

Yesavage, J. A., & Jacob, R. (1984). Effects of relaxation and mnemonics on memory, attention and anxiety in the elderly. *Experimental Aging Research, 10,* 211–214.

Yesavage, J. A., & Rose, T. L. (1983). Concentration and mnemonic training in elderly subjects with memory complaints: A study of combined therapy and order effects. *Psychiatry Research, 9*(2), 157–167.

Yesavage, J. A., Rose, T. L., & Spiegel, D. (1982). Relaxation training and memory improvement in elderly normals: Correlation of anxiety ratings and recall improvement. *Experimental Aging Research, 8,* 195–198.

Yoshimura, K., Nishibe, Y., Inoue, Y., Hirono, S., Toyoshima, K., & Minesita, T. (1976). Animal experiments in thiamine avitiminosis and cerebral function. *Journal of Nutritional Science and Vitaminology, 22,* 429–437.

Zarit, S. (1980). *Aging and mental disorders: Psychological approaches to assessment and treatment*. New York: Free Press.

Zarit, S. H. (1982). Affective correlates of self-reports about memory of older people. *International Journal of Behavioral Geriatrics, 1,* 25–34.

Zarit, S. H., Cole, K. D., & Guider, R. L. (1981). Memory training strategies and subjective complaints of memory in the aged. *The Gerontologist, 21,* 158–164.

Zarit, S. H., Gallagher, D., & Kramer, N. (1981). Memory training in the community aged: Effects on depression, memory complaint, and memory performance. *Educational Psychology, 6,* 11–27.

Zelinski, E. M., Gilewski, M. J., & Thompson, L. W. (1980). Do laboratory tests relate to self assessment of memory ability in the young and old? In L. W. Poon, J. L. Fozard, L. S. Cemak, D. Arenberg, & L. W. Thompson (Eds.), *New directions in memory and aging* (pp. 519–544). Hillsdale, NJ: Erlbaum.

CHAPTER 4

# Reading Comprehension and Aging

BONNIE J. F. MEYER
UNIVERSITY OF WASHINGTON
SEATTLE, WASHINGTON

Interest in reading comprehension and aging has increased substantially within the last decade. Examining age differences in understanding and remembering texts provides a way to study memory with materials encountered across the life span (Hartley, Harker, & Walsh, 1980). Although age-related deficits are well documented with verbatim recall of lists of words, numbers, and such (Burke & Light, 1981), they are not always found with substantive recall of texts. Certain types of older adults under certain task conditions with certain types of text can remember as much information as can younger adults (Hultsch & Dixon, 1984; Meyer & Rice, 1983b, 1986). However, under the majority of reader, task, and text conditions tested so far in the laboratory, age differences in prose processing have been found.

A number of reviews have been written recently about this growing body of literature on prose processing and aging (Cohen, in press; Hartley, 1986a; Hartley et al., 1980; Hultsch & Dixon, 1984; Meyer & Rice, 1983b, 1986). Cohen (in press) has emphasized an age-related reduction in processing capacity, rather than faulty strategies, as the cause of age-related declines in memory from texts. Hartley (1986a) has stressed traits of older readers. The reviews by Hultsch and Dixon (1984) and Meyer and Rice (1983b, 1986) have sought to identify the sources of discrepancies among extant studies by examining interacting characteristics of the learner, task, and text.

This review also will examine reading comprehension and aging through an interactional scheme of reader, task, and text variables. At this stage of knowledge and theory building, it is productive to set out the conditions under which age deficits can and cannot be expected in memory from text.

As investigators study more naturalistic tasks involving reading comprehension, such as longer texts with unlimited study time and a verbal summarization criterion task, age deficits may be less prevalent for those older adults who

Supported in part by Grant AGO3438 from the National Institute on Aging.

possess adequate processing capability and effective strategies (Craik & Rabinowitz, 1984). However, learning short texts quickly will probably continue to show the superiority of the young. As Schaie (1977–1978) pointed out, youth is the time for acquiring information regardless of its relevance. Increasing age has been associated frequently with reflection, wisdom, and instructing youth, rather than with rapid knowledge acquisition. However, with increased technological changes, older adults may be required to acquire large amounts of new information. Thus, it will be valuable to find the reader, task, and text conditions for optimal learning and memory by older adults.

## READER VARIABLES

Some of the differences among extant studies on reading comprehension and aging can be explained by differences in education, verbal ability, age level, and prior knowledge of sample participants. These characteristics of readers will be examined in this section.

### Education and Vocabulary Level of Study Participants

Age differences in memory performance with prose materials may be present or absent depending on how the investigator equates the age groups on education and verbal ability (Meyer & Rice, 1983b). Most recent studies with text materials have reported the education level and verbal ability of the adults, but a few have not reported vocabulary scores (Petros, Tabor, Cooney, & Chabot, 1983; Smith, Rebok, Smith, Hall, & Alvin, 1983; Zelinski, Gilewski, & Thompson, 1980). Both the Petros et al. and the Zelinski et al. studies showed age effects, whereas the Smith et al. study showed no main effect for age. Meyer and Rice (1983b) showed that samples of young and old adults equivalent in education (16 years) could be mismatched in terms of verbal ability. Samples equivalent in education and verbal ability showed age deficits on some measures of prose recall, whereas no age deficits were found for samples where old adults scored considerably higher on vocabulary tests than did young adults with the same amount of education. Thus, both education and verbal ability should be reported routinely.

Obtaining equivalent cross-sectional samples on verbal ability is quite complex. First, vocabulary test scores improve with age, particularly from the ages of 18 to 25 but also in the 50s and 60s, with some decline in the 80s (Botwinick, 1978). Thus, if a young group of college freshmen is selected to match the vocabulary performance of an older group, then the old group may be compared to a group of young adults with superior verbal aptitude, although current performance is equivalent. Another concern is the decline in standardized test scores of the young. It is possible that verbal aptitude, particularly those traits necessary for reading comprehension, may be equivalent for an undergraduate young group and alumni old group with unequal vocabulary scores.

In a study (Hartley, 1986b) with college undergraduates (average education, 13.9 years) in the young adult group and primarily college graduates (average education, 16 years) in the old group, older adults were superior on a vocabulary test, but young adults were superior on standardized tests of reading comprehension and abstract reasoning. Meyer, Young, and Bartlett (1986) reported the same pattern with vocabulary and reading comprehension tests.

The final concern relates to what test the experimenter selects with which to measure. A variety of vocabulary tests have been employed; little is known about how they compare in samples of young and older adults.

Age differences in text recall have been reported to interact with level of verbal ability (Meyer & Rice, 1983b; Poon, Krauss, & Bowles, 1984; Taub, 1979). Meyer and Rice (1983b) presented an analysis of four subsamples selected from a group of 314 younger and older adults, all of whom had read and recalled two expository texts. The subsamples were formed on the basis of their vocabulary scores on the Quick Word Test. These data suggested rather clearly that there are age-related deficits in memory performance for adults with average or below-average abilities and little post-high-school education. The situation is not as clear for individuals with above-average verbal ability and college education. Old adults with high vocabulary scores performed as well as a random sample of college-educated young adults; these young adults had the same education level but lower vocabulary scores. However, moderate age differences in recall were observed when the highest scorers on the vocabulary test from both the young and old groups were compared. Thus, age differences in memory performance may be present or absent depending on how the investigator equates the age groups on education and verbal ability.

Most of the extant studies on text comprehension and aging where aging deficits have not been found involved subjects with some college education [Harker, Hartley, & Walsh, 1982; Mandel & Johnson, 1984; Meyer & Rice, 1981; Simon, Dixon, Nowak, & Hultsch, 1982 (intentional learning condition); Smith et al., 1983; Taub, 1979; Young, 1983]; all but the Smith et al. study, where vocabulary was not reported, indicate at least a slight superiority by the old adults for either years of education or vocabulary scores. The one exception is a study by Thompson and Diefenderfer (1986); the older adults in this study averaged 11 years of education, whereas young adults averaged 15 years. In this study a very long text (1,600 words) was read by a group who also read an advanced organizer for the passage and a group allotted extra time to read the passage. The dependent measure was a recognition test. The effects of age and presence of the advanced organizer were nonsignificant. Divergence between the Thompson and Diefenderfer study and the many other studies of old adults with no more than high school education, where age deficits have consistently been found, may be due to the recognition test or the passage length. Several studies with nonsignificant age effects have used longer texts.

Rice and Meyer (1986) conducted an exploratory multivariate analysis designed to ascertain the relative contributions of age, verbal ability, education, reading habits, and recall strategies to the variation in performance on prose-recall tasks among 422 adults from young, middle, and old age groups. Results showed a decrease in the amount of information remembered with increasing age ($r = -.24$), but verbal ability ($r = .37$) was a better predictor than age. Multiple regression analyses were performed to clarify the relative contributions of different reader variables for predicting prose recall. Vocabulary explained about 19% of the variance, followed by age (12%), a paragraph-by-paragraph recall strategy (5%), a detail-encoding strategy (4%), a main-idea-encoding strategy (1%), and the text variable of signaling (1%). The reading habits factors made no significant contributions. These proportions of variance in total recall accounted for by age and vocabulary are very similar to those found by Glynn, Okun, Muth, and Britton (1983) with 108 adults ranging in age from 18 to 56 years. In contrast, a similar study by Hartley (1986b) found vocabulary scores to be only weakly related to recall. The strongest predictor in this study was time spent reading (accounting for 18% of the variance); the young adults tended to spend more time reading short (246–286 word) texts. Age accounted for 9% of the variance in recall performance. The strength of the reading time predictor suggests that some of the disadvantage for the old adults may relate to faulty strategies and unfamiliarity with the task demands. Meyer, Young, and Bartlett (1986) have shown that teaching older adults an effective prose-learning strategy, along with giving them practice at the prose-recall task, dramatically increased their performance. Simply giving them experience with the recall task significantly increased their performance, but not to the magnitude of those also learning the strategy. The training had the same beneficial effects for young adults.

Hultsch, Hertzog, and Dixon (1984) related text performance by young, middle-aged, and old adults to a set of intellectual ability factors (Ekstrom, French, Harman, & Derman, 1976). The ability with the largest overall relationship with text memory was general intelligence. Regression analyses indicated that age differences in text-recall performance were reduced drastically, but not eliminated, when partialed for intellectual ability (a drop from between 20% and 30% to between 3% and 4%). An age-by-verbal-comprehension interaction was not found, but an interaction was found between age and verbal productive thinking (as well as for associative memory).

Both sample selection and type of vocabulary test will be considered in an attempt to reconcile the findings of the studies of Hultsch et al. (1984) and Meyer and Rice (1983b). The sample of 150 young, middle-aged, and old adults in the Hultsch et al. study varied significantly on education (young, 14 years; middle-aged, 13 years; old, 11 years). Hultsch et al. pointed out that these differences match the average years of education for these age groups reported by the U.S.

Census Bureau in 1977. The subjects in their study were white female adults from a small city in central Pennsylvania; Meyer and Rice (1983b) have worked with volunteers from Phoenix, Arizona, an area that attracts healthy, mobile, and relatively wealthy older adults. Their high-verbal old adults had an average of 16.1 years of education, whereas their lower-verbal old adults had an average of 12.5 years of education.

Also, Meyer and Rice (1983b) utilized the Quick Word Test (Borgatta & Corsini, 1964) to measure vocabulary. Adults who score at the 25th percentile on the Quick score at the 75th percentile on the Vocabulary Subtest of the WAIS. The high-verbal old adults scored at the 93rd percentile on the Quick and hit the ceiling of the WAIS. The Quick is a tricky 100-item, multiple-choice test (i.e., heart = beat, draw, core, or vein; shoot = bang, push, twig, or jump) that appears to require considerable associative memory and verbal productive thinking. Therefore, the results of Hultsch et al. (1984) that these factors relate to prose recall more than to verbal comprehension may not be contrary to the findings of Meyer and Rice but may only reflect differences in tests used. Differences in the construction of vocabulary tests may also explain the discrepancy in the contribution attributed to vocabulary for predicting recall performance found by Rice and Meyer (1986) and by Glynn et al. (1983), who used the Quick, versus Hartley (1986b), who used the Shipley-Hartford Scale (Shipley, 1940).

In conclusion, some incompatibility among the findings from studies on prose learning and aging can be explained by differences in education and verbal ability of samples. Age deficits in prose recall are regularly found for average- and low-verbal adults with mainly high school education (Cohen, 1979; Dixon & von Eye, 1984; Dixon, Hultsch, Simon, & von Eye, 1984; Dixon et al., 1982; Glynn et al., 1983; Meyer & Rice, 1983a, b; Spilich, 1983; Spilich & Voss, 1982; Surber, Kowalski, & Pena-Paez, 1984; Taub, 1979; Zelinski, Light, & Gilewski, 1984). However, all of the discrepancy cannot be explained because some studies with highly educated, high-ability old adults report aging deficits (Cohen, 1979; Gordon & Clark, 1974; Light & Anderson, 1985; Meyer & Rice, 1983a; Zelinski et al., 1984), whereas others do not (Harker et al., 1982; Mandel & Johnson, 1984; Meyer & Rice, 1981, 1983b; Young, 1983). In general, age differences appear to be attenuated when subjects possess superior levels of semantic abilities.

In an attempt to determine factors underlying verbal ability that affect reading comprehension, Rice and Meyer (1985) examined the reading behaviors of young and older adults of high and average verbal ability. Answers to questionnaires indicated that certain reading behaviors are related to success on prose-learning tasks for both young and old adults, and old adults with average vocabulary scores report the lowest incidence of these behaviors. These data are compatible with a practice explanation; that is, older adults with high verbal skills perform as well as young adults on some prose-recall tasks because they practice the necessary reading skills, whereas those with average verbal skills do not keep in practice.

Previous research indicates that one of these important reading skills is the ability to use the "structure strategy" (Meyer, Brandt, & Bluth, 1980), in which the reader identifies and uses the text's organizational plan for a passage to guide comprehension and recall. The training program conducted by Meyer, Young, and Bartlett (1986) taught the structure strategy to older adults deficient in this strategy (primarily adults average in verbal ability). Use of the strategy and recall rose dramatically. Improvement in recall was also found for groups receiving practice only through participating in the pretest or the pretest plus practice reading the same materials as the strategy group but without instruction on the strategy. These groups did not improve as much as the strategy group.

The above studies support the contention that some age deficits result from ineffective strategies and lack of familiarity with the prose-recall task. These ineffective strategies could result from cohort differences; the reading behavior of average-verbal adults is probably determined more by schooling practices than that of higher-scoring adults, who probably pick up the structure strategy without instruction. Alternatively, the ineffective strategies could result from disuse of the structure strategy and subsequent loss of brain circuitry (Cotman & Holets, 1985), which could be regenerated with training. As suggested by Cohen (in press), ineffective strategies could result from reduced cognitive capacity with aging; however, this explanation seems less plausible because an effective strategy could be readily learned over a short time interval (five 90-min sessions).

## Age Level of Study Participants

Studies vary on the ages of subjects identified as young and old. These differences may contribute to the contradictory findings. The average age for most young groups is the 20s; the average age for most old comparison groups is the 60s. The few studies whose average age groups fall outside these ranges have reported large age deficits, as seen in Table 4–1. Substantial differences in prose recall are seen when the extreme age groups are compared. These differences may reflect age-related changes in cognitive processes involved in reading comprehension as well as cohort differences. Currently, we cannot specifically determine the unique contribution of age to differences in memory for prose.

Several studies have looked for declines with age within the 61+ age range. Rice and Meyer (1983a) found no relationship between total recall and age for 159 adults between the ages of 61 and 80. Hartley (1986a) found a significant correlation (.36) between age and recall for 44 adults between the ages of 61 and 90. She reported nonsignificant correlations for two studies with the age range covering the early 60s to the late 70s. Age-related decline may not occur until the 80s, the range where vocabulary scores also begin to decline (Botwinick, 1978).

TABLE 4–1
**Samples of Studies with Young or Old Adults Who Fall Outside the More Typical Young (20s) and Old (60s) Age Ranges.**

| | Average Age of Samples | |
|---|---|---|
| Study | Young | Old |
| Spilich (1983) | 21 | 81 |
| Spilich & Voss (1982) | 19 | 76 & 81 |
| Zelinski, Light, & Gilewski (1984) | 17 | 71 |

## Prior Knowledge of Readers

Hartley (1986a) reported moderate but significant correlations between the prior knowledge of adults and how well they recalled texts on those topics. Prior knowledge of a topic facilitated recall for young, middle-aged, old, and old-old groups.

Hultsch and Dixon (1983) systematically investigated prior knowledge and age effects on prose learning. Average-verbal, high-school-educated adults from three age groups read short biographical sketches about famous entertainment figures of various eras. The findings suggested that age differences in recall performance may be present or absent depending on the level of pre-experimental knowledge about the topic possessed by the various age groups.

Older adults appear to be especially likely to intrude bits of prior knowledge into their recall of new information (Hultsch & Dixon, 1983). Smith et al. (1983) found that the number of distortions and additions from adults' prior knowledge was a function of an age-by-text-organization interaction. Young adults added prior knowledge to make the unorganized stories more coherent; old adults added prior knowledge to make well-organized stories more interesting. Also, Surber et al. (1984) found young adults to make more theme-related intrusions in their recall of a long expository text than did old adults. These findings suggest that differences between age groups in prose recall could result from differences in perspective or purpose related to the social and intellectual contexts of each age group. No aging studies with prose learning systematically investigate these variables, but the variables may contribute to some of the confusion in the literature.

# TASK VARIABLES

There are variations among studies in the way the texts were presented and the types of dependent measures collected. These variations must be considered in integrating results about reading comprehension and aging from different studies. This section discusses differences among studies in terms of the mode and rate of presentation of the text, instructions, and types of dependent measures.

## Presentation Mode and Rate

Investigations of presentation by listening versus reading have found that performance is similar after both listening and reading when reading time is equal to listening time (Sticht & James, 1984). However, when reading is self-paced, then recall after reading is superior (Stine, Wingfield, & Poon, 1986; Taub & Kline, 1978).

A study by Dixon et al. (1982) examined the effects of input modality on the immediate and delayed recall of short newspaper articles by average-verbal, high-school-educated adults. Young and middle-aged adults were found to benefit more from the opportunity to read material than were older adults. These findings were explained as a result of older adults taking less advantage of the opportunity to review material during reading than did younger adults. Taub and Kline's study (1978) is compatible with this explanation that old adults benefit less from an opportunity for review.

In both the Dixon et al. (1982) study and the Taub and Kline (1978) study, the adults were average in verbal ability and primarily high-school-educated. In comparing high-verbal and average-verbal old adults (Meyer, 1984; Rice & Meyer, 1985), average-verbal old adults appear deficient in their use of text structure, recall of logical relationships in text, and ability to find and underline the important ideas in a text. Average-verbal old adults may be unable to take advantage of opportunities to review because of ineffective strategies for finding and utilizing the organization in text. Studies sampling high-verbal adults may not find these age deficits in utilization of review opportunities because these readers are more practiced and more analytical than their average-vocabulary counterparts.

In a study with high-verbal, college-educated adults, Cohen (1981) reported that memory for spoken information was more impaired for old adults than memory for written information. She stated that old adults performed better when they read than when they listened, whereas young adults showed no differences between input modes. Also, Cohen (1979) found age deficits in free recall for old adults when listening to a short passage at 120 wpm. However, at this presentation rate and at 200 wpm for one-paragraph descriptions, Cohen (1979) did not find age effects on verbatim questions. Presentation rate had no effect for old adults for verbatim questions but impaired their performance on inference questions. Rate had no effect on either type of question for young adults.

Stine and associates (1986) reported age-related deficits in recall of speech to be larger at a faster rate; time-compressed speech was used to vary rates of presentation from 200 to 400 wpm. These investigators also had learners stop speech input as often as necessary in order to recall it perfectly. Older adults stopped the speech after fewer words than did young adults. These findings suggest a slowing in the ability to process verbal information.

Slowing in processing ability also is evident with discourse. Six of the extant prose-learning studies controlled presentation time. Only one of these studies (Mandel & Johnson, 1984) did not report age deficits, and this study had the slowest presentation time (102 wpm); the rates of the other studies were 120 wpm or faster. Four (Cohen, 1979; Mandel & Johnson, 1984; Meyer & Rice, 1983a; Petros et al., 1983) presented texts orally without visual exposure. Zelinski et al. (1984) had their subjects read the text while it was being read to them at a fast pace. Surber et al. (1984) allowed their subjects 11 min, 30 s to read a five-and-a-half-page text. Petros et al. expected an age-by-rate (120 wpm vs. 160 wpm) interaction but did not find it. Rate impaired the recall performance to an equivalent degree for young and old subjects. The speed between 102 wpm and 120 wpm appears critical for exceeding an optimal level of processing by old adults. Meyer and Rice (1986) reported the reading time data from a study with 160 high- and average-verbal old and young adults; the average reading speed of old adults was 121 wpm, while it was 144 wpm for young adults. A pace of 120 wpm is too quick for about half of the old adults, whereas it is well within the optimal range for nearly all young adults. However, other researchers using shorter texts (Hartley, 1986b; Light & Anderson, 1985) have reported nonsignificant differences in the reading times of young and old adults.

The extant studies with long texts and a self-paced presentation have reported no age-related deficits (Harker et al., 1982; Meyer & Rice, 1981; Meyer, Young, & Bartlett, 1986; Thompson & Diefenderfer, 1986). Surber et al. (1984) and Zelinski et al. (1984) also used long texts and found aging deficits, but they limited reading time to 136 wpm (Surber et al.) and 155 wpm (Zelinski et al.). Longer articles may call for reading skills more frequently used in the lives of older adults.

One explanation for greater age deficits for faster-paced presentations than for slower- or self-paced presentations focuses on slowing with aging (Birren, 1974). Older adults are thought to be disadvantaged primarily in terms of the speed with which they can carry out mental operations such as encoding, comparison, and response selection and execution (Birren, Woods, & Williams, 1980). Another explanation emphasizes a reduction in working memory capacity with increasing age (Cohen, 1979, in press; Petros et al., 1983; Spilich, 1983). Self-paced conditions should help to reinstate information lost from working memory and serve as a memory aid to compensate for any lost capacity. As discussed above, some sophistication in reading skills may be necessary before older adults can compensate through rereading and review.

## Instructions and Types of Dependent Variables

Early studies (e.g., Schneider, Gritz, & Jarvik, 1975) employed verbatim recall and consistently reported age deficits; however, adults rarely need to memorize prose in their everyday activities.

More recent studies have employed standard prose-learning instructions; subjects are asked to attend to the passage as they would normally do to a magazine article they want to remember, and then they are asked to recall it in their own words or words from the passage. Few studies (Simon et al., 1982; Surber et al., 1984) have compared different types of instructions to subjects. Simon et al. (1982) found age deficits on incidental tasks but no age differences with intentional, standard prose-learning instructions. Surber et al. (1984) found no differences between two types of reading instructions.

Free recall of text or even answering questions about one specific text may not reflect ordinary activities of most people. These activities are no doubt closer to activities of students than to those of most adults. In studying the memory of middle-aged and older adults, assessing memory through conversation or oral recall would be more ecologically valid than written free recall. Oral recall appears to be more naturalistic than written recall, but Harker et al. (1982) found no difference between these two response modes in terms of propositions recalled, although written recall was more concise. Investigations of reading comprehension and aging should explore additional types of instructions and dependent measures that examine a reader's ability to use the information in the text to solve a problem (e.g., Mayer, 1985), assemble an object (e.g., Stone & Glock, 1981), or learn a new skill (Hartley, Hartley, & Johnson, 1984).

On many of the other task variables, such as recall versus recognition and immediate recall versus delayed recall, conflicting results appear concerning the relative number of age deficits (Hultsch & Dixon, 1984). Some studies have found equivalent age deficits for both recall and recognition (Gordon & Clark, 1974; Spilich, 1983); others have found age differences for recall but not for recognition (Spilich & Voss, 1982); still others have found no age deficits for recall and questions or recognition (Labouvie-Vief, Schell, & Weaverdyck, 1981; Meyer & Rice, 1981; Thompson & Diefenderfer, 1986). In addition, in terms of delay interval some studies found greater aging deficits immediately (Dixon et al., 1982; Hultsch & Dixon, 1983); others found greater deficits one or more weeks after presentation of texts (Gordon & Clark, 1974; Hultsch et al., 1984).

# TEXT VARIABLES

In order to clarify the literature on reading comprehension and aging it is important to understand variables in texts that affect learning and memory. Some of the inconsistencies in the research can be clarified by specifying differences among texts employed in the research and methods used to measure memory from texts. This section will discuss methods used to examine recall from texts, the top-level organization of texts and its use by readers, readers' evaluation of important text information, and the differential recall of main ideas and details in texts by readers.

## Methods Used to Examine Prose Recall

Most experiments examining reading and aging have used the prose-analysis systems of Kintsch (1974) or Meyer (1975).* Two (Mandel & Johnson, 1984; Smith et al., 1983) have used systems based on the story grammar of Mandler and Johnson (1977); both studies found no age deficits for well-organized, multiepisode stories with similar subjects under similar task conditions. Two other studies (Petros et al., 1983; Surber et al., 1984) used a procedure developed by Johnson (1970) that empirically, rather than linguistically, determines structural importance by having groups of subjects delete different amounts of unimportant text. Both studies reported age deficits.

Although different methods correspond with different findings for the above studies, an examination of most of the prose-learning studies points out that different analysis systems cannot explain the discrepant findings. More specifically, the Kintsch system was used by Dixon et al. (1983) and by Harker et al. (1982). The study by Dixon et al. reported that old adults remembered considerably less from expository text than did young adults. However, the Harker et al. study with expository text found no age differences in the amount of information remembered by young and old adults. The Meyer system has been utilized by Meyer and Rice (1981) and by Zelinski et al. (1980, 1984). Meyer and Rice found no significant age differences, but Zelinski et al. reported age differences.

Age differences may reach statistical significance more easily using the Kintsch system, where partial credit is not given. Smith et al. (1983) found age differences with strict scoring that required recall of every idea in a complex sentence for credit in recalling that sentence but found no age differences with more lenient scoring. Differences between old and younger adults in types of ideas recalled can be more sensitively measured with the Meyer system, where parts of a proposition can be scored separately. That is, instead of simply finding a deficiency in recall of propositions, the types of relationships and content present and absent in the recall can be specified. In addition, the underlying logic processed by learners from text can be examined.

*See Meyer (1983, 1985) for detailed descriptions of text structure and comparisons of the strengths and weaknesses of various prose-analysis procedures.

Dixon, Hultsch, and Hertzog (1986) have recently developed 25 similar narratives. In addition, three sets of three structurally equivalent expository texts were used in the Meyer et al. study (1986). These narrative and expository texts could provide a common pool of passages to use in future studies. Such pooling may reduce some of the confusion in the literature. However, as noted in the next sections, text variables can interact with age effects. Therefore, a variety of texts will require systematic investigation.

## Use of the Text's Top-Level Organization

In the Meyer analysis system (Meyer, 1975, 1985) all of the information from a text is represented in a detailed outline or tree structure called the content structure. The content structure shows the text's top-level organization and the interrelationships among its ideas and their relative importance.

Drawing on rhetoric and linguistics, Meyer (1985; Meyer & Freedle, 1984) has gathered evidence for at least five basic ways to organize discourse: collection, description, causation, problem/solution, and comparison. The collection structure is a list of elements associated in some manner, such as ordering in time in the case of a sequence (e.g., history texts). The description structure gives more information about a topic by presenting an attribute, specification, or setting (e.g., newspaper articles telling who, where, how, and when). The causation organization presents causal relationships as in the "if/then" antecedent/consequent statements in logic (e.g., directions, explanations). The problem/solution structure has all of the organizational components of causation with the addition of overlapping content between the problem and solution where the solution blocks a cause of the problem (e.g., scientific articles). In contrast, the comparison discourse type does not organize on the basis of time or causality but on the basis of similarities and differences (e.g., political speeches).

Several investigations have probed how these five top-level structures affect reading comprehension. In one study (Meyer et al., 1980) ninth-graders who used the author's top-level structure to organize their recall remembered more, even a week later, than those who did not. Ninth-graders who were evaluated by reading comprehension tests and by their teachers as good readers used the text's top-level structure to organize their recalls, whereas those evaluated as poor readers did not. In a study (Meyer, 1983) with average-verbal old adults (48th percentile) the best predictor of their recall from texts was whether or not they used the text's top-level structure to organize their recall protocols. These findings indicate that the ability to identify and utilize the author's top-level organization is a crucial skill in reading comprehension for older adults. Another interesting finding was an age-and-structure interaction when high-school-educated old adults were compared to ninth-graders of average vocabulary performance. For both groups, use of the top-level structure greatly facilitated recall. However, ability to utilize the author's top-level structure was even more crucial to recall for the older group (34% recall when the structure was used and 13.5% when not used, versus 28% recall when the structure was used and 15% when it was not used for the ninth-graders). For both the older subjects and the ninth-graders, when the text's structure was not used, the subjects tended simply to list sentences they remembered from the passage with no attempt to interrelate the sentences.

In contrast with the finding with average-verbal adults, a study with higher-verbal Arizona State University alumni from young, middle-aged, and old age groups found no age-related differences in use of top-level structure; nearly all of the adults from each age group used the same top-level structure as that used in the text to organize their recall (Meyer, Rice, Knight, & Jessen, 1979). Other studies (Meyer & Rice, 1986; Rice & Meyer, 1985) looked at age and verbal ability and found that high-verbal adults from all age groups used the text's top-level structure more often than did average verbal adults. More significantly, age interacted with verbal ability. Old and young high-verbal adults did not differ in their use of the text's top-level structure, but average-verbal young adults used the text's top-level structure more than did average-verbal old adults.

An intervention program (Meyer et al., 1986) with young and old adults deficient in their use of text structure has been conducted recently to see if older adults could improve their ability to find and use the top-level structure in magazine and newspaper articles. Findings from this study have shown that older adults can learn this strategy aimed at utilizing the structure in text and achieve substantial increases in the amount of information remembered.

Another way to study text structure has been to see if one discourse type is more memorable than another. Meyer and Rice (1983a) looked to see if older adults perform better after listening to passages organized with a comparison top-level structure than with a collection of descriptions. Meyer and Freedle (1984) found that graduate students remember more facts about such topics as dehydration if two views about the topic are compared rather than simply describing three paragraphs of attributes about the topic. In the Meyer and Rice (1983a) study young, middle-aged, and old adults with above-average scores on the WAIS vocabulary test listened to passages on two topics organized either as a comparison or as a collection of descriptions. Main effects of discourse type and age were statistically significant. The comparative structure yielded superior performance on recall of the identical information for all three age groups. In contrast, adults with average scores on the Vocabulary Subtest of the WAIS do not show facilitation in recall from the comparative structure (Vincent, 1985). This lack of effect from discourse type held for young, middle-aged, and old adults with these lower scores on the WAIS. Thus, lack of facilitation by the comparison structure was related to verbal ability but not to age.

### Identification of Important Ideas by Readers

In addition to looking at the top-level structure of the text and its recall, as discussed above, another method for investigating age differences in sensitivity to the hierarchical structure of text has been to ask subjects to rate the information in text according to its importance. Using this method, Mandel and Johnson (1984) and Petros et al. (1983) had subjects judge the importance of ideas in stories. Both found that young and old adults did not vary in rating the importance of information. Petros et al. also examined their data in terms of the education level of the adults (high = mean of 18 years, versus low = 12 years); no differences were found in rating the importance of ideas in a Japanese folk tale from the fifth-grade level. These findings for the high- and low-education groups of old adults are contrary to findings reported by Meyer (1984). Adults higher in education ($M$ = 17 years) judged information high in the structure of an expository text from the high school level as more important than did adults with less education ($M$ = 12 years).

Meyer and colleagues (1986) asked young and old adults deficient in use of the structure strategy to underline the ten most important ideas in texts before and after instruction in using this strategy. There were no significant age effects, but instruction interacted with pretest versus posttest performance. Adults who received instruction with the strategy increased their underlining of high-level information, whereas those without the instruction or with instruction practicing reading without the strategy decreased in underlining these main ideas.

Old adults with some college education appear to be as sensitive to the organizational structure in the text as young adults. The studies taken together suggest that the type of text (exposition or narrative), the ability or education level of the older adult, the difficulty of the text, and the nature of the rating task need to be considered in evaluating age-related differences in the sensitivity to text structure. The underlining task and the deficit for average-verbal old adults in using the top-level structure reported above suggest that this group of old adults may be deficient in their sensitivity to text structure with expository text adapted from magazine articles. However, they can be successfully trained to increase their awareness of text structure (Meyer et al., 1986).

### Differential Recall of Main Ideas and Details

Most studies examining age differences in sensitivity to text structure have examined the levels effect. The levels effect, in which information high in the hierarchical structure of a passage is better recalled than information low in the structure, is taken as evidence that the reader is sensitive to the relative importance of the ideas in a passage as it is organized by the author. Research has consistently shown the levels effect (e.g., Mandler & Johnson, 1977; Meyer, 1975). Numerous recent studies have looked for age differences in sensitivity to prose structure by examining the levels effect for each age group. These studies do not present consistent findings with respect to older adults' use of text structure; they will be reviewed in this section, and an attempt will be made to understand the reasons for these inconsistent results.

Mandel and Johnson (1984) presented clearly organized stories slowly and auditorially to adults who were above average in verbal ability and education, and they found no deficits in total recall nor in the levels effect for older adults. Meyer and Rice (1981) had the same type of subject read a lengthy expository text without many explicit organizational cues; they also found no deficits in total recall. However, the age-by-level interaction narrowly missed significance. Post-hoc multiple comparison tests showed that the young group's recall of high-level information was significantly greater than their recall of medium- and low-level information, but the levels effect, although in the usual pattern, did not reach significance for middle-aged and old subjects. With respect to answers to questions, the old and middle-aged groups were able to correctly answer significantly more detail questions than were the young group. There were no differences in questions about main ideas. All age groups remembered the main ideas equally well, but young adults recalled more of the logic and major details that supported these main ideas; the older groups recalled more of the minor details at the lowest levels of the content structure.

In a study with 300 young, middle-aged, and old adults with high or average verbal ability, subjects assigned to different conditions read different versions of two expository texts (Meyer & Rice, 1983b, 1986). In some conditions the top-level structure, hierarchical structure, and major logical relations were emphasized; in other conditions the structure was de-emphasized and the details were emphasized. An interesting interaction among the emphasis plans, level in the content structure, age, and verbal ability appeared consistently over tasks and times. This interaction resulted from little or no levels effects for the average-verbal young adults and the high-verbal old adults under conditions that de-emphasized the structure and emphasized the details, in comparison to the other groups where larger levels effects were found. In addition, the group of high-verbal old adults showed the greatest changes in the type of information remembered in response to different emphasis conditions. For this group of subjects a 19% difference was found in the recall of high- and low-level information with structure emphasized, whereas only a 1% difference was found between the two levels without emphasis of the structure. It is interesting to see, in light of the results of Meyer and Rice (1981), that the only age comparison not showing age deficits for old adults was recall of details by high-verbal adults under emphasis conditions focused on details and away from structure.

Evidently, high-verbal old adults can be highly sensitive to the levels in the organization of prose. However, their display of the levels effect is dependent on how clearly the structure of the text is emphasized and signaled. When this structure is not explicitly signaled and emphasis is placed on specific details, the older adults focus on these details and are either drawn away from the main ideas and logical relationships or are unable to identify these logical relationships without explicit cues (Cohen, 1979).

Further analyses (Meyer & Rice, 1986) showed that the high-verbal old adults were the only group that improved their recall of details (9%) when details were emphasized in the text (e.g., "notable" year of 1840). Young and old adults of high verbal ability were equivalent in their recall of details when they were emphasized. When they were not emphasized, the old adults' recall of them fell, but the emphasis manipulation did not affect the young adults. The passage used by Meyer and Rice (1981) contains little signaling and many dates, names, and numbers, and it is not highly organized; it is similar to the manipulations in the Meyer and Rice (1986) study involving no signaling of structure and specific details. Thus, the findings of Meyer and Rice (1981) appear to be limited to high-verbal old adults with passages that contain historical dates, names, and other details where the structure is not explicitly signaled.

The question remains whether the minimal levels effect exhibited by high-verbal older adults on passages without signaling and with emphasized details results from processing the details at the expense of the main ideas or simply from an inability to comprehend the logical relationships among the main ideas when they are not explicitly signaled. Research exists on both sides of the latter issue; some studies show age deficits in making inferences (Cohen, 1979, 1981), and others do not (Belmore, 1981). Light and Anderson (1985) found that old adults could make inferences to correctly match pronouns to their referent if they could remember the sentence with the referent. However, they had more trouble remembering these sentences than did young adults as the distance between the pronoun and the referent sentence increased.

Meyer and Rice (1986) systematically manipulated signaling of logical structure, signaling of details, and the specificity of details in order to answer this question. The detail manipulation involved substituting general details, such as "early last century," for specific details, such as "1829." The magnitude of the levels effects was examined for high-verbal old adults to see if they process details at the expense of logical relations and main ideas, thereby reducing the levels effect, or if instead they cannot figure out logical relations without signaling, thereby decreasing their recall of main ideas and the magnitude of the levels effect. The data supported the first explanation; the free recall data for both free and particularly the cued conditions for logical relations indicated that high-verbal older adults can identify and store these relationships when they are not explicitly signaled. When specific details are present and text structure is not emphasized, high-verbal old adults appear to process details at the expense of logical relationships and main ideas. The greater effects of these emphasis conditions on high-verbal old adults over high-verbal young adults may result from reduced cognitive capacity with aging (Cohen, in press; Light, Zelinski, &

Moore, 1982) where the effort of processing details reduces that available for main ideas.

The studies reviewed above (Mandel & Johnson, 1984; Meyer & Rice, 1981, 1986) indicate that when text is clearly organized, with emphasis on structure and main ideas, young, middle-aged, and old adults are sensitive to text structure. Average-verbal old adults do not show the facilitative effects of signaling for either free or cued recall of logical relations as do the other groups of adults (Meyer, 1983; Meyer & Rice, 1986). This taken with their deficient use of top-level structure suggests that although they show a levels effect they are deficient in some aspects of their utilization of text structure. In contrast to average-verbal old adults, high-verbal old adults are very sensitive to the emphasis plans of an author: when specific details in a passage are emphasized over the structure, these older adults appear to use their resources to process the details at the expense of fully processing the main ideas and logical relations. Therefore, the disparate findings with respect to the levels effect for these three studies can be reconciled by examining the clarity of organization and emphasis of the prose and the verbal ability of the learners.

Hultsch and Dixon (1984) argue that their recent study (Dixon et al., 1984), as well as the literature, supports the claim that age differences in use of organization in text depend on the verbal ability of the subjects. Specifically, they state that high-verbal college graduates show greater age deficits for details (low-level information), and lower-verbal high school graduates show greater deficits for main ideas. The Dixon et al. (1984) study asked 108 young (ages 20–39), middle-aged (40–57), and old (60–84) adults to read six short (98-word) passages about health and nutrition at their own pace. Young and middle-aged adults recalled more information than did old adults. They reported an interaction for age by verbal ability by level. For high-verbal adults, the three age groups did not differ in their recall of high-level information; but the young recalled more than did the middle-aged adults, and they both recalled more than the old did on the lower-level ideas. In contrast, all three of the lower-verbal groups differed significantly on the high-level ideas and showed clear age deficits; for the other levels the young and middle-aged subjects did not differ but were superior to the old adults.

Dixon et al. (1984) suggest that the literature also supports this pattern; Cohen (1979) and Dixon et al. (1982) found greater age deficits on main ideas and are said to have tested low-verbal adults. This is the case for the Dixon et al. (1982) study. However, Cohen reports deficits in gist or main-idea recall for high-verbal adults; recall of details was not reported. Dixon et al. (1984) explain that Byrd (1981), Labouvie-Vief, Schell, and Weaverdyck (unpublished, cited in Dixon et al., 1984), Spilich (1983), and Zelinski et al. (1980) found greater deficits in recall of details and tested high-verbal, college-educated adults. However, information on the types of subjects in terms of verbal ability and education is not available for Zelinski et al.

The sole study that Hultsch and Dixon (1984) could not incorporate into their interpretation was the Meyer and Rice (1981) study, because in this study with high-verbal college graduates older adults recalled details as well (free recall) or better (questions) than young adults. However, the data from Meyer and Rice (1986) show that this discrepancy can be clarified by examining the organization and emphasis of the texts. For the texts with emphasized structure, the pattern found by Dixon et al. (1984) holds. In contrast, on the versions with de-emphasized structure and emphasized details, this pattern is reversed; for high-verbal adults the results are consistent with Meyer and Rice (1981); for the lower-verbal adults there are greater age deficits on details than on main ideas.

Surber et al. (1984), Petros et al. (1983), and Zelinski et al. (1984) also have examined aging and the levels effect. Surber et al. asked above-average-verbal young and older adults to read and recall a 1,563-word passage on commercial fishing. Young adults recalled more information overall and more information at the three most important levels than did old adults, but the two groups did not differ at the lowest-level details. These results fit the pattern for text whose structure and main ideas are not clearly emphasized; perhaps that was the case for the lengthy article. Petros et al. asked adults with high and low education (no vocabulary data) to listen to two stories; they report no interaction among age, level, and education, and the scores are not available to examine the education groups with respect to age and level. However, collapsed over education a pattern similar to that for high-verbal adults on well-structured texts is found; greater aging deficits are found on the lowest-level details (young = .49; old = .37) than on the most important ideas (young = .87; old = .81). The authors point out that both age groups are sensitive to text structure because a levels effect is found for both groups. The study by Zelinski et al. (1984) does not appear to fit neatly into the interaction for age by verbal ability by organization outlined above.

## CONCLUSIONS

Most of the discrepancies in the literature with regard to the magnitude of age deficits in prose learning can be explained by examining reader, task, and text variables. A number of factors are associated with a reduction of age deficits in reading comprehension; greater prose recall in older adults is related to higher levels of education and higher scores on vocabulary, verbal productive thinking, and associative memory tests. Also, better memory from text by older adults is associated with more time spent reading in everyday life (particularly for adults with effective reading comprehension skills), more prior knowledge on a topic, and greater familiarity with the reading and recall task. Better performance is found for slower or self-paced presentation; a pace of 120 wpm or faster appears to affect adversely the recall of old adults more than young adults.

The text variable of emphasis was shown to correlate with different findings reported by investigators. For texts with emphasis placed on well-organized structures, young and old adults with high vocabulary scores are sensitive to text structure; they exhibit large levels effects, and greater age-related deficits are found in recall of details. On these same texts, old adults with average vocabulary scores show less sensitivity to text structure and exhibit greater deficits on main ideas. However, with text that de-emphasizes organization and emphasizes details, the opposite pattern is found. For the highly verbal adults fewer age deficits are found for details than for main ideas. For average-verbal adults fewer age deficits are found for main ideas than for details. High-verbal old adults appear to utilize text structure as well as do young adults. They show facilitation in recall after listening to text structured with the more organized comparative structure than with the less organized descriptive structure. They are very sensitive to the emphasis plans of an author. When specific details are emphasized over structure, old adults appear to use their resources to process details at the expense of fully processing main ideas and logical relationships. These findings suggest that when writing for these older adults, care should be given to signaling explicitly the major logical relationships if examples with specific facts are given in the text. If dates, names, and numbers are not critical to the message, then they should be deleted.

The greater effects of emphasis conditions for high-verbal old adults than for high-verbal young adults may result from reduced cognitive capacity with aging where the effort required for processing details reduces that available for figuring out implicit logical relationships among major propositions in text. It has shown, moreover, that text without signaling requires more cognitive capacity than the same text with signaling (Britton, Glynn, Meyer, & Penland, 1982). The performance of young adults with average vocabulary scores on these same texts mirrors the pattern for high-verbal old adults. It could be argued that these manipulations have similar effects on these two groups and not on high-verbal young adults because high-verbal young adults have more cognitive capacity than average-verbal young adults who were less endowed and high-verbal old adults who have experienced declines in capacity with increasing age. Alternatively, the structure strategy may be more automatic, requiring less conscious capacity in the high-verbal young adults. These text manipulations have no effect on average-verbal older adults, who perform quite poorly under all text conditions; this could reflect their initial limited capacity that was further reduced by aging. However, performance of old adults with average vocabulary scores also could result from changes in educational practice over the generations. Signaling words and text structures may have been taught to the young adults but not to the old adults. Training with these old adults shows that they can learn to use these aspects of text.

The extant literature does not perfectly fit either a model of aging involving irreversible neurological decline nor a model focusing on strategic practice.

Further investigations will need to clarify the contributions of both models toward explaining observed differences in text processes with advancing age.

## REFERENCES

Belmore, S. M. (1981). Age-related changes in processing explicit and implicit language. *Journal of Gerontology, 36,* 316–322.

Birren, J. E. (1974). Translations in gerontology—from lab to life: Psychophysiology and speed of response. *American Psychologist, 29,* 808–815.

Birren, J. E., Woods, A. M., & Williams, M. V. (1980). Behavioral slowing with aging: Causes, organization, and consequences. In L. W. Poon (Ed.), *Aging in the 1980's: Psychological issues* (pp. 293–308). Washington, DC: American Psychiatric Association.

Borgatta, E. F., & Corsini, R. J. (1964). *Manual for the Quick Word Test.* New York: Harcourt, Brace, and World.

Botwinick, J. (1978). *Aging and behavior* (2nd ed.). New York: Springer Publishing Co.

Britton, B. K., Glynn, S., Meyer, B. J. F., & Penland, M. (1982). Use of cognitive capacity in reading text. *Journal of Educational Psychology, 73,* 51–61.

Burke, D. M., & Light, L. L. (1981). Memory and aging: The role of retrieval process. *Psychological Bulletin, 90,* 513–546.

Byrd, M. (1981). *Age differences in memory for prose passages.* Unpublished doctoral dissertation, University of Toronto.

Cohen, G. (1979). Language comprehension in old age. *Cognitive Psychology, 11,* 412–429.

Cohen, G. (1981). Inferential reasoning in old age. *Cognition, 9,* 59–72.

Cohen, G. (In press). Age differences in memory for texts: Production deficiency or processing limitations? In D. M. Burke & L. L. Light (Eds.), *Language, memory and aging.* New York: Academic.

Cotman, C. W., & Holets, V. R. (1985). Structural changes at synapses with age: Plasticity and regeneration. In C. E. Finch & E. L. Schneider (Eds.), *Handbook of the biology of aging* (pp. 617–639). New York: Van Nostrand.

Craik, F. I. M., & Rabinowitz, J. C. (1984). Age differences in the acquisition and use of verbal information. In H. Bouman & D. Bouwhuis (Eds.), *Attention and performance × control of language processes.* Hillsdale, NJ: Erlbaum.

Dixon, R. A., Hultsch, D. F., & Hertzog, C. (1986, August). *Twenty-five structurally equivalent texts for use in aging research.* Paper presented at the American Psychological Association Meetings, Washington, DC.

Dixon, R. A., Hultsch, D. F., Simon, E. W., & von Eye, A. (1984). Verbal ability and text structure effects on adult age differences in text recall. *Journal of Verbal Learning Behavior, 23,* 569–578.

Dixon, R. A., Simon, E. W., Nowak, C. A., & Hultsch, D. F. (1982). Text recall in adulthood as a function of level of information, input modality, and delay interval. *Journal of Gerontology, 37,* 358–364.

Dixon, R. A., & von Eye, A. (1984). Depth of processing and text recall in adulthood. *Journal of Reading Behavior, 26,* 109–117.

Ekstrom, R. B., French, J. W., Harman, H. H., & Derman, D. (1976). *Manual for kit of factor referenced cognitive tests*. Princeton, NJ: Educational Testing Service.

Glynn, S. M., Okun, M. A., Muth, K. D., & Britton, B. K. (1983). Adults' text recall: An examination of the age-deficit hypothesis. *Journal of Reading Behavior, 15,* 31–45.

Gordon, S. K., & Clark, W. C. (1974). Application of signal detection theory to prose recall and recognition in elderly and young adults. *Journal of Gerontology, 29,* 64–72.

Harker, J. O., Hartley, J. T., & Walsh, D. A. (1982). Understanding discourse—a life-span approach. In B. A. Hutson (Eds.), *Advances in reading/language research* (Vol. 1, pp. 155–202). Greenwich, CT: JAI Press.

Hartley, A. A., Hartley, J. T., & Johnson, S. J. (1984). The older adult as computer user. In P. K. Robinson, J. Livingston, & J. E. Birren (Eds.), *Aging and technological advances* New York: Plenum.

Hartley, J. T. (1986a). Memory for prose: Perspectives on the reader. In L. W. Poon, D. C. Rubin, & B. A. Wilson (Eds.), *Everyday cognition and adult and later life* Cambridge, England: Cambridge University Press.

Hartley, J. T. (1986b). Reader and text variables as determinants of discourse memory in adulthood. *Psychology and Aging, 1,* 150–158.

Hartley, J. T., Harker, J. O., & Walsh, D. A. (1980). Contemporary issues and new directions in adult development of learning and memory. In L. W. Poon (Ed.), *Aging in the 1980's* (pp. 239–252). Washington, DC: American Psychological Association.

Hultsch, D. F., & Dixon, R. A. (1983). The role of pre-experimental knowledge in text processing in adulthood. *Experimental Aging Research, 9,* 17–22.

Hultsch, D. F., & Dixon, R. A. (1984). Memory for text materials in adulthood. In P. Baltes & O. G. Brim, Jr. (Eds.), *Life-span development and behavior* (Vol. 6; pp. 77–108). New York: Academic.

Hultsch, D. F., Hertzog, C., & Dixon, R. A. (1984). Text recall in adulthood: The role of intellectual abilities. *Developmental Psychology, 20,* 1193–1209.

Johnson, R. E. (1970). Recall of prose as a function of the structural importance of the linguistic units. *Journal of Verbal Learning and Verbal Behavior, 9,* 12–20.

Kintsch, W. (1974). *The representation of meaning in memory*. Hillsdale, NJ: Erlbaum.

Labouvie-Vief, G., Schell, D. A., & Weaverdyck, S. E. (1981). *Recall deficit in the aged: A fable recalled.* Unpublished manuscript, Wayne State University, Detroit.

Light, L. L., & Anderson, P. A. (1985). Working-memory capacity, age, and memory for discourse. *Journal of Gerontology, 45,* 737–747.

Light, L. L., Zelinski, E. M., & Moore, M. (1982). Adult age differences in reasoning from new information. *Journal of Experimental Psychology: Learning, Memory, and Cognition, 8,* 435–447.

Mandel, R. G., & Johnson, N. S. (1984). A developmental analysis of story recall and comprehension in adulthood. *Journal of Verbal Learning and Verbal Behavior, 23,* 643–659.

Mandler, J. M., & Johnson, N. S. (1977). Remembrance of things parsed: Story structure and recall. *Cognitive Psychology, 9,* 111–151.

Mayer, R. E. (1985). Structural analysis of science prose: Can we increase problem-solving performance? In B. K. Britton & J. Black (Eds.), *Understanding expository text* (pp. 65–87). Hillsdale, NJ: Erlbaum.

Meyer, B. J. F. (1975). *The organization of prose and its effects on memory*. Amsterdam: Elsevier North-Holland.

Meyer, B. J. F. (1983). Text structure and its use in studying comprehension across the adult life span. In B. A. Hutson (Ed.), *Advances in reading/language research* (Vol. 2, pp. 9–54). Greenwich, CT: JAI Press.

Meyer, B. J. F. (1984). Text dimensions and cognitive processing. In H. Mandl, N. Stein, & T. Trabasso (Eds.), *Learning from texts* (pp. 3–52). Hillsdale, NJ: Erlbaum.

Meyer, B. J. F. (1985). Prose analysis: Procedures, purposes, and problems. In B. K. Britton & J. Black (Eds.), *Understanding expository text* (pp. 11–64, 269–304). Hillsdale, NJ: Erlbaum.

Meyer, B. J. F., Brandt, D. M., & Bluth, G. J. (1980). Use of the top-level structure in text: Key for reading comprehension of ninth-grade students. *Reading Research Quarterly, 16*, 72–103.

Meyer, B. J. F., & Freedle, R. O. (1984). The effects of different discourse types on recall. *American Educational Research Journal, 21*, 121–143.

Meyer, B. J. F., & Rice, G. E. (1981). Information recalled from prose by young, middle, and old adults. *Experimental Aging Research, 7*, 253–268.

Meyer, B. J. F., & Rice, G. E. (1983a, December) *Effects of discourse type on recall by young, middle, and old adults with high and average vocabulary scores*. Paper presented at the National Reading Conference, Austin, TX.

Meyer, B. J. F., & Rice, G. E. (1983b). Learning and memory from text across the adult life span. In J. Fine & R. O. Freedle (Eds.), *Developmental studies in discourse* (pp. 291–306). Norwood, NJ: Ablex.

Meyer, B. J. F., & Rice, G. E. (1986). Prose processing in adulthood: The text, the reader and the task. In L. W. Poon, D. C. Rubin, & B. A. Wilson (Eds.), *Everyday cognition and adult and later life*. Cambridge, England: Cambridge University Press.

Meyer, B. J. F., Rice, G. E., Knight, C. C., & Jessen, J. L. (1979). *Effects of comparative and descriptive discourse types on the reading performance of young, middle, and old adults*. Prose Learning Series #7. Tempe, AZ: Arizona State University, Department of Educational Psychology.

Meyer, B. J. F., Young, C. J., & Bartlett, B. J. (1986, August). *A prose learning strategy: Effects on old and young adults*. Paper presented at the American Psychological Association, Washington, DC.

Petros, T., Tabor, L., Cooney, T., & Chabot, R. J. (1983). Adult age differences in sensitivity to semantic structure of prose. *Developmental Psychology, 19*, 907–914.

Poon, L. N., Krauss, I. K., & Bowles, N. L. (1984). On subject selection in cognitive aging research. *Experimental Aging Research, 10*, 43–49.

Rice, G. E., & Meyer, B. J. F. (1985). Reading behavior and prose recall performance of young and older adults with high and average verbal ability. *Educational Gerontology, 11*, 57–72.

Rice, G. E., & Meyer, B. J. F. (1986). Prose recall: Effects of aging, verbal ability, and reading behavior. *Journal of Gerontology, 41*, 469–480.

Schaie, K. W. (1977–1978). Towards a stage theory of adult development. *International Journal of Aging and Human Development, 8*, 129–138.

Schneider, N. F., Gritz, E. R., & Jarvik, M. E. (1975). Age differences in learning, immediate and one-week delayed recall. *Gerontologia, 21*, 10–20.

Shipley, W. C. (1940). A self-administering scale for measuring intellectual impairment and deterioration. *Journal of Psychology, 9,* 371–377.

Simon, E. W., Dixon, R. A., Nowak, C. A., & Hultsch, D. F. (1982). Orienting task effects on text recall in adulthood. *Journal of Gerontology, 31,* 575–580.

Smith, S. W., Rebok, G. W., Smith, W. R., Hall, S. E., & Alvin, M. (1983). Adult age differences in the use of story structure in delayed free recall. *Experimental Aging Research, 9,* 191–195.

Spilich, G. J. (1983). Life-span components of text processing; structural and procedural differences. *Journal of Verbal Learning and Verbal Behavior, 22,* 231–244.

Spilich, G. J., & Voss, J. F. (1982). Contextual effects upon text memory for young, aged-normal, and aged memory-impaired individuals. *Experimental Aging Research, 8,* 45–49.

Sticht, T. G., & James, J. H. (1984). Listening and reading. In P. D. Pearson (Ed.), *Handbook of reading research* (pp. 293–318). New York: Longman.

Stine, E. L., Wingfield, A., & Poon, L. W. (1986). Speech comprehension and memory through adulthood: The roles of time and strategy. In L. W. Poon, D. C. Rubin, & B. A. Wilson (Eds.), *Everyday cognition and adult and later life.* Cambridge, England: Cambridge University Press.

Stone, D. E., & Glock, M. D. (1981). How do young adults read directions with and without pictures? *Journal of Educational Psychology, 73,* 419–426.

Surber, J. R., Kowalski, A. H., & Pena-Paez, A. (1984). Effects of aging on recall of extended expository prose. *Experimental Aging Research, 10,* 25–28.

Taub, H. A. (1979). Comprehension and memory of prose materials by young and old adults. *Experimental Aging Research, 5,* 3–13.

Taub, H. A., & Kline, G. E. (1978). Recall of prose as a function of age and input modality. *Journal of Gerontology, 33,* 725–730.

Thompson, D. N., & Diefenderfer, K. (1986, August). *The use of advance organizers with older adults of limited verbal ability.* Paper presented at the meeting of the American Educational Research Association, San Francisco.

Vincent, J. P. (1985). *Effects of discourse types on memory of prose by young, middle-age, and old adults with average vocabularies.* Unpublished doctoral dissertation, Arizona State University, Tempe, AZ.

Young, C. J. (1983). *Integration of facts across textual distances by young and old adults.* Unpublished master's thesis, Arizona State University, Tempe, AZ.

Zelinski, E. M., Gilewski, M. J., & Thompson, L. W. (1980). Do laboratory tests relate to self-assessment of memory ability in the young and old? In L. W. Poon, J. L. Fozard, L. S. Cermak, D. Arenberg, & L. W. Thompson (Eds.), *New directions in memory and aging: Proceedings of the George Talland Memorial Conference* (pp. 519–544). Hillsdale, NJ: Erlbaum.

Zelinski, E. M., Light, L. L., & Gilewski, M. J. (1984). Adult age differences in memory for prose: The question of sensitivity to passage structure. *Developmental Psychology, 20,* 1181–1192.

*This page intentionally left blank*

CHAPTER 5

# Intellectual Abilities and Age

WALTER R. CUNNINGHAM
DEPARTMENT OF PSYCHOLOGY
UNIVERSITY OF FLORIDA
GAINESVILLE, FLORIDA

This chapter is intended to review and evaluate psychometrically oriented studies of intellectual abilities and age. It includes a discussion of theoretical developments and descriptive studies of structural differences and age changes in levels of abilities. Experimental studies of intelligence variables are also considered. In the broad sense that intelligence is used in this review (e.g., Guilford, 1967; Horn, 1980), some research on simple and choice reaction time studies is also included. Methodology is considered where particularly pertinent. Major areas not included are learning and memory, studies of clinical subgroups such as Alzheimer's or Down's syndrome patients, and studies of language or linguistic functioning and social cognition. Finally, the areas of terminal drop–terminal decline and training/intervention studies are excluded because the author feels that these areas merit separate reviews (also, see chapters by Thompson, Gong, Haskins, & Gallagher, and Willis, this volume).

What are the objectives in studying intellectual functioning in relation to age? At a descriptive level, it is desired to understand, first, the structural characteristics of measures and how they change with age. This is a fundamental issue because approximate equivalence of structure is a key assumption in virtually all studies of level of performance. Also, at a descriptive level, an understanding of the age course of different intellectual abilities is needed. For a long time there has been a tendency to broadly categorize individual ability tests as age-sensitive or not. With the development and application in aging studies of systematic taxonomies of intellectual ability factors, such as the Primary Mental Abilities or the Educational Testing Service Kit of Factor Referenced Tests (Ekstrom, French, & Harmon, 1976), it is possible to begin categorizing at the level of constructs, which is apt to be more reliable than categorizing with regard to

Support for preparation of this chapter was provided by NIA Grant #R01 AG04337. This support is gratefully acknowledged.

individual tests because of the danger of specific or narrow test characteristics biasing the age relationship. It is also desirable to identify the type of age relationship: for example, linear, linear accelerating, stability with drop after 50 and/or over age 70. It is also necessary to classify different factors in terms of their susceptibility to various extraneous influences, including education, sex differences, cohort differences, and health factors. It is only when such evaluations have been made that it is possible to make fully rational and rigorous judgments in the selection of dependent variables for controlled manipulation studies that address the nature of cognitive aging. Further, it is desirable to seek to evaluate which individual factors of intelligence are most important in everyday life and which are most exercised. This could lead to a better understanding of intellectual functioning in everyday life and to added ecological validity for abilities. In this regard see the interesting article by Frederickson (1986).

## THEORIES AND MODELS OF INTELLIGENCE

In the last decade (which is the period of this review), there have been important advances in theorizing in both the study of intelligence in general and the aging of intelligence in particular. One of the common psychometric prototype models is a hierarchical model with individual items (questions) at the base, individual tests at the second level, and primary or common factors next, followed by second- and/or third-level higher-order factors, with general intelligence, or "g," at the top (see Figure 5-1). In this context, it is possible to study intellectual functioning at various levels. Clearly, at the test level there are so many available individual measures that it is difficult to plan research systematically with respect to a taxonomy of abilities. At the "g" level, many relationships with age are submerged, since some effective indicators of "g" are age-sensitive, such as measures of inductive reasoning, and some are insensitive, such as measures of verbal comprehension. This variation in age sensitivity implies that measurement in research on aging should be oriented toward the middle level of hierarchical models: either primary or common factors and second-order factors. Briefly, then, studies at a low level in the hierarchy lack parsimony, and those at the high level of the hierarchy are almost certain to obscure important age relationships.

Several hierarchical models of intelligence have been proposed [see Guilford's (1967) discussion in which several such models are discussed in contrast to his nonhierarchical model], but the best articulated one and also the one that has the clearest implications for adult development is the Cattell/Horn theory of fluid and crystallized intelligence. Horn (e.g., 1980) has continued to refine and articulate this hierarchical model.

Other theoreticians have moved beyond the traditional factor-analytic framework. A potentially significant development in the theory of intelligence is the formulation of Sternberg's (1985) triarchic theory. This theory consists of (1)

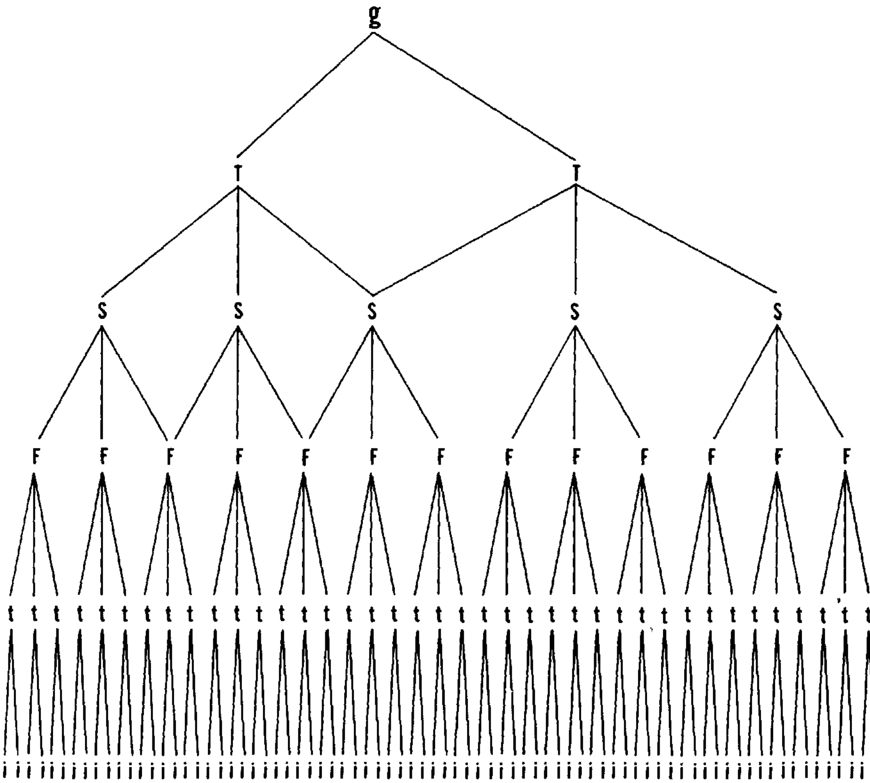


**Figure 5-1.** A schematic diagram of a hierarchical structure of ability factors. i, Items or questions; t, individual tests; F, common or primary ability factors; S, second-order factors; T, third-order factors; g, general factor.

a contextual part that relates intelligence to the environment, (2) a componential aspect regarding processes and mental mechanisms supporting intelligent behavior, and (3) an experiential part that takes account of the experience of the subject with the type of reasoning problem presented. Because high familiarity increases the likelihood of automatic processing, the measurement of intelligence (according to the theory) is more valid with tasks of low to intermediate familiarity with the subject, so that controlled processing is required. This implies that intelligence shows itself best in novel tasks, or at least tasks that cannot be dealt with routinely. According to the theory (Sternberg, 1986), there are three types of reasoning: selective encoding, selective comparison, and selective combination. The two former aspects are more prominent in inductive reasoning; the last is more significant in deductive reasoning. In a thoughtful recent article, Berg and Sternberg (1985) have discussed the relationships between this theory and adult aging. The relationships with several other recent and useful theoretical developments were also discussed (Baltes, Dittman-Kohli, & Dixon, 1984; Denney, 1982).

Cerella (1985) studied 189 latency tasks from 35 studies with regression models. Results were confirmed by application to 69 tasks from newly published studies. Models were developed to describe data both across studies and within studies. On the basis of these quantitative (regression) models of the slowing of information processing with age, Cerella concluded that slowing of computational processes (higher-order processes) is of greater magnitude than slowing of sensorimotor processes. Greene (1983) provides an interesting discussion of "time dynamic" quantitative models of slowing with age. He argues that such approaches have both substantive and mathematical advantages over the more usual "static" models used in most aging research.

Cognitive processing models of reaction time–dependent variables in young adults continue to flourish (e.g., Chase, 1978). It can be expected that application of such processing models to tasks involved in intellectual abilities and aging will occur in the future. It also should be recognized that the measurement of intelligence via reaction-time measures has also seen a resurgence recently in child and young adult literature (e.g., Vernon, 1986).

## ON THE NATURE OF AGING

Some aspects of aging, such as disuse, learning, and the like, can easily be addressed by psychologists using familiar conceptual bases. However, because biological decline is clearly one aspect of aging and intelligence, it is natural to look to the biological sciences, particularly the emerging neurosciences, for theoretical and conceptual guidance in attempting to formulate and prioritize behavioral research.

Unfortunately, a fundamental problem for behavioral research is that the nature of biological aging remains controversial. There is no wide consensus on exactly what aging is, nor is there agreement on which mechanism or mechanisms are critical. Shock (1977) provides a review of some of the major viewpoints on biological theories of aging. He expresses doubt that any one theory will provide a comprehensive account of biological aging. It is clear, however, that a better understanding of the nature of biological decline with age would greatly facilitate behavioral research. But these relationships may be quite complex. It seems probable that aging itself is of a multidimensional character, with different physiological systems and different neural systems showing different characteristic patterns of aging.

Along these lines, Creasy and Rapoport (1985) have taken issue with the idea of global aging. Reviewing a wide variety of biological and physiological phenomena, they conclude that there are significant individual differences in some neurological changes with age. It seems logical then that individual differences in patterns of intellectual change would be expected. It is possible, further, that biologically based cohort differences in intellectual functioning could occur in interactions with such mechanisms as nutrition, lifestyle, health information, and service delivery. Drachman (1983) has taken the position that the dementias represent accelerated aging and that cognitive aging may be related to cholinergic functioning. Also, it is important to note that Buell and Coleman (1981) found evidence for dendritic growth in the normal aged. This finding underscores the plausibility of late-life positive or compensatory intellectual development. These researchers state that their study was the first demonstration of plasticity in the adult human brain. Clearly, if these findings are supported by further work they could have important implications for psychological conceptions of cognition in late life.

It appears that rapid developments in neuroscience may motivate improved theoretical statements regarding the nature of decline in aging, as well as the possible organismic compensatory reactions to structural decline. Close monitoring of developments in the biology of aging and integration with empirical behavioral results could conceivably result in significant theoretical advances.

Another issue concerns the tendency of psychologists to think in terms of linear functions. Though simple and elegant, such functions often appear to belie the complexity of the biological substratum of behavioral functioning. Because many bodily functions have reserve capacity, considerable loss of capacity can occur without notable loss in function. However, when some critical value of loss does occur, then decrement in function would follow. Clearly, a quantitative representation of this situation at a behavioral level would involve a straight line and then a linear decline. Other, more complex functions are also possible. Consider a person who has a series of small strokes at random intervals: losses in performance would probably have a staircase pattern except that the "steps" would be of differing interval length. Another kind of pattern would be recovery of function. This is altogether plausible because of the fact that alternate cells may replace earlier functions. Of course, this would be a complex function. More explicit consideration of such functions would be a useful advance.

## SOME BACKGROUND

Progress in the field of aging and intelligence for the past few decades might be characterized as an erosion of the universal decrement hypothesis and also a drift toward carefully qualified decrement conclusions with respect to age level and types of variables. The earliest cross-sectional work on intelligence was interpreted as providing evidence for generalized decline (Jones & Conrad, 1933). Various studies began to demonstrate exceptions and qualifications to this interpretation. Lorge (1936) demonstrated that highly speeded general intelligence tests showed larger age differences than two less speeded tests. Lorge interpreted this result as a performance rather than a capacity deficit. This interpretation is now widely regarded as outdated because a careful reading of the reaction time literature indicates that central slowing may be of greater magnitude than peripheral, performance-related slowing (see Birren, 1965, and Salthouse, 1985, for more modern views). Foulds and Raven (1948) showed that inductive reasoning was more closely associated with age than verbal comprehension when occupational level was controlled. Owens (1953; 1966) and Cunningham and Owens (1983) showed that a decrement hypothesis was inadequate for college-educated males through the age of 50 for the Army Alpha subtests and for selected variables through age 60. Schaie (1983, for an overview), using sequential methodologies, further demonstrated the inadequacy of a universal decrement model and concluded that cohort differences were an important source of variance. Some of Schaie's conclusions were heatedly debated (e.g., Horn & Donaldson, 1976; see also Baltes & Schaie, 1976). Cunningham and Birren (1976) found strong age declines but no cohort differences in middle age for a highly speeded relations factor but did find cohort differences for other variables. Kausler (1982) reviewed several research reports indicating that cohort differences did not appear to be an important source of variance for some variables commonly employed in experimental psychology.

Botwinick (1977) provided a careful review of the earlier literature and concluded that decline was still in the picture. It was obvious, however, that unqualified decrement models were clearly inconsistent with the available data and that decrement hypotheses now needed to be carefully qualified with respect to age and intellectual ability.

## STRUCTURAL STUDIES

Since virtually all methods of evaluating change or difference in individual variables or factors assume approximate equivalence of structure, such studies are basic to hypotheses regarding level. Degrees of structural invariance are well discussed by LaBouvie (1980). The past decade has seen a resurgence in interest in examining ability structures in relation to age.

Longitudinal comparisons with the Army Alpha Examination (Cunningham & Birren, 1980), cross-sectional comparisons with a designed battery based on the Educational Testing Service factor system (Cunningham, 1980a, b, 1981), and longitudinal follow-ups (Cunningham, Smook, & Tomer, 1985) indicate no change in dimensionality or salient factor loadings at the common factor level, but there is a tendency for different factors to become more interrelated within the age range of 20 to the late 70s. Hertzog and Schaie (1986) employed a "g" model and found that Primary Mental Ability indicators showed increased loadings on, an indication of greater association with age. At the level of item packets, higher correlations were found for older examinees on the Graduate Record Examination (Stricker & Rock, 1985). Reports of correlations within individuals over time are unanimous in indicating a high level of consistency of individual differences on factor scores, sometimes above 0.9 (see, for example, Conley, 1984).

Most studies with multiple indicators for separate ability factors have shown stability with regard to dimensionality. Two discordant results must be considered. Baltes, Cornelius, Sprio, Nesselroade, and Willis (1980), in a very interesting study, modeled both primary and higher-order factors. They expressed a preference for a model that was more integrated than what was expected, based on theoretically appealing results from young adulthood. Naturally, the authors' conclusions would be far more compelling if there were an empirical young adult comparison group and a simultaneous analysis. White and Cunningham (1986) also found a surprising result: an increase in the number of primary-level factors in a battery of timed, highly speeded tests. Although every single covariance was increased in the old comparison group as compared with the young adults, two additional factors were found in the old. Usually increased association leads to a reduced number of factors (if there is any change). One of the extra factors appeared to be an order-of-presentation artifact, and the second did not allow for a clear-cut interpretation but could possibly reflect emerging individual differences with respect to visualization or processing of spatial information.

This reviewer has never seen fully convincing statistical evidence for a reduction in the number of primary factors with an adequate number of multiple indicators per factor and empirical comparisons across age groups that would support a strong type of integration hypothesis. As noted, most recent studies show increased association among variables and factors and thus provide widespread support for a limited, weaker kind of integration.

Cohen, Schaie, and Gribbin (1977) found no sex differences in factor structure when appropriately scaled covariances were compared. Cunningham and Birren (1980) found no significant cohort differences for structure for two cohorts of college students separated in time by 40 years. The author is not aware of a comparable time-lag study of structure in the elderly.

## LEVEL-OF-PERFORMANCE STUDIES

Several studies were concerned with age changes or differences in mean performance. More and more researchers are beginning to operationalize intelligence variables in terms of ability factors, either with the preferred approach of utilizing multiple indicators or at least employing a previously validated marker variable to represent the construct of interest. This is in marked contrast to earlier periods of research, when it was routine to use applied instruments, such as the WAIS, that lack a systematic scientific rationale.

Schaie and Hertzog (1983) reported analyses of 14-year cohort sequential data on five of the Primary Mental Abilities tests based on the pioneering research program of Thurstone. The 14-year comparisons revealed clear evidence for decline after age 60, with slight declines detected in the 50s. Cohort effects were also found for all five variables. Cunningham, White, and Smook (1985) also found clear evidence for decline after age 60 for three variables representing verbal comprehension, numerical facility, and perceptual speed. For the first two variables, cohort effects were detected, and declines were relatively small. Importantly, the perceptual speed variable showed pronounced declines and negligible cohort differences.

Berg (1980) reported only small declines for a 70-year-old sample based on 5-year longitudinal data. He also detected cohort differences. Lachman (1983) reports declines for perceptual speed and memory span in a 2-year follow-up but no declines for indicators of fluid and crystallized intelligence. With a 2-year test interval, retest effects are probably a serious problem (e.g., Eisdorfer, 1963). It appears that longer retest intervals or parallel forms are more likely to detect significant declines.

Horn (1980), reviewing cross-sectional data, continues to conclude that fluid intelligence declines in middle adulthood. Analyses indicate that perceptual speed declines appear to be involved in the age differences in fluid intelligence. Longitudinal comparisons of fluid intelligence measures in middle age are badly needed to evaluate further the issue of decline. Sattler (1982) reviewed normative data for the WAIS and noted that the digit symbol subtest continues to be the most age-sensitive. Digit symbol is a measure of perceptual speed, but it is not a relatively pure measure because of significant learning and memory components. Schroth (1983) showed that certain types of problem solving were related to fluid intelligence and that such tasks were not related to educational level. Cornelius (1984) found that adults rated age-sensitive tests as less familiar, more difficult, and more effortful than age-insensitive tests.

There is now an increasing understanding of various intellectual ability factors. The factors that have been the most heavily researched are perceptual speed, verbal comprehension, inductive reasoning, and spatial and visualization abilities. Some recent results for these and other ability factors are summarized below.

A key variable in cognitive aging is speediness. There is converging evidence from many studies that measures of perceptual speed and choice reaction time generally show the highest correlation with age. Such measures also appear to be less related to various cultural influences such as educational level and cohort differences. However, there are extraneous variables that do come into play. Depression is well known to be related to speed of response, and there is now considerable evidence of a relationship between speed and exercise characteristics (e.g., Botwinick & Thompson, 1968; Spirduso, 1975). The role of time limits on tests is a potentially important one. There is a tendency in some quarters to dismiss declines in speed as merely a performance factor and to dismiss age decrements in speeded tests as secondary to time limits. The impact of time limits on intelligence tests cannot be evaluated globally because there are several interacting factors: the item length of the test relative to average number of items attempted in the time limit allowed and also the homogeneity or lack thereof of item difficulty. For example, with steeply ascending item difficulties, most subjects may be stopped by questions beyond their ability level before time is called, so in this situation the time limit is irrelevant to the performance of most of the subjects. The Arithmetic Problems subtest of the Army Alpha is a good example of this situation. Most research on reaction time that has attempted to decompose the total response times into specific components has concluded that central decision time is the major aspect of age-related slowing. Also, the intimate relationship between measures of simple perceptual speed and complex reasoning tasks (e.g., Horn, 1980) argue against the kind of performance interpretation advanced by Lorge (1936) decades ago. Another aspect of speediness concerns the Birren hypothesis (e.g., Birren, 1965) that declines in speed may account for declines in other abilities. There is a resurgence of interest in this idea (e.g., Salthouse, 1985; Salthouse & Somberg, 1982) but increased critical reaction as well (Botwinick, 1984, chap. 13).

Verbal comprehension measures tend to be the least age-sensitive. From the very slight declines detected even at quite advanced ages, it is quite plausible that if adequate control of educational and health factors were employed there might be *no* decline in verbal comprehension. Cerella and Fozard (1984) have attempted to account for this age insensitivity by studying lexical access time. They found comparable access times in young and old subjects and suggest that this may be implicated in the relative preservation of linguistic functioning. Their finding is an example of the fact that not all aspects of cognitive functioning show speed declines. Sometimes relatively simple changes in a measurement procedure can result in important differences in age/ability relationships. Well-practiced arithmetic operations (as in the ETS factor of numerical facility) also appear to be relatively age-insensitive.

Several intellectual abilities show greater age sensitivity than verbal comprehension but greater cohort differences than perceptual speed measures. Inductive reasoning measures (which measure one aspect of fluid intelligence) show markedly different cross-sectional and longitudinal comparisons, with evidence of reliable but small declines in the 50s (Schaie & Hertzog, 1983). Further longitudinal research with more extensive marker variables for fluid intelligence is badly needed to help clarify age relationships for inductive reasoning as well as other indicators of fluid intelligence. Kausler and Puckett (1980) found a strong positive correlation between figural relations and paired-associate learning in the elderly. Spatial and visualization abilities also show longitudinal declines at least by the 60s. Some analytic work regarding stimulus parameters in the Block Design task has been done (Royer, Gilmore, & Gruhn, 1984). Task uncertainty had an important impact on age relationships for this task. Word fluency measures tend to show significant declines in the 50s and 60s but with significant cohort differences as well. Various measures of creativity seem to fit into this general area of age decline/cohort differences, but most of the work has been cross-sectional (e.g., Ruth & Birren, 1985), and thus not enough sequential analyses are available for firm conclusions.

There are many concepts such as wisdom or mature judgment that may not develop until later in life. Such constructs have not been operationalized to the same extent as the abilities just reviewed. Whether reliable and valid measures of such constructs would add something new beyond what has been learned from existing ability factors remains to be seen. The effort appears worthwhile, and there is a need for rigorous test development work to extend preliminary efforts along these lines (Clayton, 1982). Many commentators are optimistic about the possibilities of such assessments, but the problem is the great effort required for quality test development: large samples, careful iterative item analysis and reliability estimates, a series of studies to evaluate discriminate and convergent validity as well as other aspects of construct validity. Such a project would require concerted effort over a period of years. And of course there is the dismal possibility that such measures may do little more than reflect verbal comprehension, socioeconomic status, or some combination thereof. This reviewer believes inquiries of wisdom to be a worthwhile area of endeavor, but it is easy to see why there is a much larger number of commentators calling for such efforts than psychometricians ready to take up the task. Another little-researched area is social role-taking (e.g., Powell, 1980), as well as the general area of social intelligence (e.g., Guilford, 1967).

It is extremely important at this junction to understand one point. The great controversy between proponents of decline and proponents of growth/stability is clearly moving toward consensus. It is quite clear from recent empirical results (Cunningham et al., 1985; Schaie & Hertzog, 1983) that most intellectual abilities begin to decline in the 60s. A few of these declines are quite large (e.g., some perceptual speed tasks showing greater than one standard deviation decrement per decade after age 60); however, many are reliable but small, often only a fraction of a standard deviation (Schaie & Hertzog, 1983). Except for highly speeded tasks, stability or increments in performance characterize individuals in their 20s and 30s. More intensive study of the decades of the 40s and 50s is clearly needed.

Another issue concerns individual differences in age change and their prediction. It appears that some individuals show relatively early declines on many variables and that others seem to show only small declines even on highly speeded variables. The prediction of such differences in rates of aging is a significant theoretical problem that may have important practical implications. Although some recent effort has been made in this direction (e.g., Manton, Siegler, & Woodbury, 1986), more research on this is clearly warranted.

## RELATIONSHIPS WITH OTHER VARIABLES

There are many studies relating general intelligence or abilities to other variables, such as lifestyle, health, or personality. A popular topic of study is the relationship among alcoholism, normal aging, and intellectual functioning (Blusewicz, Schenkenberg, Dustman, & Beck, 1977; Noonberg, Goldstein, & Page, 1985; Overall, Hoffman, & Levin, 1978; Parker, Parker, Brody, & Schoenberg, 1982). One issue, as yet unresolved, is whether alcoholism mimics premature aging. There are several articles relating intellectual function to various aspects of cardiovascular disease (e.g., Pentz, Elias, Wood, & Schultz, 1979). Butler, Dickinson, Katholi, and Halsey (1983) found a strong correlation between intelligence and cerebral blood flow in cross-sectional data with various diagnostic groups. Hertzog, Schaie, and Gribbin (1978), in an important methodological study, found that individuals with cardiovascular disease were more likely to drop out of longitudinal studies than were healthy individuals. Elsayed, Ismail, and Young (1980) found that exercise was related to fluid intelligence scores. Ferris, Crook, Sathananthan, and Gershon (1976) studied the use of reaction time in the diagnosis of senility. Bennett and Eklund (1983) considered the possible effects of vision on performance, although Storandt and Futterman (1982) report negative results for some tasks. This is a topic that should be more extensively researched because some losses of intellectual functioning may be an artifact of impaired vision. Prohaska, Parham, and Teitelman (1984) studied age differences in attributions of causality in relation to intellectual functioning.

Another important area of study evaluates antecedent–consequent relationships. This could mean that losses in some abilities predate and result in losses of other abilities within the intelligence domain (Witt & Cunningham, 1978; but see Schaie, 1983, for negative results). It is also possible that some personality variables may have an antecedent relationship to some ability variables (Lachman 1983; Lachman & Jelalian, 1984; Mason & Rebok, 1984; McCrae & Costa, 1985). Several studies now suggest that physical health is predictive of maintenance of intellectual functioning (Schaie & Hertzog, 1986). More research along these lines is clearly indicated.

An emerging area of research concerns practical intelligence and its relationships with psychometric intelligence (Dixon & Baltes, 1986). Although early efforts at developing ecologically valid tests (e.g., Demming & Pressey, 1957) were not particularly successful, recent preliminary work (e.g., Willis & Schaie, 1986) raises the possibility that there are reliable relationships between traditional psychometric tests and both perceived competence and practical tests of basic skills needed in everyday life. A provocative aspect of this work was that fluid intelligence measures were surprisingly successful in predicting performance on real-life tasks.

Although a searching evaluation of the nature of decline is an essential goal of aging and ability research, an equally important goal is understanding the nature of mature capacities of older adults. Studies of crystallized intelligence, the expertise engendered by years of experience, the development of automaticity in middle and late adulthood, and selective optimization are all critical to a balanced and comprehensive understanding of intelligence in adulthood. This general area parallels current trends in adult cognitive psychology toward studying expertise and specialization (Dixon, Kramer, & Baltes, 1985).

## METHODOLOGICAL ISSUES

There has been a continuing refinement of methodological understanding and applications of research methodologies. Poon, Krauss, and Bowles (1984), in an important article on current practice in subject selection, draw attention to the importance of careful subject description and also identify current modes of subject selection. Schaie (1978) has considered issues of external validity of intelligence measures in adulthood, which remains a thorny problem. Storandt and Hudson (1975) review problems with the application of analysis of covariance in aging research. Adam (1978) has identified problems in evaluating age, cohort, and time of measurement effects in analyzing sequential data. Schaie and Hertzog (1982) have emphasized the need for theoretically motivated assumptions in analyzing sequential data. Methods of restricted factor analysis and linear structural equation modeling have become popular in studies of intellectual abilities (see Hertzog, this volume).

## A PERSPECTIVE

Research interest in intelligence and aging remains vigorous. New theoretical proposals and refinements of multivariate methods, together with the increased analysis of longitudinal data, show promise of an enhanced understanding of intelligence and aging. LaRue and Jarvik (1978) expect that the next century will see healthier and wealthier older people. It is hoped that the advances in knowledge discussed here will facilitate and make practical a higher-level use of intellectual capabilities as well. An increased appreciation of the course of change in intellectual function should allow leaders in the business community to make optimal use of the abilities of the older worker. Baugher (1978) indicates that only slight occupational performance declines are seen in most older workers in positions that are not physically demanding. This is an important issue because the current low birth rate implies that there will be a greater need in the future for effective older workers, who will probably make up a larger proportion of the labor force than is the case today.

In terms of directions for future research, it seems likely that there will be increased emphasis on antecedants of change and type of patterns of change in intellectual functioning. It also seems likely that there will be increased emphasis on ecological validity of intellectual abilities in everyday life. It is possible that anthropological studies may be conducted to evaluate which aspects of intellectual functioning are important in the everyday life of young adults and the elderly. It would then be possible to evaluate more rigorously which intellectual variables are most important.

Another issue has to do with unique abilities of the old and/or abilities that develop significantly in the 40s and 50s. These hypothetical abilities may not have been previously developed, so they were not detected in early studies focused on children or young adults. Systematic test studies with large samples and sophisticated psychometrics will be required to see *if* such abilities exist and if they can predict ecologically valid criteria. If they do, they may turn out to have psychometric properties and age relationships similar to the variables we have been studying for a long time, but there is also the possibility of identifying ability constructs that may be unique and previously undiscovered.

Certain trends are becoming evident in the literature. Woodruff (1983) has provided a broad framework of the stages of intelligence and aging. Certainly a greater tendency toward the experimental study of intellectual variables has occurred recently, which suggests greater scientific maturity. Recent theoretical advances also give promise of a situation in which more focused experimental study is warranted. On the other hand, considerable descriptive and naturalistic study remains to be done. Some well-replicated psychometric factors of intelligence have never been studied in elderly samples. Also, new measures that may be sensitive to the mature capacities of older people will need to be studied to evaluate what a natural age course looks like. It appears, however, that more and more one can confidently expect that there will be increased employment of controlled, manipulated experiments motivated in a sound theoretical manner to enhance and illuminate our understanding of intelligence and aging.

## REFERENCES

Adam, J. (1978). Sequential strategies and the separation of age, cohort, and time-of-measurment contributions to developmental data. *Psychological Bulletin, 85*, 1309–1316.

Baltes, P. B., Cornelus, S. W., Spiro, A. III, Nesselroade, J. R., & Willis, S. L. (1980). Integration vs. differentiation of fluid-crystallized intelligence in old age. *Developmental Psychology, 16*, 625–635.

Baltes, P. B., Dittmann-Kohli, F., & Dixon, R. (1984). New perspectives on the development of intelligence in adulthood: Toward a dual-process conception and a model of selective optimization with compensation. In P. B. Baltes & O. G. Brim (Eds.), *Life-span; development and behavior, 6,* 33–76.

Baltes, P. B., & Schaie, K. W. (1976). On the plasticity of intelligence in adulthood and old age: Where Horn and Donaldson fail. *American Psychologist, 31,* 720–725.

Baugher, D. (1978). Is the older worker inherently incompetent? *Aging and Work, 1,* 243–250.

Bennett, E. S., & Eklund, S. J. (1983). Vision changes, intelligence, and aging: Part I. *Educational Gerontology, 9,* 255–278.

Berg, S. (1980). *Psychological functioning in 70- and 75-year-old people.* Copenhagen: Munksgaard.

Berg, C., & Sternberg, R. (1985). A triarchic theory of intellectual development during adulthood. *Developmental Review, 5,* 334–370.

Birren, J. E. (1965). Age changes in speed of behavior: Its central nature and physiological correlates. In A. T. Welford & J. E. Birren (Eds.), *Behavior, aging and the nervous system* (pp. 1–26). Springfield, IL: Charles C Thomas.

Blusewicz, M. J., Schenkenberg, T., Dustman, R. E., & Beck, E. C. (1977). WAIS performance in young normal, young alcoholic, and elderly normal groups: An evaluation of organicity and mental aging indices. *Journal of Clinical Psychology, 33,* 1149–1153.

Botwinick, J. (1977). Intellectual abilities. In J. E. Birren & K. W. Schaie (Eds.), *Handbook of the psychology of aging* (pp. 580–605). New York: Van Nostrand Reinhold.

Botwinick, J. (1984). *Aging and behavior.* New York: Springer Publishing Co.

Botwinick, J., & Thompson, L. (1968). Age difference in reaction time: An artifact? *Gerontologist, 8,* 25–28.

Buell, S. J., & Coleman, P. D. (1981). Quantitative evidence for selective dendritic growth in normal human aging but not in senile dementia. *Brain Research, 214,* 23–41.

Butler, R. W., Dickinson, W. A., Katholi, C., & Halsey, J. H. (1983). The comparative effects of organic brain disease on cerebral blood flow and measured intelligence. *Annals of Neurology, 13,* 155–159.

Cerella, J. (1985). Information processing rates in the elderly. *Psychological Bulletin, 98,* 67–83.

Cerella, J., & Fozard, J. L. (1984). Lexical access and age. *Developmental Psychology, 20,* 235–243.

Chase, W. G. (1978). Elementary information processes. In K. W. Estes (Ed.), *Handbook of learning and cognitive processes* (pp. 19–90). Hillsdale, NJ: Erlbaum.

Clayton, V. (1982). Wisdom and intelligence: The nature and function of knowledge in the later years. *International Journal of Aging and Human Development, 15,* 315–321.

Cohen, D., Schaie, K. W., & Gribbin, K. (1977). The organization of spatial abilities in older men and women. *Journal of Gerontology, 32,* 578–585.

Conley, J. J. (1984). The hierarchy of consistency: A review and model of longitudinal findings on adult individual differences in intelligence, personality and self-opinion. *Personality and Individual Differences, 5,* 11–25.

Cornelius, S. W. (1984). Classic pattern of intellectual aging: Test familiarity, difficulty, and performance. *Journal of Gerontology, 39,* 201–206.

Creasy, H., & Rapoport, S. I. (1985). The aging human brain. *Annals of Neurology, 17,* 2–10.

Cunningham, W. R. (1980a). Age comparative factor analysis of ability variables in adulthood and old age. *Intelligence, 7,* 133–149.

Cunningham, W. R. (1980b). Speed, age, and qualitative differences in cognitive functioning. In L. W. Poon (Ed.), *Aging in the 1980's: Selected contemporary issues in the psychology of aging.* Washington, DC: American Psychological Association.

Cunningham, W. R. (1981). Ability factor structure differences in adulthood and old age. *Multivariate Behavioral Research, 16,* 3–22.

Cunningham, W. R., & Birren, J. E. (1976). Age changes in human abilities: a 28-year longitudinal study. *Developmental Psychology, 12,* 81–82.

Cunningham, W. R., & Birren, J. E. (1980). Age changes in the factor structure of intellectual abilities in adulthood and old age. *Educational and Psychological Measurement, 40,* 271–290.

Cunningham, W. R., & Owens, W. A. (1983). The Iowa State study of the adult development of intellectual abilities. In K. W. Schaie (Ed.), *Longitudinal studies of psychological development* (pp. 20–39). New York: Guilford Press.

Cunningham, W. R., Smook, G., & Tomer, A. (1985, November). *Age changes in factor structure of highly speeded tests.* Paper presented at the meeting of the Society for Multivariate Experimental Psychology, Berkeley, CA.

Cunningham, W. R., White, N., & Smook, G. (1985, August). *Longitudinal losses in intellectual abilities in the elderly.* Paper presented at the meeting of the American Psychological Association, Los Angeles, CA.

Demming, J. A., & Pressesy, S. L. (1957). Tests indigenous to the adult and older years. *Journal of Counseling Psychology, 4,* 144–148.

Denney, N. W. (1982). Aging and cognitive changes. In B. B. Wolman (Ed.), *Handbook of developmental psychology* (pp. 807–827). Englewood Cliffs, NJ: Prentice-Hall.

Dixon, R. A., & Baltes, P. B. (1986). Toward life-span research on the functions and pragmatics of intelligence. In R. J. Sternberg & R. K. Wagner (Eds.), *Practical intelligence: Nature and origins of competence in the everyday world* (pp. 203–234). New York: Cambridge University Press.

Dixon, R. A., Kramer, D. A., & Baltes, P. B. (1985). Intelligence: A life-span developmental perspective. In B. B. Wolman (Ed.), *Handbook of intelligence: Theories measurements, and applications* (pp. 301–350). New York: Wiley.

Drachman, D. A. (1983). How normal aging relates to dementia: A critique and classification. In D. Samuel, S. Algeri, & S. Gershon (Eds), *Aging of the brain.* New York: Raven Press.

Eisdorfer, C. (1963). The WAIS performance of the aged: A retest evaluation. *Journal of Gerontology, 18,* 169–172.

Ekstrom, R. B., French, J., & Harman, M. (1976). *Manual for kit of factor-referenced tests.* Princeton, NJ: Educational Testing Service.

Elsayed, M., Ismail, A. H., & Young, R. J. (1980). Intellectual differences of adult men related to age and physical fitness before and after an exercise program. *Journal of Gerontology, 35,* 383–387.

Ferris, S., Crook, T., Sathananthan, G., & Gershon, S. (1976). Reaction time as a diagnostic measure in senility. *Journal of the American Geriatrics Society, 24,* 529–533.

Foulds, G. A., & Raven, J. C. (1948). Normal changes in the mental abilities of adults as age advances. *Journal of Mental Science, 94,* 133–142.

Frederickson, N. (1986). Toward a broader conception of human intelligence. *American Psychologist, 41,* 445–452.

Greene, V. L. (1983). Age dynamic models of information-processing task latency: A theoretical note. *Journal of Gerontology, 38,* 46–50.

Guilford, J. P. (1967). *The nature of human intelligence.* New York: McGraw-Hill.

Hertzog, C., & Schaie, K. W. (1986). Stability and change; in adult intelligence: I. Analysis of longitudinal covariance structures. *Psychology and Aging, 1,* 159–171.

Hertzog, C., Schaie, K. W., & Gribbin, K. (1978). Cardiovascular disease and changes in intellectual functioning from middle to old age. *Journal of Gerontology, 33,* 872–883.

Horn, J. L. (1980). Concepts of intellect in relation to learning and adult development. *Intelligence, 4,* 285–317.

Horn, J. L., & Donaldson, G. (1976). On the myth of intellectual decline. *American Psychologist, 31,* 701–719.

Jones, H. E., & Conrad, H. S. (1933). The growth and decline of intelligence: A study of a homogeneous group between the ages of ten and sixty. *Genetic Psychology Monographs, 13,* 223–298.

Kausler, D. H. (1982). *Experimental psychology and human aging.* New York: Wiley.

Kausler, D. H., & Puckett, J. M. (1980). Frequency judgements and correlated cognitive abilities in young and elderly adults. *Journal of Gerontology, 35,* 376–382.

Labouvie, E. W. (1980). Identity versus equivalence of psychological measures and constructs. In L. W. Poon (Ed.), *Aging in the 1980's: Selected contemporary issues in the psychology of aging.* Washington, DC: American Psychological Association.

Lachman, M. E. (1983). Perceptions of intellectual aging: Antecedent or consequence of intellectual functioning? *Developmental Psychology, 19,* 482–498.

Lachman, M. E., & Jelalian, E. J. (1984). Self-efficacy and attributions for intellectual performance in young and elderly adults. *Journal of Gerontology, 39,* 577–582.

LaRue, A., & Jarvik, L. F. (1978). Aging and intellectual functioning: Great expectations? In L. F. Jarvik (Ed.), *Aging into the 21st century* (pp. 79–96). New York: Gardner Press.

Lorge, I. (1936). The influence of the test upon the nature of mental decline as a function of age. *Journal of Educational Psychology, 27,* 100–110.

Manton, K. G., Siegler, I. C., & Woodbury, M. A. (1986). Patterns of intellectual development in later life. *Journal of Gerontology, 41,* 486–499.

Mason, C. F., & Rebok, G. W. (1984). Psychologists' self-perceptions of their intellectual functioning. *International Journal of Behavioral Development, 7,* 255–266.

McCrae, R. R., & Costa, P. T. (1985). Updating Norman's "Adequate Taxonomy": Intelligence and personality dimensions in natural language and in questionnaires. *Journal of Personality and Social Psychology, 49,* 710–721.

Noonberg, A., Goldstein, G., & Page, H. A. (1985). Premature aging in male alcoholics: "Accelerated aging" or "increased vulnerability"? *Alcoholism: Clinical and Experimental Research, 9,* 334–338.

Overall, J. E., Hoffmann, N. G., & Levin, H. (1978). Effects of aging, organicity, alcoholism, and functional psychopathology on WAIS subtest profiles. *Journal of Consulting and Clinical Psychology, 46,* 1315–1322.

Owens, W. A. (1953). Age and mental abilities: A longitudinal study. *Genetic Psychology Monographs, 48,* 3–59.

Owens, W. A. (1966). Age and mental ability: A second adult follow-up. *Journal of Educational Psychology, 57,* 311–325.

Parker, E. S., Parker, D. A., Brody, J. A., & Schoenberg, R. (1982). Cognitive patterns resembling premature aging in male social drinkers. *Alcoholism: Clinical and Experimental Research, 6,* 46–95.

Pentz, C. A., Elias, M. F., Wood, W. G., & Schultz, N. A. (1979). Relationship of age and hypertension to neuropsychological test performance. *Experimental Aging Research, 5,* 351–372.

Poon, L. W., Krauss, I. K., & Bowles, N. L. (1984). On subject selection in cognitive aging research. *Experimental Aging Research, 10,* 43–49.

Powell, P. M. (1980). Advanced social role-taking and cognitive development in gifted adults. *International Journal of Aging and Human Development, 11,* 177–193.

Prohaska, T. R., Parham, I. A., & Teitelman, J. (1984). Age differences in attributions to causality: Implications for intellectual assessment. *Experimental Aging Research, 10,* 111–117.

Royer, F. L., Gilmore, G. C., & Gruhn, J. J. (1984). Stimulus parameters that produce age differences in block design performance. *Journal of Clinical Psychology, 40,* 1474–1485.

Ruth, J., & Birren, J. E. (1985). Creativity in adulthood and old age: Relations to intelligence, sex and mode of testing. *International Journal of Behavioral Development, 8,* 99–109.

Salthouse, T. A. (1985). Speed of behavior and the implications for cognition. In J. E. Birren & K. W. Schaie (Eds.), *Handbook of the psychology of aging* (pp. 400–426). New York: Van Nostrand Reinhold.

Salthouse, T. A., & Somberg, B. L. (1982). Isolating the age deficit in speeded performance. *Journal of Gerontology, 37,* 59–63.

Sattler, J. M. (1982). Age effects on Wechsler Adult Intelligence Scale–Revised Tests. *Journal of Consulting and Clinical Psychology, 50,* 785–786.

Schaie, K. W. (1978). External validity in the assessment of intellectual development in adulthood. *Journal of Gerontology, 33,* 695–701.

Schaie, K. W. (1983). The Seattle Longitudinal Study: A 21-year exploration of psychometric intelligence in adulthood. In K. W. Schaie (Ed.), *Longitudinal studies of adult psychological development* (pp. 64–135). New York: Guilford Press.

Schaie, K. W., & Hertzog, C. (1982). Longitudinal methods. In B. B. Wolman (Ed.), *Handbook of developmental psychology* (pp. 91–115). Englewood Cliffs, NJ: Prentice-Hall.

Schaie, K. W., & Hertzog, C. (1983). Fourteen year cohort sequential analyses of adult intellectual development. *Developmental Psychology, 19,* 531–543.

Schaie, K. W., & Hertzog, C. (1986). Toward a comprehensive model of adult intellectual development: Contributions of the Seattle Longitudinal Study. In R. J. Sternberg (Ed.), *Advances in human intelligence,* Vol. 3, (pp. 79–118). Hillsdale, NJ: Erlbaum.

Schroth, M. L. (1983). A study of aging, intelligence and problem solving. *Psychological Reports, 53,* 1271–1279.

Shock, N. W. (1977). Biological theories of aging. In J. E. Birren & K. W. Schaie, *Handbook of the psychology of aging* (pp. 103–115). New York: Van Nostrand Reinhold.

Spirduso, W. W. (1975). Reaction and movement time as a function of age and physical activity level. *Journal of Gerontology, 30,* 435–440.

Sternberg, R. J. (1985). *Beyond IQ: A triarchic theory of human intelligence.* Cambridge: Cambridge University Press.

Sternberg, R. J. (1986). Toward a unified theory of human reasoning. *Intelligence, 10,* 281–314.

Storandt, M., & Futterman, A. (1982). Stimulus size and performance on two subtests of the Wechsler Adult Intelligence Scale by younger and older adults. *Journal of Gerontology, 37,* 602–693.

Storandt, M., & Hudson, W. (1975). Misuse of analysis of covariance in aging research and some partial solutions. *Experimental Aging Research, 1,* 121–125.

Stricker, L. J., & Rock, D. A. (1985). The structure of the GRE General Test for older examinees: A confirmatory factor analysis. Princeton, NJ: Educational Testing Service.

Vernon, P. A. (1986). The g-loading of intelligence tests and their relationship with reaction time: A comment on Ruchalla et al. *Intelligence, 10,* 93–100.

White, N., & Cunningham, W. R. (1987). The age comparative construct validity of speeded cognitive factors. *Multivariate Behavioral Research, 22,* 249–265.

Willis, S. L., & Schaie, K. W. (1986). Practical intelligence in later adulthood. In R. J. Sternberg & R. K. Wagner (Eds.), *Practical intelligence: Origins of competence in the everyday world* (pp. 236–268). New York: Cambridge University Press.

Witt, S. J., & Cunningham, W. R. (1979). Cognitive speed and subsequent intellectual development. *Journal of Gerontology, 34,* 540–546.

Woodruff, D. S. (1983). A review of aging and cognitive processes. *Research on Aging, 5,* 139–153.

CHAPTER 6

# The Role of Experience in Cognitive Aging

TIMOTHY A. SALTHOUSE
SCHOOL OF PSYCHOLOGY
GEORGIA INSTITUTE OF TECHNOLOGY
ATLANTA, GEORGIA

Although it is generally expert rather than novice levels of performance that are the most esteemed in society, expertise has been a largely neglected dimension of human performance. In fact, most psychological researchers deliberately attempt to eliminate the effects of prior experience in their evaluations of an individual's capabilities by utilizing novel and unfamiliar tasks and materials. Although this experience-minimizing strategy has a long tradition in psychology (dating at least to Ebbinghaus and the invention of nonsense syllables) and has influenced the development of numerous psychometric tests of cognitive functioning, it can be considered somewhat misdirected and possibly even perverse from the perspective of ecological validity because the effects of experience are frequently orders of magnitude greater than the performance differences observed across individuals at the same level of experience. At minimum, therefore, researchers interested in individual differences in behavior should be familiar with the nature of the variations in performance attributable to experience and, ideally, should be cognizant of how those experience effects interact with the individual difference of interest. The present chapter addresses these issues with reference to individual differences in cognition associated with increased age in adulthood.

At the outset it is important to clarify how the terms *expertise, experience, practice,* and *training* will be used in the present context. Basically, expertise is viewed as the extremely high levels of skill in a given activity domain that sometimes occur as a consequence of experience, and practice and training are interpreted as systematic ways of providing that experience. Training is usually distinguished from practice in that there is an attempt to control the nature of the

This chapter was written while the author was supported by an NIA Research Career Development Award (K04 AG00146-01A1). I would like to thank Neil Charness and Bill Hoyer for thoughtful comments on an earlier draft.

experience acquisition in training situations, whereas there is little direction or control in practice situations; but they are similar in that both try to manipulate the quality or quantity of relevant experience received by an individual.

Conceptualizing experience in this task-specific, or at least domain-restricted, manner has the advantage of allowing at least a theoretical separation of the effects of age and the effects of experience. This potentially important distinction has been blurred when experience has been interpreted in very general terms, almost as if it were synonymous with time or age. It is extremely difficult to determine the cognitive effects of something as ill-defined as life experience, but it does seem feasible to examine the consequences on cognition of experience with a specific activity. Moreover, only in the latter case is it practical to ask questions about the reciprocal influences on cognition of age and experience.

The chapter is organized into six distinct sections. The first is simply a brief overview of basic research on expertise with unselected populations, that is, individuals from a broad variety of backgrounds and individual-difference groupings. The second section consists of an examination of the classical distinction between cognitive abilities that do and do not exhibit declines with increased age from the perspective of a contrast between novice and expert levels of performance. Practice effects in studies of aging are reviewed in the third section, with practice referring both to specific intervention manipulations and to the effects of mere repetition. Studies of the effects of age in actual occupational activities are discussed in the fourth section, including the limitations of this type of research for the purpose of investigating the role of experience in cognitive aging.

The fifth section of the chapter is devoted to discussing a promising new approach for investigating experience effects termed the Molar Equivalence–Molecular Decomposition Strategy. This strategy differs from earlier approaches in that the focus is not on the examination of age differences in adults with comparable amounts of experience but instead on the determination of how people of different ages, and presumably different amounts of relevant experience, accomplish the same overall level of performance. The final section in the chapter consists of a discussion of alternative conceptualizations of the relations between age and experience. Of particular interest is whether experience should be considered a causal factor contributing to observed age differences in cognitive performance, or whether experience is best conceptualized as a dimension limiting potential generalization of results obtained in laboratory settings.

## BRIEF OVERVIEW OF EXPERTISE RESEARCH

The fundamental question of concern in most research on expertise is, in what way do experts and novices differ that allows the former to achieve such dramatically better levels of performance than the latter? Answers to this question obviously vary across activity domains, and in only a few domains are the answers yet definitive. Nevertheless, some very intriguing findings have emerged from research in this area, and a few of these results will be briefly summarized here to lay a foundation for the subsequent discussion of the joint effects of age and experience.

It is certainly not surprising that research has revealed that expertise in a given domain is associated with more extensive declarative (factual) and procedural (action or "how to") knowledge relevant to that domain. However, recent discoveries have revealed that this knowledge is also better organized in experts than in novices and that there appear to be more automatic connections between the perceptual or pattern-recognizing processes and the procedural or response processes among the more skilled individuals in a given domain.

Evidence for these inferences derives from a variety of sources. For example, experts in physics (Chi, Feltovich, & Glaser, 1982), mathematics (Schoenfeld & Herrmann, 1982), and computer programming (Adelson, 1981, 1984) have been found to sort or group domain-relevant items according to underlying "deep-structure" principles, whereas novices rely on more superficial "surface" features. It has also been reported that the internal representations of expert problem solvers are more principled and structured than those of novices (e.g., Chase & Chi, 1981; Chi, Feltovich, & Glaser, 1981; Chi & Glaser, 1980; Greeno, 1980; Voss, Tyler, & Yengo, 1983), thereby leading more directly to appropriate action sequences. And finally, there are numerous demonstrations that experts in an area are superior to novices in recalling domain-specific material but no different in recalling material that is not organized or structured according to the conventions of that area. This result, which has been interpreted as indicating that the expertise is associated with a facilitation of the encoding of domain-specific information, has been reported in studies of chess (Chase & Simon, 1973; Chi, 1978; DeGroot, 1978; Frey & Adesman, 1976; Lane & Robertson, 1979), bridge (Charness, 1979; Engle & Bukstel, 1978), music (Halpern & Bower, 1982), the game of go (Reitman, 1976), and with technical electronic drawings (Egan & Schwartz, 1979).

It is important to note that the effects of practice or expertise are not restricted to complex higher-order activities, because substantial practice effects have been reported in tasks as elementary as memory span (e.g., Ericsson, 1985), signal detection, perceptual discrimination, and choice reaction time (Salthouse & Somberg, 1982). In fact, beneficial effects of experience seem to be so pervasive that it has been suggested (Salthouse, 1985, Chap. 5) that they can be found in nearly all stages or components of information processing that have been identified. To the extent that this is true, the study of the effects of extensive experience and expertise has obvious implications for investigating individual differences in information processing. The remaining sections of the chapter contain discussions of some of these implications for the variable of age in adulthood.

## DOES EXPERIENCE PRODUCE CRYSTALLIZED KNOWLEDGE?

From the very earliest systematic investigations of adult age differences in cognitive functioning, researchers have made distinctions between intellectual abilities that exhibit rather dramatic age-related declines and intellectual abilities that either do not decline, or may actually increase, across adulthood. (See Table 4.1 in Salthouse, 1982, for illustrations of some of the terminology used to characterize this contrast.) The most popular terms in recent years have been the labels *fluid* and *crystallized* (e.g., Cattell, 1972; Horn, 1982; Horn & Cattell, 1967), with fluid abilities assumed to decline with age and crystallized abilities assumed to at least be maintained, or possibly even increase, with age.

Examination of the types of tasks postulated to assess the age-stable or age-increasing crystallized abilities suggests that, for the most part, what is being evaluated are the products of earlier processing, or what might be termed the crystallized residue of prior experience. For example, tests of vocabulary, factual knowledge, remote associations, or analogies based on esoteric information have been used as indices of an individual's level of crystallized ability, and all of these are clearly dependent on the quantity and quality of one's past experiences. Because increased age is generally associated with greater amounts of experience, it is certainly not surprising that performance on tasks dependent on experience does not decline with increased age (at least not until the typical retirement age of 65 to 70). In fact, the most puzzling aspect of the relation between age and crystallized abilities seems to be why, in light of the greater experience of older adults, there are so few reported increases in crystallized ability across adulthood. That is, if crystallized abilities primarily depend on cumulative experience, and if adults in their 60s have had about 40 more years of experience than adults in their 20s, why are the former not markedly superior to the latter in the performance of experience-dependent tasks rather than merely performing at roughly comparable levels?

At least four hypotheses can be advanced to account for the general failure to find more pervasive age-related increases in crystallized abilities. One hypothesis is that decreases in the efficiency of fluid ability processes presumed to be responsible for the effective conversion of experience into knowledge more than offset the increases attributable to greater experience. This hypothesis is clearly plausible because considerable research seems to support the idea that fluid abilities experience fairly substantial age-related declines, but at present one can only speculate about the specific correspondence between the benefits of increased experience and the costs of impaired efficiency of fluid abilities.

A second hypothesis, first proposed by Hebb (1942), is that there is a threshold level of experience relevant to performance on tests of crystallized abilities, and that once that threshold is exceeded, further increments in experience do not contribute to increases in performance. This interpretation seems reasonable if one assumes that the pool of potential information to which one is exposed (or from which relevant test items are sampled) is finite and relatively small. However, the existence of the well-publicized "information explosion" in contemporary society tends to weaken the credibility of the finite-knowledge assumption, and thus the hypothesis, at least in its strong version, should probably not be considered very tenable at the present time.

The third hypothesis to account for the failure to discover more age-related increases in crystallized abilities is that after a certain amount of knowledge has been acquired, further knowledge results in a higher level of abstraction and is not necessarily reflected by increments in measures designed to assess quantity of information. For example, Horn (1982) suggested that "improvements in . . . [crystallized ability] . . . probably reflect individuals' restructurings of their knowledge systems to make the knowledge increasingly more cohesive, correct, and accessible" (p. 266). Birren (1969) also speculated that ". . . with increased experience the adult forms broader concepts . . . [and consequently] . . . the adult, as he grows older, may be able to deal with his environment on a more abstract basis" (p. 25). Unfortunately, there currently seems to be very little evidence relevant to the existence or nature of these hypothesized qualitative changes in knowledge, and thus this hypothesis must also be considered speculative at the present time.

A fourth hypothesis that might be proposed to account for the general absence of expected increases with age in crystallized abilities is that as people grow older their opportunities to acquire new information often decrease because of occupational specialization and a narrowing of professional and personal interests. This hypothesis is distinct from the previous two hypotheses because no threshold level of knowledge or qualitative shift in the type of acquired knowledge is assumed, but instead there are postulated to be limits on the range of information to which one is exposed because of circumstances of one's life. Two implications of this view are that clearly increasing trends should be observed (1) when the information being queried falls within the individual's current realm of interests; or (2) when it is reasonable to assume that, because of the nature of one's occupation, opportunities to acquire new information have not been restricted.

Both of these expectations have largely been supported in the research literature. For example, Demming and Pressey (1957) found that older adults were better than young adults at answering questions based on "practical" information, such as the meaning of common legal terms, the use of yellow pages in the telephone book, and the type of people who might be called on to perform specific services. Gardner and Monge (1977) also reported an advantage of older adults in answering questions about death and disease. Furthermore, there are a number of reports that scores on tests of general information or vocabulary tend to increase with age among individuals drawn from occupations such as teachers or college professors (e.g., Garfield & Blek, 1952; Lachman & Lachman, 1980; Lachman, Lachman, & Taylor, 1982; Sorenson, 1933; Sward, 1945). Because these occupations, perhaps more than most others, seem to provide a nearly continuous exposure to new ideas and terminology, the findings that teachers and professors tend to exhibit age-related increases in measures of crystallized ability is consistent with the reduced-exposure interpretation of the failure to find more age-related increases in measures of crystallized ability.

Regardless of which of the four hypotheses to account for the lack of more frequent findings of age-related increases in crystallized ability is eventually supported, it seems reasonable to suggest that many cases of stability or increments in performance associated with increased age are attributable to greater experience on the part of older adults. It is still too early to conclude that abilities labeled as crystallized differ from those labeled as fluid solely in terms of the amount of experience adults typically receive with each class of ability, but this speculation seems generally consistent with the available data and certainly deserves further investigation.

## DIRECT MANIPULATION OF EXPERIENCE

One means of investigating the role of experience in cognitive aging is to determine whether age trends can be modified with direct manipulation of experience. Two distinct approaches to this issue have been employed. In both cases researchers have attempted to manipulate the quantity or quality of experience the individuals receive, but the goals of these manipulations have been quite different. Research conducted under the rubric of "training" has generally concentrated on demonstrating the existence of considerable plasticity or modifiability in the behavior of older adults, whereas age-comparative practice studies have attempted to determine whether the effects of age are invariant across different amounts of experience.

Many of the training studies (for reviews, see Baltes & Willis, 1982; Willis, 1985) have been motivated by a desire to investigate the validity of a stereotype of hopelessly incompetent older adults, as exemplified by clichés such as, "You can't teach an old dog new tricks." This pessimistic view warranted serious challenge because it has had considerable public acceptance and was advocated by no less a distinguished figure than William James, generally acclaimed as the father of American psychology:

> Outside of their own business, the ideas gained by men before they are twenty-five are practically the only ideas they shall have in their lives. They cannot get anything new. Disinterested curiosity is past, the mental grooves and channels set, the power of assimilation gone. (James, 1890, p. 402)

For a variety of reasons, including results from training studies, extreme views such as these are no longer held by most contemporary researchers in the area of cognitive aging. For example, the following remarks appeared a decade ago in an introduction to a review of age effects in learning and memory: "If the adage, 'You can't teach an old dog new tricks,' was not buried in the previous handbook . . . the research reported since then should complete the internment" (Arenberg & Robertson-Tchabo, 1977, p. 421).

To most cognitive-aging investigators, therefore, the issue is not whether older adults are capable of learning or exhibit behavioral plasticity but the degree to which their learning effectiveness or range of plasticity differs from that of young adults. Because numerous studies have convincingly demonstrated that the ability to learn or improve with experience is not completely lost in later adulthood, the meaningful question is not whether there is a complete or *absolute* loss in cognitive modifiability with increased age but rather whether there is a *relative* loss, and if so, why.

Unfortunately, because the focus of most training studies was on the existence of behavioral plasticity in later life, many have employed only a single (typically older adult) age group and are consequently of limited value with respect to the issue of relative loss. That is, when only one age group receives the training, it is impossible to determine whether the benefits of training would have been larger, smaller, or equivalent had the training been administered at different ages.

Age-comparative practice studies are also limited in value because very few studies have been reported in which adults of different ages have been administered practice or some type of experimental manipulation extending across more than a single session. Moreover, most of those studies have involved perceptual–motor activities such as choice reaction time, visual search, and card-sorting (e.g., Berg, Hertzog, & Hunt, 1982; Leonard & Newman, 1965; Madden & Nebes, 1980; Murrell, 1970; Noble, Baker, & Jones, 1964; Plude & Hoyer, 1981; Rabbitt, 1964; Salthouse & Somberg, 1982), although memory span tasks (Kliegl & Baltes, 1987; Taub, 1973; Taub & Long, 1972) and mental computation tasks (Charness, 1984, personal communication) have also been investigated.

The dominant finding from the available age-comparative practice studies has been that practice results in considerable improvement among all age groups but that age differences in overall level of performance are seldom completely eliminated with experience. It is still not clear from the existing literature whether there are reliable age differences in the rate of improvement associated with practice or experience, or whether such differences do occur but are a function of as yet unidentified parameters of the task or conditions of the practice.

Two points regarding the literature concerning effects of manipulated experience on age differences in cognitive functioning warrant special emphasis. The first is that there is at present no evidence that some degree of expertise in most cognitive tasks cannot be acquired by adults up to at least age 75. A discovery that many older adults with a few hours of experience outperform even the most talented of inexperienced young adults on a large variety of cognitive activities should therefore not be surprising. An obvious implication is that one's level of performance should always be evaluated relative to the amount of relevant practice or experience one has received and relative to the amount one can expect to receive in the context to which the researcher wishes to generalize. Very misleading conclusions could be reached if individuals are compared when they differ in the quantity of relevant experience, or if novice performance is assessed when attempting to predict performance in a work situation where people will have considerable experience.

The second point with respect to the results of the manipulated-experience studies is that the currently available evidence suggests that the age differences on many cognitive tasks are relatively invariant across at least moderate levels of experience. As noted above, adults of all ages appear to benefit from experience, and therefore experienced older adults will often be found to perform better than most young adults with lesser amounts of experience. However, when the confounding between age and task-specific experience is eliminated, the bulk of the existing data seems to suggest that age differences in performance still remain. This conclusion should be considered quite tentative because only a few task domains have been subjected to investigation, and the range of experience examined thus far has been quite limited; but it is of considerable importance for theoretical interpretations of the cause of age differences in cognitive functioning. We will return to this issue in the final section of the chapter.

## OCCUPATIONAL EXPERIENCE STUDIES

One important limitation of research attempting to manipulate the amount of relevant experience an individual receives is that it is enormously difficult to provide quantities of experience that come close to approaching that encountered in daily life or in most occupational situations. To illustrate, very few experimental studies have been reported in which age differences have been examined after 5 hours of practice—which might be considered equivalent to a single day on a new job. Furthermore, there have apparently been no studies in which the performance of young and old adults was contrasted after the equivalent of 1 month's experience, approximately 100 hours; and yet in many occupations people would still be considered rank novices after only a month on the job.

One means of overcoming these limitations of experimentally imposed experience studies might be to inspect the relationship between age and performance in actual occupational activities. Of course, there are numerous factors that complicate the interpretation of these relations simply in terms of experience, but occupational studies do have the distinct advantage of allowing examination of a much larger range of experience than is generally possible in experimental studies.

Unfortunately, but perhaps not unexpectedly, recent reviews of the effects of age on job performance (e.g., Davies & Sparrow, 1985; Rhodes, 1983; Waldman & Avolio, 1986) suggest that there is little overall consistency in the relevant literature. The nature of the relationship between age and performance apparently depends not only on the level of experience possessed by the worker but also on the type of job and the specific performance measure employed.

A particular concern from the perspective of determining the effects of experience on possible age differences in performance is that the measures available to assess actual job performance are rather crude (e.g., production records, supervisor ratings, performance appraisals) and may not be sensitive enough to detect age differences should they actually exist. Doubts about measurement insensitivity could possibly be resolved by making performance comparisons between experienced and inexperienced individuals in the relevant activity and demonstrating that age-related differences in performance can be detected among the inexperienced individuals even if they are not apparent among experienced individuals. For example, LaRiviere and Simonson (1965) and Smith and Greene (1962) both reported that age trends in speed of handwriting were minimal to nonexistent among adults from clerical and managerial occupations in which handwriting is a common daily activity, but that pronounced age-related declines in handwriting speed were evident for occupational groups in which handwriting was less frequently used.

Two studies by Murrell and his colleagues provide an especially intriguing demonstration of this interaction between age and experience. In the first study, Murrell, Powesland, and Forsaith (1962) compared inexperienced adults in their 20s with inexperienced adults in their 50s, and experienced adults in their 20s with experienced adults in their 50s, in the speed of aiming an industrial drill. The primary result was that "typical" age-related deficits in speed of performance were evident among the inexperienced or novice adults, but experienced workers in their 50s were just as fast as experienced workers in their 20s. A later study by Murrell and Humphries (1978) involving the activity of simultaneous translation revealed a similar age-by-experience interaction in that young novices were superior to old novices, but older professional translators performed equivalently to young professional translators.

Although the studies just discussed appear to provide convincing evidence that experience may attenuate or eliminate at least some of the detrimental effects associated with aging, there are at least two reasons why one should be cautious in accepting this interpretation. First, it is quite possible that something like "survival of the fittest" could have occurred among the experienced workers so that the older workers who remain available for performance comparison are more competent in certain occupationally relevant dimensions than their age cohorts who left that occupation. This type of selective attrition would have the consequence of biasing the contrast of experienced workers in favor of older adults, with no comparable bias operating among the inexperienced workers. Such a confounding would obviously jeopardize the interpretation of age-by-experience interactions in terms of experience attenuating the age effects, and thus the question of its existence must be resolved before the results should be considered strong support for the experiential interpretation.

A second weakness of the studies discussed above is that they were not analytical with respect to how experience could have led to the elimination or attenuation of age effects. In other words, even if one were to accept the interpretation that the absence of age trends among experienced individuals is due to experience somehow compensating for age-related declines, the studies provide no hint as to the mechanisms or processes that might have been used to achieve this compensation. It is primarily to address the question of exactly how experience might compensate for age-related impairments that the research strategy described in the following section was formulated.

## THE MOLAR EQUIVALENCE–MOLECULAR DECOMPOSITION STRATEGY

The preceding two research approaches each have advantages and disadvantages for the purpose of investigating the joint effects of age and experience. Practice studies have the advantage of rigorously controlling the amount of experience each individual receives and generally allowing very precise measurements of performance. However, they have the disadvantage of a quite restricted range of practice or experience that can be investigated because of the practical difficulties associated with providing extensive experience within a laboratory setting. Occupational studies allow the examination of much greater amounts of experience, albeit with some vagueness about the specific quantity or quality of experience received by any given individual. However, because performance in occupational settings is commonly evaluated with existing measures relevant to actual employment, and not with measures selected for their theoretical or analytical precision, the results from such studies are frequently not as theoretically informative as one would desire.

A new research strategy designed to avoid the problems of attempting to provide realistic amounts of experience in the laboratory, and the imprecision associated with relying on available measures of occupational assessment, was introduced several years ago by Neil Charness. This strategy, which I have called the Molar Equivalence–Molecular Decomposition Strategy (Salthouse, 1984), relies on naturalistic activities to capitalize on real-world experience but then decomposes those activities into their meaningful components to allow the detailed analysis and sensitivity of measurement characteristic of laboratory-based research.

The strategy involves selecting a sample of adults from a wide range of ages and a wide range of proficiency on some molar activity that in the aggregate exhibits no correlation between age and overall competence on the molar activity. The molar activity is then decomposed into molecular processes, and age trends are examined in each component process. By equating adults of different ages on molar proficiency it becomes possible to determine how people of different ages, and presumably different degrees of competency on relevant molecular processes, are able to achieve the same level of performance on the molar activity. A distinct advantage of this strategy is that the focus on the mechanisms responsible for accomplishing a given level of molar performance allows the investigator to determine what compensatory mechanisms are used by older adults to overcome the deficits normally experienced with increased age.

As mentioned above, the Molar Equivalence–Molecular Decomposition Strategy was introduced by Neil Charness in his studies of skilled bridge (Charness, 1979, 1983) and chess (Charness, 1981a, b, c) players. A consistent finding in these studies was that memory for domain-relevant information was positively related to measures of skill in the activity but was negatively related to the player's age. This was evident in a measure of the accuracy of recalling the identities of an assemblage of cards in bridge (1979) and in the accuracy of reproducing configurations of chess pieces (1981a, c). Unfortunately, no definitive conclusions were possible concerning the mechanisms used by older adults to compensate for their declining memory efficiency and still perform at a level of overall skill comparable to that of young adults.

One possible compensatory mechanism considered by Charness in the domain of chess was that older players had a more extensive knowledge base or "vocabulary" of chess patterns and associated actions. However, a discovery that there were no age differences in the quality of static evaluation of games in progress (1981a), together with the finding that older players relative to young players either had smaller-sized memory chunks (1981a) or did not differ in chunk size (1981c), was inconsistent with this interpretation because greater knowledge should result in better evaluations and larger knowledge units or chunks.

A finding that older players took less time than young players to select an equally good move led to the suggestion that "the compensating mechanism is more efficient search of the problem space" (1981a, p. 37). However, this interpretation was later placed in doubt when analyses (1981b) of the verbal protocols of the players while selecting the moves revealed that the older players considered significantly fewer alternative moves than did young players. The shorter time on the part of older players may therefore reflect search that is less extensive, rather than search that is more efficient. Charness himself seems to have accepted an interpretation of this type because in a recent discussion of these results (1985) he suggests that the age differences in search time may be an artifact of the young players continuing to search until the time limit, whereas older players stopped searching as soon as they found an acceptable move.

Another application of the Molar Equivalence–Molecular Decomposition Strategy has been reported by Salthouse (1984) in the domain of transcription typing. Typists between 19 and 72 years of age and ranging from 17 to 104 net words per minute in skill participated in the activity of normal typing, and in a series of typing-like tasks. Molar equivalence was established by selecting the sample of typists so that there was a near-zero ($r = -.01$) correlation between age and typing skill evaluated in terms of net words per minute, and then the activity of typing was decomposed by examining performance on a variety of tasks designed to assess proficiency on molecular processes presumed to be involved in typing.

A number of different measures of molecular proficiency were examined in this study. Several measures of perceptual–motor speed (e.g., choice reaction time, speed of repetitive tapping, rate of digit symbol substitution) revealed typical differences in favor of young adults (i.e., correlations between age and speed ranging from –0.4 to –0.6), but only one measure exhibited a difference favoring older adults ($r = +0.37$) consistent with the operation of a compensatory mechanism. This measure was derived from a manipulation of the number of simultaneously visible to-be-typed characters and was interpreted as an indication of how far ahead of the currently typed character the typist was focusing his or her attention. Because a greater span of anticipation minimizes the importance of the speed of perceptual–motor processes as a major factor in skilled typing, the larger span on the part of older typists was considered an extremely effective compensatory mechanism.

Research with the Molar Equivalence–Molecular Decomposition Strategy is still in its infancy, and it has thus far been applied only to the activities of bridge, chess, and transcription typing. It seems natural to extend it to activities like medical diagnosis, economic or weather forecasting, and virtually any type of multidimensional decision-making in which successful performance is dependent both on abilities that might be expected to exhibit age-related declines and abilities that might be expected to improve with experience. Many questions also remain unanswered concerning issues that might be addressed by the Molar Equivalence–Molecular Decomposition Strategy. Three of particular interest at present are described below.

One intriguing question, for which the answer is likely to be no but which currently lacks relevant data, is whether an extended anticipatory period is the only compensatory mechanism available to older adults. A larger eye–hand span with increased age among skilled typists is the only age-related compensatory mechanism with unequivocal evidence discovered thus far, but it seems reasonable to expect that a variety of different mechanisms might be employed by older adults to optimize their performance in activities in which they are highly experienced. Further systematic research with a number of different activities should allow this issue to be explored and should increase understanding of the nature of age-related compensation in cognitive functioning.

Another interesting question is whether the mechanisms presumably employed by older adults to compensate for their declining capacities are the same mechanisms used by skilled individuals at any age to accomplish their high degree of skill. In the case of typing it was discovered that a similar mechanism of expanded anticipation, as reflected in a larger eye–hand span, was employed by skilled typists and by older typists. However, it is at least possible that the processes used by highly skilled individuals to achieve a superior level of proficiency are not identical to those used by older adults to achieve a moderate level of proficiency in the face of declines in relevant capacities.

This distinction is of considerable theoretical importance because it might allow the researcher to determine whether what appears to be compensation is not actually a case of selective decline. That is, the mechanism might have developed during or after the period in which the decline occurred as a conscious or unconscious means of compensation, or it could have been developed during the skill-acquisition phase and for some reason was preserved at a high level while other components of overall performance experienced age-related declines. Expensive and laborious longitudinal studies could be conducted to investigate this issue, but the viability of the selective decline interpretation would be severely weakened if it were discovered that highly skilled individuals at any age employed different mechanisms from those utilized by moderately skilled older individuals.

A related question is whether it might be possible to selectively train compensatory mechanisms, or whether they are developed only after an extensive period of skill acquisition. Should the former prove to be the case, there might be tremendous potential for remediating age-related performance differences in activities considered important enough to warrant specific training procedures. Unfortunately, because so little is yet understood about the nature of age-related compensatory mechanisms, it is still too early to know whether these mechanisms might be selectively facilitated by short-term interventions.

## CONCEPTUALIZATIONS OF THE ROLE OF EXPERIENCE IN ADULT COGNITION

This final section of the chapter is concerned with discussing, and provisionally evaluating, two alternative conceptualizations of the role of experience in age differences in cognition. From one perspective, differential experience is viewed as a causal factor contributing to many of the age differences observed in cognitive functioning; from the other perspective, experience is merely thought of as a dimension to be considered when attempting to generalize from a particular set of results.

It is often claimed, in both the popular press and in the scientific literature, that age effects are less pronounced in familiar activities than in novel or unfamiliar activities. This assertion probably has a large degree of truth because familiar activities are, by definition, those with the greatest amount of experience, and older adults will often be found to have had more experience than young adults. What is not yet known is whether this assertion is also true when the amount of experience is equated across age groups.

There are two reasons for this lack of knowledge about age trends when the amount of experience is extensive and equivalent among all individuals. One is that the relevant studies have been, and will probably continue to be, very rare, because it is extremely expensive and time-consuming to provide enough experience to achieve highly competent levels of performance on a complex activity in the laboratory. It might be possible to obtain precise records of the amount and quality of experience received by people of different ages in occupational settings, but this would probably require much more monitoring than is the practice at the present time.

The second reason it is difficult to determine whether age differences are truly attenuated when experience is equated at high levels is that the sensitivity of measurement is generally reduced when performance reaches expert levels. That is, the tasks and measures designed for assessment in the general population will likely have little discriminability at extremely high levels of performance. This again is not an insurmountable problem, but measurement insensitivity has probably contributed to a lack of solid knowledge about age effects with highly practiced activities.

It is also not known at present whether experience retards, prevents, or even remediates age-related declines, or whether it simply obscures those declines by superimposing experience-related improvements on top of them. The issue here is, exactly what is the role of experience in cognitive aging? The following discussion considers two different perspectives on this issue.

What is sometimes referred to as the "disuse theory of aging" postulates that at least some of the age-related deficits observed in cognitive tasks are attributable to older adults being less familiar or experienced with those activities, or the materials used in them, than young adults. To the extent that there is this type of confounding, with older adults having less experience with the materials or tasks than young adults, then it is at least conceivable that some of the cognitive performance differences observed across adults of different ages are artifacts of differential experience.

Although this line of reasoning is quite plausible, several issues should be carefully considered before accepting the interpretation that previously reported age differences in cognitive functioning are artifacts of differential experience. One issue is whether or not there is actually evidence that cognitive tasks in which performance differences in favor of young adults are typically found are those with which young adults have had more experience than older adults. It is often speculated that older adults, compared to young adults, have had less recent practice with "school-related activities" if for no other reason than the greater interval elapsing since their formal schooling; but this assertion has seldom been convincingly documented. Cornelius (1984) did report that fluid tests of cognitive ability are rated less familiar than crystallized ability tests by adults of all ages, and particularly so by older adults who performed at the lowest levels on the fluid tests. These results are consistent with the disuse interpretation, but they cannot be considered conclusive because the ratings were generated by the participants after having performed the tests, and hence it is possible that perceptions of one's performance influenced the ratings of familiarity.

Research indicating that age trends can be reversed by reliance on specialized knowledge favoring older adults is sometimes cited in support of the differential-familiarity interpretation. A number of studies have reported that older adults, compared to young adults, are either faster at identification or more accurate in recall with "dated" words or objects (e.g., Barrett & Watkins, 1986; Barrett & Wright, 1981; Poon & Fozard, 1976; Worden & Sherman-Brown, 1983) and with names or information about politicians, musicians, or actors and actresses popular before 1945 (e.g., Hawley-Dunn & McIntosh, 1984; Hultsch & Dixon, 1983).

The meaning of these results with generation-specific materials is still unclear, however, because although they unequivocally demonstrate an age-related increase in performance attributable to specific experience, the opportunities for young adults to acquire this type of information was severely limited. The findings therefore serve to confirm the idea that the possession of specialized knowledge can influence performance on a variety of cognitive tasks, but they do not necessarily implicate lack of familiarity with tasks or materials as a factor contributing to the frequently reported age differences in performance. Only if it could be assumed that older adults had many fewer opportunities than young adults to acquire information about the materials commonly used in assessments of cognitive functioning would these findings be relevant to an experiential interpretation of age differences in performance. Because evidence relevant to this assumption currently seems to be lacking, it is consequently premature to claim, as some have suggested, that this type of material provides the only truly "age-fair" cognitive assessment currently possible and that results suggesting age-related decreases in effectiveness of cognitive functioning are merely artifacts of differential experience across the adult years.

Another issue that should be addressed with respect to the disuse interpretation of cognitive aging phenomena is whether differential experience is truly sufficient to account for commonly observed age differences in cognitive performance. That is, even if a correlation were established between the existence or magnitude of age differences in cognitive performance and the degree of inexperience or unfamiliarity with the tasks or materials, one would not know whether differential experience was the primary factor contributing to age differences in cognitive functioning.

Two sets of observations seem to rule out this latter interpretation. The first is that fairly typical patterns of age differences are often reported in measures of fluid cognition (e.g., reasoning, problem solving, and memory) when comparisons are made between young and old students (e.g., Arenberg & Robertson-Tchabo, 1985; Hartley, 1986; Hooper, Hooper, & Colbert, 1984), or between people of different ages engaged in the same intellectually demanding profession, such as teachers (e.g., Alpaugh & Birren, 1977; Lachman & Lachman, 1980; Lachman, Lachman, & Taylor, 1982) or college professors (e.g., Perlmutter, 1978; Sward, 1945). To the extent that people in the same occupational category share similar experiences, it seems unreasonable to attribute the existence of age differences in certain types of cognitive functioning to variations in quality or quantity of experience.

The second set of observations relevant to the proposal that age differences in certain cognitive abilities might originate because the tasks are more familiar to young adults than to older adults is that typical age trends favoring young adults have been observed when the tasks were deliberately oriented toward adult activities. For example, concept identification abilities have been assessed in the context of discovering which foods were poisoned after a meal in a restaurant (e.g., Arenberg, 1968; Hartley, 1981; Hayslip & Sterns, 1979); reasoning and problem-solving abilities have been evaluated with practical problems deliberately constructed to appeal to adults rather than children (e.g., Cohen, 1981; Denney & Palmer, 1981; Denney, Pearce, & Palmer, 1982); critical thinking ability has been assessed in the form of questions about the interpretations of newspaper-like stories (e.g., Burton & Joel, 1945; Cohen & Faulkner, 1981; Friend & Zubek, 1958) or familiar proverbs (e.g., Bromley, 1957); and memory ability has been assessed with items from a fictitious shopping list (e.g., McCarthy, Ferris, Clark, & Crook, 1981) and items from coherent stories (e.g., Arbuckle & Harsany, 1985; Byrd, 1985; Cohen, 1979; Cohen & Faulkner, 1984; Hartley, 1986; Petros, Tabor, Cooney, & Chabot, 1983; Spilich, 1983; Surber, Kowalski, & Pena-Paez, 1984), as well as by asking questions about previously exposed scenes or maps (e.g., Bartlett, Till, Gernsbacher, & Gorman, 1983; Bruce & Herman, 1983; Light & Zelinski, 1983; Perlmutter, Metzger, Nezworski, & Miller, 1981; Thomas, 1985); recently experienced events, conversations, or activities (e.g., Bromley, 1958; Horn, Donaldson, & Ekstrom, 1981; Kausler & Hakami, 1983a, b; Kausler, Lichty, & Davis, 1985; Kausler, Lichty, & Freund, 1985; Kausler, Lichty, Hakami, & Freund, 1986; Peak, 1968, 1970), or recently viewed motion pictures (e.g., Jones, Conrad, & Horn, 1928). Despite the apparent ecological validity of these assessments, each of the studies cited above reported increased age to be associated with poorer performance. The available evidence, therefore, does not seem to support the view that the only reason older adults perform poorly on cognitive tasks is that they are less familiar with activities of this type than are young adults.

A third type of evidence that could be of considerable relevance to the disuse interpretation would be results indicating that age differences in performance are eliminated after all individuals have received comparable amounts of experience or training. A finding of this nature might be especially convincing because it would suggest that the initial age differences were apparently reversible and thus may well have been caused by low levels of prior experience on the part of older adults.

Although this kind of experiential intervention involving either training or practice is currently very popular in the area of cognitive aging, the results of such studies are not often easily interpretable. The major problem is that interventions can have a number of effects that have quite different types of implications. For example, greater benefits of manipulated experience on the part of older adults compared to young adults could be due to the experience (1) altering the mechanism responsible for the initial age differences, (2) altering some other mechanism, or (3) reducing the gap between one's performance and one's competence.

Fortunately, there appear to be ways in which these possibilities could conceivably be discriminated. For example, the third alternative might be distinguished from the first two by examining the intervention effects over an extended period. That is, the performance–competence gap alternative should be operative only at relatively low levels of experience because if the behavior is not easily changed, then it probably reflects true competence rather than mere performance. Examination of the specificity of the effects associated with the experiential intervention might further allow a distinction between the first and second alternatives. If the experience manipulation influences the mechanism responsible for the initial differences between young and older adults, then not only should the latter improve more than the former, but this improvement should be restricted to the abilities in which older adults are inferior to young adults and for which the experience has been relevant.

Interpretation of intervention studies is hampered by still another complication. This is that even when ideal results are obtained (i.e., the older adults improve more in the impaired ability after the provision of relevant experience so that the age differences are eliminated), one cannot necessarily conclude that the initial age differences were remediated, because quite different mechanisms may have been involved in the development of those differences and in their apparent elimination by the intervention. To illustrate, providing bifocal corrective lenses will likely improve the visual performance of adults who have become presbyopic, but the intervention of glasses would not be considered to remediate the deficit because the mechanism is not identical to that responsible for producing the initial deficit. A conclusion that remediation was actually involved in the elimination of the deficit therefore requires a detailed analysis of the processes contributing to performance while the impairments were developing and after the introduction of the intervention.

Preliminary results from this type of analysis were reported in a recent study by Willis (1986), in which an attempt was made to characterize longitudinal decline and training benefits in terms of speed and accuracy components of performance. The major finding in this study was that both speed and accuracy declined with age but that training was primarily associated with an increase in accuracy. Although this might be interpreted as suggesting that different mechanisms are involved in age-related decline and experience-mediated improvements, further research is obviously necessary before a definitive conclusion can be reached concerning the possibility of truly reversing age-related differences in cognition by experiential interventions.

The role of experience as a causal factor responsible for age differences in cognition is therefore still very much an open question. Experience has been demonstrated to exert considerable influence on nearly all aspects of performance; thus, if there are age differences in the type or amount of experience, then experiential factors could be an important determinant of age differences in cognitive performance. However, the available evidence suggests that differential experience is not the only factor involved in cognitive age differences because similar types of young superiority are found even when the materials or tasks are designed to be ecologically valid for adults of all ages, and consequently for which experience is presumably equivalent across the adult years or to the advantage of older adults. Studies in which the nature or quantity of experience received by the research participants is manipulated via practice or training may eventually help resolve this question, but problems of interpretation have thus far limited the contributions of this approach.

A second way of conceptualizing the role of experience in cognitive aging is in terms of a dimension to be considered when attempting to make generalizations about occupational effectiveness or everyday functioning based on results from laboratory studies. Because the research evidence clearly suggests that adults of all ages can benefit from experience and because increased age will generally be found to be positively correlated with amount of relevant experience, it seems reasonable to suggest that research based on adults with little or no experience in the activities being measured may not be particularly meaningful for the purpose of predicting competence of experienced individuals. Although differential experience may not be the source of most age differences observed in cognitive functioning, amount of relevant experience is still a vastly more important source of variations in many types of cognitive performance than is an individual's age. For most practical purposes, therefore, the more important question may not be the individual's age, but his or her level of expertise in the activity of interest.

## SUMMARY

A major theme of this chapter has been that specific experience is an extremely important variable moderating human performance and one that should be considered when attempting to examine any type of individual differences in behavior. It is possible that differential experience is responsible for the distinct age trends evident in process, or fluid, as opposed to product, or crystallized, aspects of cognitive functioning; and it is certainly the case that level of experience is an important consideration in attempting to generalize from laboratory situations to real world activities. Research has convincingly demonstrated that adults of all ages benefit from experience; thus, comparisons of experienced older adults with inexperienced young adults will probably favor the former in many situations. The mechanisms responsible for improvement associated with experience are still not known—particularly whether or not they are the same as those involved in the decline in performance associated with increased age—but a promising new approach, the Molar Equivalence–Molecular Decomposition Strategy, may eventually provide answers to this question. And finally, the evidence still appears inconclusive on the issue of whether differential experience is a causal factor in the age differences in cognitive functioning.

## REFERENCES

Adelson, B. (1981). Problem solving and the development of abstract categories in programming languages. *Memory & Cognition, 9,* 422–433.

Adelson, B. (1984). When novices surpass experts: The difficulty of a task may increase with expertise. *Journal of Experimental Psychology: Learning, Memory and Cognition, 10,* 483–495.

Alpaugh, P. K., & Birren, J. E. (1977). Variables affecting creative contributions across the adult life span. *Human Development, 20,* 240–248.

Arbuckle, T. Y., & Harsany, M. (1985). Adult age differences in recall of a moral dilemma under intentional, incidental, and dual-task instructions. *Experimental Aging Research, 11,* 175–177.

Arenberg, D. (1968). Concept problem solving in young and old adults. *Journal of Gerontology, 23,* 279–282.

Arenberg, D., & Robertson-Tchabo, E. A. (1977). Learning and aging. In J. E. Birren & K. W. Schaie (Eds.), *Handbook of the psychology of aging* (pp. 421–449). New York: Van Nostrand.

Arenberg, D., & Robertson-Tchabo, E. A. (1985). Adult age differences in memory and linguistic integration revisited. *Experimental Aging Research, 11,* 187–191.

Baltes, P. B., & Willis, S. L. (1982). Plasticity and enhancement of intellectual functioning in old age: Penn State's Adult Development and Enrichment Project (ADEPT). In F. I. M. Craik & S. Trehub (Eds.), *Aging and cognitive processes* (pp. 353–389). New York: Plenum.

Barrett, T. R., & Watkins, S. K. (1986). Word familiarity and cardiovascular health as determinants of age-related recall differences. *Journal of Gerontology, 41,* 222–224.

Barrett, T. R., & Wright, M. (1981). Age-related facilitation in recall following semantic processing. *Journal of Gerontology, 36,* 194–199.

Bartlett, J. C., Till, R. E., Gernsbacher, M., & Gorman, W. (1983). Age-related differences in memory for lateral orientation of pictures. *Journal of Gerontology, 38,* 439–446.

Berg, C., Hertzog, C., & Hunt, E. (1982). Age differences in the speed of mental rotation. *Developmental Psychology, 18,* 95–107.

Birren, J. E. (1969). Age and decision strategies. In A. T. Welford & J. E. Birren (Eds.), *Interdisciplinary topics in gerontology, Vol. 4* (pp. 23–36). Basel: S. Karger.

Bromley, D. B. (1957). Some effects of age on the quality of intellectual output. *Journal of Gerontology, 12,* 318–323.

Bromley, D. B. (1958). Some effects of age on short-term learning and remembering. *Journal of Gerontology, 13,* 398–406.

Bruce, P. R., & Herman, J. F. (1983). Spatial knowledge of young and elderly adults: Scene recognition from familiar and unfamiliar perspectives. *Experimental Aging Research, 9,* 169–173.

Burton, A., & Joel, W. (1945). Adult norms for the Watson-Glaser Tests of Critical Thinking. *Journal of Psychology, 19,* 43–48.

Byrd, M. (1985). Age differences in the ability to recall and summarize textual information. *Experimental Aging Research, 11,* 87–91.

Cattell, R. B. (1972). *Abilities: Their structure, growth, and action.* Boston: Houghton-Mifflin.

Charness, N. (1979). Components of skill in bridge. *Canadian Journal of Psychology, 33,* 1–16.

Charness, N. (1981a). Aging and skilled problem solving. *Journal of Experimental Psychology: General, 110,* 21–38.

Charness, N. (1981b). Search in chess: Age and skill differences. *Journal of Experimental Psychology: Human Perception and Performance, 7,* 467–476.

Charness, N. (1981c). Visual short-term memory and aging in chess players. *Journal of Gerontology, 36,* 615–619.

Charness, N. (1983). Age, skill, and bridge bidding: A chronometric analysis. *Journal of Verbal Learning and Verbal Behavior, 22,* 406–416.

Charness, N. (1985). Aging and problem-solving performance. In N. Charness (Ed.), *Aging and human performance* (pp. 226–259). Chichester, England: Wiley.

Chase, W. G., & Chi, M. T. H. (1981). Cognitive skill: Implications for spatial skill in large-scale environments. In J. H. Harvey (Ed.), *Cognition, social behavior, and the environment* (pp. 111–136). Hillsdale, NJ: Erlbaum.

Chase, W. G., & Simon, H. A. (1973). Perception in chess. *Cognitive Psychology, 4,* 55–81.

Chi, M. T. H. (1978). Knowledge structures and memory development. In R. C. Siegler (Ed.), *Children's thinking: What develops?* (pp. 73–96). Hillsdale, NJ: Erlbaum.

Chi, M. T. H., Feltovich, P. J., & Glaser, R. (1981). Categorization and representation of physics problems by experts and novices. *Cognitive Science, 5,* 121–152.

Chi, M. T. H., & Glaser, R. (1980). The measurement of expertise: Analysis of the development of knowledge and skill as a basis for assessing achievement. In E. L. Baker & E. S. Quellmalz (Eds.), *Educational testing and evaluation: Design analysis and policy* (pp. 37–47). Beverly Hills, CA: Sage.

Cohen, G. (1979). Language comprehension in old age. *Cognitive Psychology, 11,* 412–429.

Cohen, G. (1981). Inferential reasoning in old age. *Cognition, 9,* 59–72.

Cohen, G., & Faulkner, D. (1981). Memory for discourse in old age. *Discourse Processes, 4,* 253–265.

Cohen, G., & Faulkner, D. (1984). Memory for text: Some age differences in the nature of the information that is retained after listening to texts. In H. Buoma & D. G. Bouwhuis (Eds.), *Attention and performance,* Vol. 10 (pp. 501–513). Hillsdale, NJ: Erlbaum.

Cornelius, S. W. (1984). Classic pattern of intellectual aging: Test familiarity, difficulty, and performance. *Journal of Gerontology, 39,* 201–206.

Davies, D. R., & Sparrow, P. R. (1985). Age and work behaviour. In N. Charness (Ed.), *Aging and human performance* (pp. 293–332). Chichester, England: Wiley.

DeGroot, A. D. (1978). *Thought and choice in chess* (2nd ed.). The Hague: Mouton.

Demming, J. A., & Pressey, S. L. (1957). Tests indigenous to the adult and older years. *Journal of Counseling Psychology, 4,* 144–148.

Denney, N. W., & Palmer, A. M. (1981). Adult age differences in traditional and practical problem-solving measures. *Journal of Gerontology, 36,* 323–328.

Denney, N. W., Pearce, K. A., & Palmer, A. M. (1982). A developmental study of adults' performance on traditional and practical problem-solving tasks. *Experimental Aging Research, 8,* 115–118.

Egan, D. E., & Schwartz, B. J. (1979). Chunking in recall of symbolic drawings. *Memory & Cognition, 7,* 149–158.

Engle, R. W., & Bukstel, L. (1978). Memory processes among bridge players of differing expertise. *American Journal of Psychology, 91,* 673–689.

Ericsson, K. A. (1985). Memory skill. *Canadian Journal of Psychology, 39,* 188–231.

Frey, P. W., & Adesman, P. (1976). Recall memory for visually presented chess positions. *Memory & Cognition, 4,* 541–547.

Friend, C. M., & Zubek, J. P. (1958). The effects of age on critical thinking ability. *Journal of Gerontologist, 13,* 407–413.

Gardner, E. F., & Monge, R. H. (1977). Adult age differences in cognitive abilities and educational background. *Experimental Aging Research, 3,* 337–383.

Garfield, S. L., & Blek, L. (1952). Age, vocabulary level, and mental impairment. *Journal of Consulting Psychology, 16,* 395–398.

Greeno, J. G. (1980). Some examples of cognitive task analysis with instructional implications. In R. E. Snow, P. Federico, & W. E. Montague (Eds.), *Aptitude, learning and instruction,* Vol. 2 (pp. 1–21). Hillsdale, NJ: Erlbaum.

Halpern, A. R., & Bower, G. H. (1982). Musical expertise and melodic structure in memory for musical notation. *American Journal of Psychology, 95,* 31–50.

Hartley, A. (1981). Adult age differences in deductive reasoning. *Journal of Gerontology, 36,* 700–706.

Hartley, J. (1986). Reader and text variables as determinants of discourse memory in adulthood. *Psychology and Aging, 1,* 150–158.

Hawley-Dunn, P., & McIntosh, J. L. (1984). Meaningfulness and recall of names by young and old adults. *Journal of Gerontology, 39,* 583–585.

Hayslip, B., & Sterns, H. (1979). Age differences in relationships between crystallized and fluid intelligences and problem solving. *Journal of Gerontology, 34,* 404–414.

Hebb, D. O. (1942). The effect of early and late brain injury upon test scores and the nature of normal adult intelligence. *Proceedings of the American Philosophical Society, 85,* 275–292.

Hooper, F. H., Hooper, J. O., & Colbert, K. C. (1984). *Personality and memory correlates of intellectual functioning: Young adulthood to old age.* Basel: S. Karger.

Horn, J. L. (1982). The theory of fluid and crystallized intelligence in relation to concepts of cognitive psychology and aging in adulthood. In F. I. M. Craik & S. Trehub (Eds.), *Aging and cognitive processes* (pp. 237–278). New York: Plenum.

Horn, J. L., & Cattell, R. B. (1967). Age differences in fluid and crystallized intelligence. *Acta Psychologica, 26,* 107–129.

Horn, J. L., Donaldson, G., & Ekstrom, R. (1981). Apprehension, memory and fluid intelligence decline in adulthood. *Research on Aging, 3,* 33–84.

Hultsch, D. F., & Dixon, R. A. (1983). The role of pre-experimental knowledge in text processing in adulthood. *Experimental Aging Research, 9,* 17–22.

James, W. (1890). *Principles of psychology,* Vol. 2. New York: Holt.

Jones, H. E., Conrad, H., & Horn, A. (1928). Psychological studies of motion pictures. II. Observation and recall as a function of age. *University of California Publications in Psychology, 3,* 225–243.

Kausler, D. H., & Hakami, M. K. (1983a). Memory for activities: Adult age differences and intentionality. *Developmental Psychology, 119,* 889–894.

Kausler, D. H., & Hakami, M. K. (1983b). Memory for topics of conversation: Adult age differences and intentionality. *Experimental Aging Research, 9,* 153–157.

Kausler, D. H., Lichty, W., & Davis, R. T. (1985). Temporal memory for performed activities: Intentionality and age differences. *Developmental Psychology, 21,* 1132–1138.

Kausler, D. H., Lichty, W., & Freund, J. S. (1985). Adult age differences in recognition memory and frequency judgments for planned versus performed activities. *Developmental Psychology, 21,* 647–654.

Kausler, D. H., Lichty, W., Hakami, M. K., & Freund, J. S. (1986). Activity duration and adult age differences in memory for activity performance. *Psychology and Aging, 1,* 80–81.

Kliegl, R., & Baltes, P. B. (1987). Theory-guided analysis of mechanisms of development and aging through testing-the-limits and research on expertise. In C. Schooler & K. W. Schaie (Eds.), *Cognitive functioning and social structure over the life course* (pp. 95–119). Norwood, NJ: Ablex.

Lachman, R., & Lachman, J. L. (1980). Age and the actualization of world knowledge. In L. W. Poon, J. L. Fozard, L. S. Cermak, D. Arenberg, & L. W. Thompson (Eds.), *New directions in memory and aging* (pp. 285–311). Hillsdale, NJ: Erlbaum.

Lachman, R., Lachman, J. L., & Taylor, D. W. (1982). Reallocation of mental resources over the productive lifespan: Assumptions and task analyses. In F. I. M. Craik & S. Trehub (Eds.), *Aging and cognitive processes* (pp. 279–308). New York: Plenum.

Lane, D. M., & Robertson, L. (1979). The generality of the levels of processing hypothesis: An application to memory for chess positions. *Memory & Cognition, 7,* 253–256.

LaRiviere, J. E., & Simonson, E. (1965). The effect of age and occupation on speed of writing. *Journal of Gerontology, 20,* 415–416.

Leonard, J. A., & Newman, R. C. (1965). On the acquisition and maintenance of high speed and high accuracy in a keyboard task. *Ergonomics, 8,* 281–304.

Light, L. L., & Zelinski, E. M. (1983). Memory for spatial information in young and old adults. *Developmental Psychology, 19,* 901–906.

Madden, D. J., & Nebes, R. D. (1980). Aging and the development of automaticity in visual search. *Developmental Psychology, 16,* 377–384.

McCarthy, M., Ferris, S. H., Clark, E., & Crook, T. (1981). Acquisition and retention of categorized material in normal aging and senile dementia. *Experimental Aging Research, 7*, 127–135.

Murrell, K. F. H. (1970). The effect of extensive practice on age differences in reaction time. *Journal of Gerontology, 25*, 268–274.

Murrell, K. F. H., & Humphries, S. (1978). Age, experience, and short-term memory. In M. M. Gruneberg, P. E. Morris, & R. N. Sykes (Eds.), *Practical aspects of memory* (pp. 363–365). London: Academic Press.

Murrell, K. F. H., Powesland, P. F., & Forsaith, B. (1962). A study of pillar-drilling in relation to age. *Occupational Psychology, 36*, 45–52.

Noble, C. E., Baker, B. L., & Jones, T. A. (1964). Age and sex parameters in psychomotor learning. *Perceptual & Motor Skills, 19*, 935–945.

Peak, D. T. (1968). Changes in short-term memory in a group of aging community residents. *Journal of Gerontology, 23*, 9–16.

Peak, D. T. (1970). A replication study of changes in short-term memory in a group of aging community residents. *Journal of Gerontology, 25*, 316–319.

Perlmutter, M. (1978). What is memory aging the aging of? *Developmental Psychology, 14*, 330–345.

Perlmutter, M., Metzger, R., Nezworski, T., & Miller, K. (1981). Spatial and temporal memory in 20 and 60 year olds. *Journal of Gerontology, 36*, 59–65.

Petros, T., Tabor, L., Cooney, T., & Chabot, R. J. (1983). Adult age differences in sensitivity to semantic structure of prose. *Developmental Psychology, 19*, 907–914.

Plude, D. J., & Hoyer, W. J. (1981). Adult age differences in visual search as a function of stimulus mapping and processing level. *Journal of Gerontology, 36*, 598–604.

Poon, L. W., & Fozard, J. L. (1976). Speed of retrieval from long-term memory in relation to age, familiarity, and datedness of information. *Journal of Gerontology, 33*, 711–717.

Rabbitt, P. M. A. (1964). Set and age in a choice response task. *Journal of Gerontology, 19*, 301–306.

Reitman, J. S. (1976). Skilled perception in GO: Deducing memory structures from inter-response times. *Cognitive Psychology, 8*, 336–356.

Rhodes, S. R. (1983). Age-related differences in work attitudes and behavior: A review and conceptual analysis. *Psychological Bulletin, 93*, 328–367.

Salthouse, T. A. (1982). *Adult cognition*. New York: Springer-Verlag.

Salthouse, T. A. (1984). Effects of age and skill in typing. *Journal of Experimental Psychology: General, 113*, 345–371.

Salthouse, T. A. (1985). *A theory of cognitive aging*. Amsterdam: North-Holland.

Salthouse, T. A., & Somberg, B. L. (1982). Skilled performance: The effects of adult age and experience on elementary processes. *Journal of Experimental Psychology: General, 111*, 176–207.

Schoenfeld, A. H., & Herrmann, D. J. (1982). Problem perception and knowledge structure in expert and novice mathematical problem solvers. *Journal of Experimental Psychology: Learning, Memory and Cognition, 8*, 484–494.

Smith, K. U., & Greene, D. (1962). Scientific motion study and ageing processes in performance. *Ergonomics, 5*, 155–164.

Sorenson, H. (1933). Mental ability over a wide range of adult ages. *Journal of Applied Psychology, 17*, 729–741.

Spilich, G. J. (1983). Life-span components of text processing: Structural and procedural differences. *Journal of Verbal Learning and Verbal Behavior, 22,* 231–244.

Surber, J. R., Kowalski, A. H., & Pena-Paez, A. (1984). Effects of aging on the recall of extended expository prose. *Experimental Aging Research, 10,* 25–28.

Sward, K. (1945). Age and mental ability in superior men. *American Journal of Psychology, 58,* 443–479.

Taub, H. A. (1973). Memory span, practice and aging. *Journal of Gerontology, 28,* 335–338.

Taub, H. A., & Long, M. K. (1972). The effects of practice on short-term memory of young and old subjects. *Journal of Gerontology, 27,* 494–499.

Thomas, J. L. (1985). Visual memory: Adult age differences in map recall and learning strategies. *Experimental Aging Research, 11,* 93–95.

Voss, J. F., Tyler, S. W., & Yengo, L. A. (1983). Individual differences in the solving of social science problems. In R. F. Dillon & R. R. Schmeck (Eds.), *Individual differences in cognition,* Vol. 1 (pp. 205–232). New York: Academic Press.

Waldman, D. A., & Avolio, B. J. (1986). A meta-analysis of age differences in job performance. *Journal of Applied Psychology, 71,* 33–38.

Willis, S. L. (1985). Towards an educational psychology of the older adult learner: Intellectual and cognitive bases. In J. E. Birren & K. W. Schaie (Eds.), *Handbook of the psychology of aging* (2nd ed.) (pp. 818–847). New York: Van Nostrand Reinhold.

Willis, S. L. (1986, August). *Inductive reasoning: Longitudinal change and cognitive training.* Paper presented at the meeting of the American Psychological Association, Washington, DC.

Worden, P. E., & Sherman-Brown, S. (1983). A word-frequency cohort effect in young versus elderly adults' memory for words. *Developmental Psychology, 19,* 521–530.

CHAPTER 7

# Cognitive Training and Everyday Competence

SHERRY L. WILLIS
DEPARTMENT OF INDIVIDUAL AND FAMILY STUDIES
THE PENNSYLVANIA STATE UNIVERSITY
UNIVERSITY PARK, PENNSYLVANIA

This chapter will be divided into three major sections, with each section focusing on an issue associated with cognitive training research with the elderly. In the first section, we examine what are some major questions or goals addressed by cognitive training research and consider the appropriateness of age-comparative research designs in addressing these questions. In the second section, we discuss the implications of cognitive training for enhancing competence in real-life tasks. In the third section, the findings of cognitive training are related to current models of intellectual aging.

## MAJOR QUESTIONS ADDRESSED IN COGNITIVE TRAINING RESEARCH

The implicit goal of most cognitive training research has been to increase our understanding of intellectual aging (Denney, 1982; Sterns & Sanders, 1980; Willis, in press). Much of the training literature has focused on three major questions regarding intellectual aging:

1. To what extent can the elderly's cognitive performance be modified (improved), and what is the range of individual differences in the magnitude of improvement?
2. What types of experimental manipulations are effective in modifying the elderly's cognitive performance?
3. What aspects of cognitive performance are acutally modified via cognitive intervention?

Preparation of this chapter was supported by research grants AG03544 and AG05304 from the National Institute on Aging.

Before discussing each of these questions in more detail, one particular limitation of the current training literature should be noted. Virtually all training research has focused on cognitive domains (e.g., memory, problem solving, fluid intelligence) that show the largest age differences or greatest age-related decline. Although targeting training efforts on deficiencies may at first appear reasonable, it remains, nevertheless, that little is known regarding the potential for further enhancement of cognitive domains (e.g., verbal ability) that exhibit little normative decline and thus are considered well-functioning in many elderly (Baltes, Dittman-Kohli, & Dixon, 1984).

This dearth of cognitive training research on normatively stable abilities is problematic both in regard to the development of theories of intellectual aging and in regard to applied concerns. From a theoretical perspective, behavioral plasticity is an issue that needs to be examined with regard to stable as well as declining areas of cognitive functioning in order to understand across cognitive domains the range of variability that can be produced through experimental manipulation (Kliegl & Baltes, in press). Examination of plasticity in well-functioning cognitive domains may be particularly important to understanding areas of growth and development unique to old age.

From an applied perspective, a singular focus on remediation or compensation for deficits may result in a limited and unbalanced approach to behavioral intervention. Some approaches to rehabilitation argue for emphasizing the individual's "strengths," rather than the "weaknesses." For example, verbal ability has been found in several studies to be a significant predictor of working memory in old age; in particular, verbal ability has been related to use of mnemonic strategies (Poon, 1985). However, enhancement of verbal ability as an intervention procedure has received little attention in memory training research (Poon, Fozard, Cermak, Arenberg, & Thompson, 1980).

## Examining the Range of Plasticity/Variability in Training Improvement

The most frequently addressed question in training research focuses on the extent to which intervention procedures are effective in improving the performance of subjects receiving training. What was the magnitude of improvement associated with training? This issue has sometimes been discussed in terms of developmental plasticity (Baltes & Baltes, 1980; Baltes & Willis, 1982). What is the range of plasticity in the individual's cognitive performance that can be elicited via experimental manipulation? Plasticity has typically been measured by comparing the individual's normal (unexercised) performance level with his/her optimal performance level, as assessed following some type of training or practice (Denney, 1982).

It is important to note that plasticity is concerned primarily with *intra-*

*individual* change. The emphasis is on the range or magnitude of change that can be observed within the *same* individual when assessed at two or more time points (e.g., pretest vs. posttest) or under multiple experimental conditions. If longitudinal data are available, plasticity may be assessed in terms of the individual's performance at some earlier point in development (Schaie & Willis, 1986). For example, the researcher may examine whether the magnitude of training effects was such that the individual's level of performance was remediated to the level demonstrated at an earlier developmental age (e.g., middle adulthood); note that the focus is still on intraindividual comparisons.

The researcher is typically also interested in *individual differences* in intraindividual change associated with training. The range of variability may be examined within the same group before and after treatment. For example, does training alter the range of individual differences within the treatment group? Alternatively, the focus may be on *between-group* comparisons of variability. Does the range of variability differ for various groups exposed to the same or different treatments?

In cognitive training research, plasticity and variability have been measured in three ways: mean level of performance, change scores, and overlap in distributions. We will discuss some of the conditions and limitations associated with each procedure.

*Mean Level.* The most commonly used procedure for evaluating training effects has been mean level of performance. Reporting effects in terms of mean level is most appropriate when the focus is on intraindividual change; the same persons' mean performance scores prior to and after training are compared.

In many training studies, however, the major comparison focuses on individual differences in intraindividual change. For example, the mean scores of the treatment group and a control/comparison group are compared at posttest. If the level of performance after training is to be compared across groups, then the various groups must have a comparable performance baseline at some point prior to training, or group differences must be statistically adjusted (Campbell & Stanley, 1963). The pretest score can serve as this common baseline. The pretest score is used as the common baseline most frequently when comparing groups of the same age cohort. Subjects are assigned to treatment conditions via random assignment or matching procedures so that the mean pretest scores for the groups are comparable. In age comparative research, the assumption is made that the age cohorts performed at comparable levels at a previous developmental period; thus, a common performance baseline is assumed to have occurred in young adulthood. In a later section of this chapter we will discuss why we consider such assumptions problematic.

*Change Scores.* Computation of change scores is another approach to assessing magnitude of training gain. The difference between the posttest and pretest scores becomes the dependent variable. Change scores have one advantage over raw total scores in that they do not reflect the possible pretest differences among treatment/comparison groups in level of performance. The question becomes, Does the amount of pre–posttest training improvement differ between treatment conditions (or comparison groups)?

There has been considerable controversy over the use of change scores (Cronbach & Furby, 1970; Harris, 1963). However, several developmental methodologists (Campbell & Stanley, 1963; Nesselroade, Stigler, & Baltes, 1980; Nunnally, 1982) have strongly supported the use of change scores in developmental and experimental studies of change as the most direct procedure for assessing change. Gain scores have often been criticized for their unreliability. However, the reliability of change scores is a function of the reliability of the measures from which the change scores were derived. If the reliability of the pre–posttest measures is good, error of measurement problems would be expected to affect interpretation of results only minimally.

*Overlap in Distributions.* A third approach to assessing training improvement is to examine the amount of overlap in the distribution of scores (Kerlinger, 1973). Statistical tests used to assess training effects when mean scores or change scores are the dependent variables are based on sample size and variability. To understand the actual magnitude of intraindividual change or interindividual differences associated with training, it is useful to examine the degree to which score distributions converge or diverge across occasions or groups.

If variability in intraindividual change is the major question, then the proportion of overlap between distribution of scores at pretest versus posttest for the same group can be examined. If interindividual differences are the major concern, then the proportion of overlap in distribution of posttest scores for various groups can be examined.

## Age-Comparative Studies of the Magnitude of Training Effects

The focus of a number of training studies has been on comparing the magnitude of training effects for old versus young adults (e.g., Bellucci & Hoyer, 1975; Le Breck & Baron, 1987; Taub & Long, 1972). It has been argued that a younger comparison group is required in gerontological training studies in order to address the issue of remediation of age-related decline (Denney, 1982). Interpretation of age-comparative training studies has been based on a number of assumptions regarding the course of adult intellectual development. Age-comparative training studies have typically employed mean scores or change scores as dependent variables. We find problematic both the assumptions underlying age-comparative training research and the procedures used to compare training effects.

Several researchers have argued that training effects should be greater for older age cohorts than for younger age cohorts. This hypothesis of greater training effects for the elderly is based on several assumptions that longitudinal research findings indicate are not tenable (Schaie, 1983). First, it is assumed that the elderly were at a comparable performance level (baseline) as the young when at the same chronological age. Second, it is assumed that virtually all elderly in the sample have suffered age-related decline on the target variable. Third, it is assumed that the younger age group is functioning nearer to its peak level of functioning; thus, the magnitude of training improvement should be less for the young. Given these assumptions, it is argued that training gain should be greater for the older group.

Cohort-sequential longitudinal research findings, however, indicate that for virtually all of the cognitive abilities studied, older cohorts performed at a significantly lower level when at the same age than the younger comparison group (see Cunningham, this volume; Schaie, 1983). The assumption of equivalent performance baselines for different cohorts when at the same chronological age is not tenable.

Figure 7-1 illustrates baseline performance (1970, 1977) and training effects (1984-Pre, 1984-Pt) for the 1910 and 1917 birth cohorts, trained on Spatial Orientation ability (Schaie & Willis, 1985). Note that there are significant differences in the mean performance level of the two cohorts when compared at the baseline ages of 60 and 67, prior to training (i.e., 1970 and 1977 for 1910 cohort; 1977 and 1984-Pre for 1917 cohort). The mean score for the 1910 cohort is significantly below that for the 1917 cohort at both ages. Significant training improvement (1984-Pt) is demonstrated for both age cohorts. That is, intraindividual training gain is demonstrated by the finding that the 1917 cohort's posttraining mean score is above its score 14 years previously, and the posttraining performance of the 1910 cohort is at the mean level of their performance in 1970. Training was effective in remediating, on average, the age-related decline for the 1910 and 1917 cohorts; however, the initial cohort difference in level of performance remains. In order for mean posttest scores to be comparable for the two age cohorts, as argued in age-comparative research, training would have to modify not only age-related decline but also initial cohort differences.

In cross-sectional age-comparative training studies, the researcher has available only the pre–posttest scores from Figure 7-1. The researcher focuses on the age differences in posttest mean scores, and, confounding age and cohort in his/her interpretation, incorrectly concludes that training does not eliminate the "age deficit."

The second faulty assumption often made in age-comparative training research further complicates interpretation of findings. It is assumed that most elderly in the sample have experienced reliable age-related decline on the target variable. However, longitudinal research indicates that there are wide individual differences in the timing and rate of age-related decline. For example, older participants (age, 64–95; $N = 229$) from the Seattle Longitudinal Study were classified as having remained stable or having reliably declined over the previous

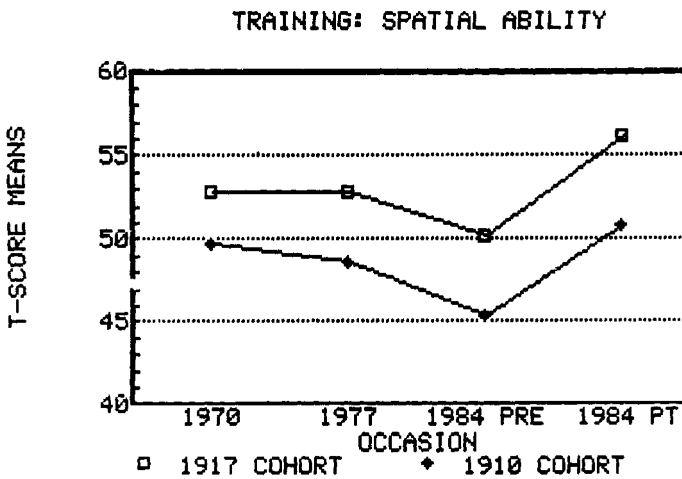


**Figure 7-1.** PMA Spatial Orientation T-score means for the 1910 and 1917 birth cohorts at four occasions: 1970, 1977, 1984 Pretest, 1984 Posttest.

14-year period on two abilities (Inductive Reasoning, Spatial Orientation) that show early normative patterns of decline (Schaie & Willis, 1986; Willis & Schaie, 1986a). Only 21.8% of the subjects had declined on both abilities; 15% had declined only on Inductive Reasoning; 16% had declined on Spatial Orientation; 46.7% of the sample had not declined on either ability.

These data should not be interpreted as evidence against the reality of age-related decline, but are only shown to demonstrate that there are wide individual differences in the timing and rate of decline. If training researchers selected subjects 80 years of age and older, then they might accurately assume that most of their subjects had experienced at least some age-related decline. However, most older persons included in training studies thus far have been the young-old, that age period in which there are the widest individual differences in patterns of decline (Willis, 1985). Without prior longitudinal data the researcher cannot accurately assume that all of the young-old subjects participating in psychological research have experienced substantial age-related decline.

Figure 7-2 illustrates the complexities of interpreting training effects in older adults (Willis & Schaie, in press). The top figure presents data for a total group of 118 older subjects trained on Spatial Orientation ability. On the left-hand side of the figure, the magnitude of age-related decline over a 14-year period (1970–1984) prior to training is shown separately for men and women. On the right side of the figure, the magnitude of pre–posttest training improvement on spatial ability is shown. It appears that, on average, the magnitude of training gain for men is comparable to the magnitude of age-related decline, and training gain for women exceeds the magnitude of age-related decline. However, an inspection of

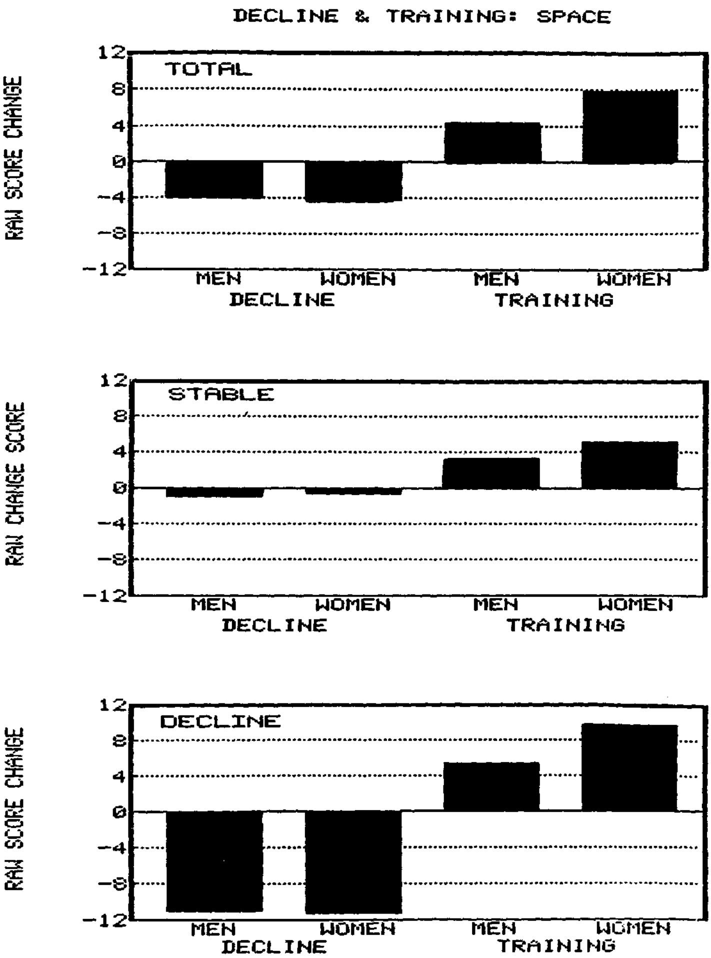


**Figure 7-2.** PMA Spatial Orientation raw change score means for total group (top figure), stable subjects (middle figure), and decline subjects (lower figure). In each figure the 1970–1984 mean raw change scores are shown on the left side. The pre–posttest mean raw change scores are on the right side.

the middle and lower figures, showing magnitude of age-related decline and training gain separately for stable ($N = 51$) and decline ($N = 67$) subjects, indicates that the interpretation given above is too simplistic. Significant training improvement occurred for both stable and decline subjects; however, there are differences in the magnitude and qualitative nature of training improvement for the two groups.

Separate examination of training gains for the stable and decline groups clarifies interpretation of effects for the total group (top figure). It becomes evident that the sizable training gain for the total group of women represents a confound of remediation of age-related loss for decliners and training improvement above prior baseline performance for stables. The investigator involved in age-comparative training research cannot accurately assume that all older adults in the sample have experienced prior age-related decline, and thus that training improvement represents solely the remediation of age-related loss. The magnitude of training gain in older samples will depend partially on the proportion of the sample represented in the stable versus decliner groups; hence, predictions of the relative magnitude of training gain for young versus old are highly problematic in the absence of longitudinal data.

Contrary to the hypotheses of some age-comparative researchers, findings from several studies indicated that the age × treatment interaction was not significant; that is, the magnitude of training gain for old and young did not differ significantly (Beres & Baron, 1981; Coyne, 1981; Erber, 1976; Grant, Storandt, & Botwinick, 1978; Le Breck & Baron, 1987; Taub & Long, 1972). While the decline group exhibited somewhat greater training gain than the stable group, the mean scores of the decliners at posttest will be lower than the mean scores of the stable group, since training for decliners represented partial remediation of prior age-related loss, while training gain for stables represents significant improvement above their prior baseline (1970) level of performance.

Age comparisons of training improvement in terms of level of performance at posttest (e.g., mean scores) is particularly deceiving, given cohort differences in performance level at comparable ages. Matching performance levels of older and younger age cohorts immediately prior to training in order to achieve equivalent baselines of performance is problematic in that such matching procedures may result in the less advantaged subset of the younger age cohort being compared with the more advantaged subset of the older age cohort.

One often neglected but useful approach to age comparisons of training effects involves examining the proportion of overlap in the distribution of scores for the two age groups (Kerlinger, 1973). For example, although there was a significant difference in the mean posttest scores of the 1910 and 1917 cohorts (Figure 7-1), there is considerable overlap in the distribution of posttest scores for the two groups. Figure 7-3 illustrates the overlap in posttest scores for the 1910 and 1917 cohorts trained on Spatial Orientation (Schaie & Willis, 1986). (Scores are reported in T-score points, scaled to the total group's pretest score.) In comparing overlap in distributions, one must consider the proportion of scores in the lower-scoring group (i.e., 1910 cohort) that fall below the distribution of the higher-scoring group (i.e., 1917 cohort), and also the proportion of scores in the higher-scoring group that lie above the distribution of the lower-scoring group. Approximately 6.4% ($N = 2$) of the scores for the 1910 cohort fell below the distribution of the 1917 cohort. There was complete overlap in the distribu-

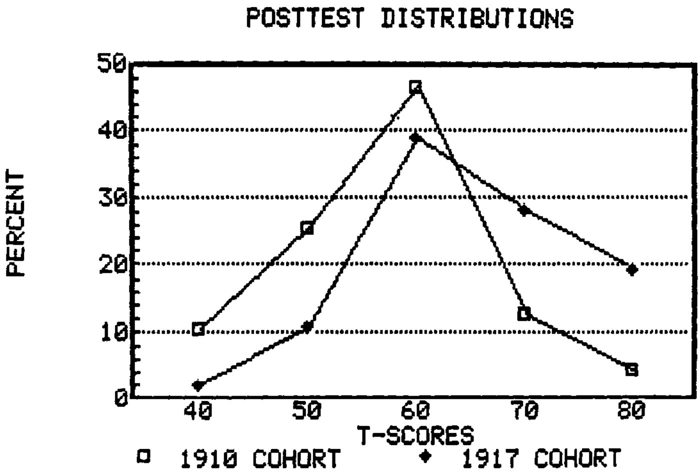


**Figure 7-3.** PMA Spatial Orientation score distribution (in T-scores) at posttest for 1910 and 1917 birth cohorts.

tions at the upper end (1910 Score Range: 33–78; 1917 Score Range: 39–78). More significantly, there is a 93.6% overlap in score distributions for the two cohorts. Thus, the majority of subjects in the 1910 cohort are performing within the same range as the 1917 cohort at posttest. In this example, we have compared two relatively close birth cohorts. When more disparate cohorts are compared, cohort differences will increase, and the overlap in distributions at pre- and posttest will, therefore, be smaller.

In summary, what are the implications for both the assessment and interpretation of age-comparative training research? First, there are serious limitations in the extent to which age-comparative training research can inform us about the process of age-related change in cognitive functioning. Assumptions that a younger age cohort can be used as a proxy for the older age cohort at an earlier developmental period appear untenable. Cohort differences in level of performance have been reported for many cognitive abilities when cohorts are compared at the same chronological age. Assumptions regarding comparable levels of performance for the two cohorts when in young adulthood are consequently violated. The use of mean scores to assess age differences in training effects is not appropriate when the focus is on the modifiability of age-related change. Cohort differences in mean scores may persist although substantial intraindividual training gain has occured.

Change scores are also not useful in understanding age-related change, given that a comparable performance baseline cannot be assumed to exist across cohorts. However, change scores can be employed to answer questions regarding age differences in the range of plasticity associated with training. For example, the researcher may ask whether there are age differences in the magnitude of training gain, as measured by change scores, or the treatment × age interaction. If age differences in change scores are nonsignificant, then it may be argued that the range of plasticity associated with training does not differ by age cohort (Beres & Baron, 1981; Coyne, 1981; Grant, Storandt & Botwinick, 1978). Older adults are capable of improving the same amount, on average, as younger age cohorts, even though age differences in level of performance may remain. Change scores may also be used to assess age differences in the amounts and types of training intervention that may be required to achieve comparable magnitudes of training gains. For example, simple practice experience (without feedback regarding response correctness) may be sufficient to achieve a certain mean gain score for younger age cohorts, while for older age cohorts an intervention involving strategy training might be required to achieve a comparable mean gain score.

Examination of the overlap by age in score distributions may also not be very useful in addressing the age-related change issue in training research, given that researchers will rarely have longitudinal data that could be used to determine which of the elderly subjects have experienced age-related decline. However, examination of overlap will inform the researcher about the proportion of old and young subjects that are functioning within the same performance range following training (Beres & Baron, 1981). Although cohort differences and unremediated age-related decline may result in mean score differences between young and old, there will still be considerable overlap in the distributions. This type of analysis is also useful if a valid external criterion exists. For example, if a job requires a certain level of word processing proficiency, then examination of overlap in age distributions of word processing scores following training would inform the researcher of the proportion of old and young reaching the desired criterion.

## Experimental Conditions Associated with Training Effects

A second major question addressed in training research deals with the types of experimental manipulations (training procedures) that are effective in improving cognitive functioning in the elderly. Just as the cognitive abilities targeted for training research have been those showing early age-related declines, so the training procedures employed have involved the cognitive processes and behaviors believed to be associated with age deficits. For example, Scogin, Storandt, and Lott (1985) gave training on four mnemonic strategies (method of loci, novel interacting images, categorization, chunking) often found deficient in the memory performance of older adults. Mergler and Hoyer (1981) examined the effectiveness of social praise in training older adults on classification skills, given that many older adults experience loss of self-confidence and negative stereotypes of intellectual aging. Although there has been research combining or comparing pharmacological and psychological intervention procedures, the majority of training studies conducted in the social sciences have focused solely on behavioral, educative procedures (Yesavage, Westphal, & Rush, 1981; Rosenberg, Greenwald, & Davis, 1983). The underlying assumption has been that at least part of age differences and/or age-related decline in cognitive functioning is associated with experiential deficits in the elderly's environment.

Types of experimental manipulations have varied along at least two dimensions. First, researchers have varied the degree of *intensity* of the experimental treatment. By intensity, we mean the amount of experience (e.g., number of training sessions, number of problems attempted) the subject received during training and whether the intervention involved procedures such as feedback and modeling/instruction on specific cognitive strategies.

The second dimension focuses on *cognitively oriented* intervention procedures versus *noncognitively oriented* procedures. That is, intervention may focus on cognitive strategies and behaviors specific to the ability to be trained (e.g., use of mnemonic strategies in short-term memory). In contrast, intervention may focus on noncognitive behaviors and variables (e.g., social praise, anxiety reduction, extrinsic reinforcement) that are not specific to a particular mental ability or skill but that are known to affect performance on measures of the target ability; these have been called performance variables.

*Intensity of Training Procedures.* The elderly's performance on a number of cognitive abilities and skills has been shown to improve with even very limited exposure to intervention conditions. Thus, the major question is the relative effectiveness of various training procedures. A low-intensity "practice only" condition, in which the subject practices on a set of problems related to the target ability but with no feedback regarding correctness of response, has been compared with a "practice with feedback" condition. In turn, practice conditions have been compared with training conditions involving modeling or instruction on specific cognitive strategies, as well as practice and feedback. With some exceptions, more intensive conditions involving modeling/instruction of cognitive strategies and feedback have resulted in greater training improvement than have less intensive practice-only conditions. It should be noted that the relative effectiveness of various training procedures is often difficult to evaluate because intervention procedures have varied with the specific cognitive ability/skill being studied, and there have been few replication studies. We will briefly review some of the training studies that have compared intervention procedures varying in intensity.

Hornblum and Overton (1976) and Schultz and Hoyer (1976) compared the relative effectiveness of practice-with-feedback versus practice-with-no-feedback conditions on training in area conservation and spatial egocentrism, respectively. Practice with feedback was found to be more effective in both studies. In contrast, Hoyer, Labouvie, and Baltes (1973) found no difference in posttest performance between a reinforced practice-with-feedback and a nonreinforced practice-with-no-feedback condition when perceptual speed was the target of training.

In a concept attainment study, Sanders, Sterns, Smith, and Sanders (1975) found that reinforced (token) strategy training and nonreinforced training conditions were more effective than a practice-with-feedback condition; both training procedures involved provision of strategies relevant to problem solution. Denney and Denney (1974) compared the effectiveness of two modeling conditions in training in problem solving with the Twenty Questions task. No difference in training effectiveness was found between the exemplary modeling condition in which the experimenter simply modeled asking constraint-seeking questions, and the cognitive-strategy-modeling condition in which the experimenter both verbalized the strategy for formulating and using constraint-seeking questions and modeled the use of constraint-seeking questions.

The fact that subjects improve significantly even in a practice-with-no-feedback condition suggests that for many elderly the cognitive processes required for problem solving are intact and can be activated when the elderly find themselves in practice situations requiring the repeated use of these skills (Overton & Newman, 1982). However, training procedures that provide immediate feedback regarding the correctness of responses appear to be very helpful, particularly in difficult problem-solving situations (e.g., area conservation, spatial egocentrism problems). Feedback allows the elderly to monitor and evaluate whether they are using problem-solving strategies. In contrast, in very simple problem-solving situations, such as the Hoyer et al. (1973) study involving perceptual speed tasks, the elderly can readily judge the accuracy of their responses and are less in need of external feedback.

The largest training effects occur in training conditions in which there is modeling/instruction on appropriate cognitive strategies, as well as feedback and practice (Baltes & Willis, 1982; Denney, 1979). Descriptive research on a number of cognitive processes and abilities has demonstrated that many elderly do not spontaneously use cognitive strategies relevant to a particular problem-solving situation but that they apparently have these strategies within their repertoire and can utilize them effectively when encouraged or motivated to do so (Poon, 1985; Yesavage, 1983). Thus, the effectiveness of including cognitive strategies in intervention procedures appears to be in activating the elderly's use of these procedures rather than in the training of these strategies de novo (Overton & Newman, 1982). The instructor's modeling of the use of specific cognitive strategies appears to be particularly useful because it provides the elderly with a concrete, observable example of how to employ the strategy effectively, in contrast to the instructor's giving an abstract, verbal rule regarding the strategy without illustrating how to use it (Denney & Denney, 1974).

In most studies that included a strategy training condition, there has been an adult instructor who modeled use of the cognitive strategies, prompted subjects to utilize the strategies, and gave feedback regarding the effective use of the strategies. A few recent studies have suggested that while inclusion of cognitive strategy training is important, there may be alternatives to the traditional instructor. Blackburn and Papalia (1986) compared the traditional instructor-directed cognitive strategies condition with a self-instructed interactive condition. In the later condition, older adults discussed among themselves how they solved practice problems and explained strategies to one another; feedback on correct answers to problems was also available. There were no significant differences in magnitude of training improvement between the two conditions. Scogin, Storandt, and Lott (1985) examined the effectiveness of a self-taught program of memory skills training. Subjects completed 16 study sessions in their homes, focusing on four mnemonic techniques (method of loci, novel interacting images, categorization, and chunking). Significant training effects were found and maintained at a 1-month follow-up posttest. Since strategy training appears to be activating already existing competencies in the elderly, peer tutoring or self-guided instruction may be viable alternatives to the traditional instructor role and may deserve further exploration. However, the presence of an instructor may be particularly useful when the subjects are learning truly new skills and competencies or when subjects are functioning at a very low level of competence.

*Noncognitive Training Procedures.* It has been hypothesized that variables such as low motivation, test anxiety, and negative stereotypes of intellectual aging interfere with the elderly's performance on cognitive measures. Several training studies have included intervention procedures targeted at these performance variables.

Denney (1980) examined the effectiveness of three performance variables (monetary reinforcement, manipulation of self-confidence, additional time to plan a game strategy) and found that none of the conditions resulted in improved performance on the Twenty Questions task. Mergler and Hoyer (1981) reported that noncontingent social praise had no effect on classification performance. Hoyer, Labouvie, and Baltes (1973) found no difference in performance on perceptual speed tasks for a practice-only versus a monetarily reinforced practice condition. Sanders, Sterns, Smith, and Sanders (1975) reported no difference in effectiveness of a reinforced-strategy training condition and a strategy-training-only condition; the reinforced condition involved the earning of tokens. Willis, Cornelius, Blow, and Baltes (1983) found that a social contact condition was not effective in improvement of attentional processes.

Review of the above literature suggests that noncognitive variables have not been effective when they were the sole focus of the treatment condition. However, there is some evidence for effectiveness when the emphasis is on selected noncognitive variables that are particularly relevant to the target cognitive ability or strategy and when these noncognitive variables are included in combination with strategy training. For example, Yesavage (Yesavage, Sheik, & Lapp, in press) has conducted training research on face–name memory recognition using an imagery-driven mnemonic strategy. Prior descriptive research indicates that many elderly have difficulty in forming and using images (Poon et al., 1980). Yesavage (1983) has found pretraining on imagery per se, followed by the mnemonic training, to be particularly effective. In addition, pretraining on anxiety reduction has been found to be effective in utilizing imagery strategies (Yesavage & Rose, 1984).

## The Nature of Training Improvement

Although most training studies have reported significant improvement in performance as a function of some intervention procedure, there is considerable debate on what it is that is actually modified as a function of training and how changes in performance resulting from training should be interpreted (Donaldson, 1981; Willis & Baltes, 1981). We will discuss the nature of training effects in terms of three issues: training at the level of the construct, the ability-specific nature of training effects, and the particular behaviors and processes modified as a function of training.

*Training at the Level of the Construct.* In discussing the nature of training effects, it is important to begin with the acknowledgment that the target of training research is a cognitive construct or latent variable (e.g., memory span, inductive reasoning). The primary concern is not improvement on a particular test per se (e.g., WAIS Digit Symbol Substitution task, Raven's Progressive Matrices), but rather to obtain change on the latent construct represented by the particular measure (Schaie, Willis, Hertzog, & Schulenberg, in press; Willis & Schaie, 1986a). Latent constructs cannot be directly observed or measured but rather must be estimated by performance on observable tests that have been shown empirically to represent that construct. Performance, as measured by observable test scores, represents a combination of that proportion of the variance common to the latent construct and that proportion of the variance that is unique to a particular measure. It is that proportion of variance in performance associated with the construct that is of interest in assessing training effects. When training studies rely on only one test to assess training gain, it is impossible to estimate the proportion of variance in the score that is associated with the cognitive construct of interest. Subjects' performances on multiple measures representing the latent construct are needed to assess whether training improvements can be attributed to a particular cognitive construct.

Factor-analytic procedures provide one mechanism for studying training effects at the construct level. Ability factor scores represent that proportion of variance in performance that is associated with a particular latent construct. Although factor-analytic procedures have been most commonly employed in research guided by psychometric models of intelligence, these methods could also be usefully employed in research on memory processes or problem-solving abilities and would permit researchers to examine their findings more precisely at the latent construct level.

In our recent studies (Willis & Schaie, 1986a), we have found significant training effects at the factorial level for the abilities of inductive reasoning and spatial orientation. These findings are evidence of training improvement at the latent construct level.

*Structural Invariance and Training Effects.* Although findings of training effects at the level of ability factor scores indicate that training improvement represents more than "teaching the test," our interpretation is based on assumptions regarding the structural stability of the measurement framework from pre- to posttest (Donaldson, 1981; Schaie et al., in press). Structural invariance addresses questions such as the following:

1. Are the same latent constructs represented in the assessment battery at pre- and posttest?
2. Are the observable measures representative of the same latent constructs before and after intervention?
3. Have the relationships among these constructs remained constant from pre- to posttest?

If assumptions regarding structural stability are not met, then interpretation of exactly what was modified as a function of training becomes ambiguous. For example, if a test representing the target ability is shown to "load" primarily on Factor A at pretest but on Factor B at posttest, then it is unclear what cognitive ability/skill that measure represents (and hence, the nature of the training effect). The existing descriptive literature offers strong support for assumptions of structural invariance (Baltes, Cornelius, Nesselroade, Spiro, & Willis, 1980; Reinert, 1970). However, the issue merits further empirical study within the training literature.

In recent training research we have examined the pre–posttest structural stability of a measurement battery representing the five primary mental abilities of verbal meaning, inductive reasoning, spatial orientation, number, and perceptual speed (Schaie, Willis, Hertzog, & Schulenberg, in press). The question examined was whether training on inductive reasoning or spatial abilities significantly altered the relationships among these abilities. We found virtually complete structural stability for the abilities (verbal, number, speed) that were not the target of training. There were some slight pre–posttest shifts in the regression weights for measures representing the trained abilities. However, all measures were still representative of the constructs they were selected to represent at pretest, and the shifts in the regression weights did not alter the interpretation of the ability-specific nature of the training effects.

These findings of structural stability were to be expected, given that the psychometric measures employed are highly reliable and have evidenced strong saturations on the particular ability constructs. However, there is need for further examination of structural stability in the training context, particularly with regard to less reliable (i.e., more statelike) constructs. For example, there is suggestive evidence that changes occur in the relationship between memory span and fluid-type abilities at various phases in the learning curve (Hofland, Willis, & Baltes, 1981; Labouvie, Frohring, Baltes, & Goulet, 1973).

*Ability-Specific Nature of Training Effects.* Findings from the intervention literature indicate that training effects are specific to the ability/skill that was the focus of training (Baltes & Willis, 1982; Willis, Blieszner, & Baltes, 1981; Willis & Schaie, 1986). Demonstration of ability-specific effects requires two conditions:

1. Training effects must be shown for multiple measures of the ability that was the focus of training; using factor analytic procedures, training effects can be demonstrated at the construct level.
2. No training effects should occur for measures of empirically distinct abilities that were not the focus of training.

Both conditions must be met for an ability-specific interpretation of training effects.

Some have argued that training effects should extend to abilities that are empirically distinct from the ability/cognitive process that was the target of training (Donaldson, 1981). Why this should be so is unclear to us. First, training procedures have typically focused on those cognitive strategies and behaviors that are directly related to performance on the target ability, and thus it would be expected that training effects would be limited to the target ability. Second, the current state of the field of cognitive psychology is not such that it is possible to specify cognitive strategies that are common (i.e., generalizable) across empirically distinct abilities. In mainstream cognitive psychology, it has proved exceedingly difficult to specify and operationalize metacognitive components or executive processes that are truly generalizable across multiple cognitive domains. Componential analyses have typically been limited to one particular ability construct (e.g., analogical reasoning), and attempts to define metacomponents have remained at the level of theoretical discussion (Detterman, 1980; Sternberg, 1982).

Focusing training efforts at the level of a specific ability makes sense from the perspective of longitudinal research findings (Cunningham, this volume; Schaie, 1983). There are wide individual differences not only in the timing of the onset of cognitive decline but also in terms of which particular abilities or skills exhibit early decline. In young–old age, cognitive decline tends to be highly specific and individual. That is, many individuals show decline on one ability but not on another, even when only abilities exhibiting normative patterns of early decline are considered. Moreover, the particular ability showing decline varies by individual. Thus, a prescriptive, individualized approach to training that would result in ability-specific effects would seem most useful.

*Specific Behaviors Modified as a Function of Training.* Training improvement, if measured by the total number of items answered correctly, may occur in several ways. As a result of training, the older subjects may respond more quickly, therefore attempting more problems. The total number of correct (and incorrect) responses will increase, as a function of more items being attempted. However, the proportion of correct items to the total number of items attempted may not change; thus, there will be little or no change in accuracy. Alternatively, there may be little increase in the total number of items attempted as a function of training, but the subject may become more accurate, as evidenced by a decrease in the proportion of commission errors and an increase in the proportion of correct responses.

Error analyses of training data are particularly useful in understanding the qualitative nature of behavioral change associated with training. In their study of spatial egocentrism, Schultz and Hoyer (1976) found that training improvement occurred as a result of a significant reduction in perceptual judgment errors (wrong responses) but not in egocentric responses per se. In fact, this sample of elderly made relatively few egocentric judgments, even prior to training. Berg, Hertzog, and Hunt (1982) examined the effects of practice on the spatial ability of mental rotation for older men and women. Practice was found to be particularly beneficial for older women; improved performance for older women was attributed primarily to decreased reaction times, not to decreases in commission errors.

Error analyses indicate that various treatment conditions may differentially affect accuracy of performance. In a training study on fluid abilities, Baltes, Dittman-Kohli, and Kliegl (1986) found a significant increase in the number of correct responses for both the cognitive training and a no-treatment control group. However, cognitive training was also effective in decreasing the proportion of commission errors, thus raising the accuracy level. In contrast, the no-treatment control group exhibited an increase in commission errors. These findings are supported by results from two studies involving practice with no feedback conditions (Hofland, 1981; Hofland et al., 1981). Subjects in the practice conditions exhibited significant increases in the total number of items attempted and in the number of correct responses; however, the proportion of commission errors did not significantly decrease. Thus, while an increase in number of correct responses can be elicited via a variety of treatment conditions, a cognitive strategy training condition appears to be particularly effective in improving accuracy.

Our recent training research also suggests that the qualitative nature of training improvement may vary with the particular ability that is the target of training improvement and with whether the training subject has experienced previous decline on the target ability (Willis, 1986; Willis & Schaie, 1986a). For example, the elderly's performance on fluid abilities, such as figural relations and inductive reasoning, is characterized by a large number of commission errors. Therefore, an important outcome of training on these fluid abilities is a reduction in the proportion of commission errors (i.e., an increase in accuracy). Error analyses of our training research on inductive reasoning support this conclusion (Willis, in press.)

Descriptive research on spatial orientation ability (mental rotation) indicates that the major source of individual differences (including age differences) is in the speed of mental rotation (Berg et al., 1982; Cerella, Poon, & Fozard, 1981); the rate of commission errors is relatively low. Thus, one would predict that training on mental rotation would result in an increase in the number of items attempted, reflecting increased speed of mental rotation, but that there would be relatively little change in error rate. Error analyses of our mental rotation training study only partially support these hypotheses. For subjects experiencing no prior decline in the ability, training improvement does reflect primarily an increase in response speed. However, for subjects experiencing prior decline, training improvement reflects improved accuracy as well as some increase in speed of mental rotation (Willis & Schaie, in press).

## RELATION OF COGNITIVE TRAINING TO COMPETENCE IN REAL-LIFE ACTIVITIES

The types of mental abilities and processes that have been the target of cognitive training research have been derived from psychometric, Piagetian, and information processing approaches to the study of intellectual aging. The training research literature cited above indicates that there is considerable plasticity in the elderly's functioning in these domains. These findings argue against a position of irreversible cognitive decrement for all individuals and abilities.

There remains, however, the important question of the implications of cognitive training research for improving the competence of older adults in activities of daily living. What are the relationships between the types of cognitive domains examined in cognitive training research and competence in activities of daily living? Can performance on real-life tasks be improved? What types of training might be useful in improving performance on real-life tasks? Research related to such questions is very limited. In this final section of the paper we will briefly outline one possible procedure for examining these issues.

### Practical Intelligence: Definition and Measurement

We must begin with definitions. The term *practical intelligence* has been used to differentiate between academic intelligence (e.g, psychometric, Piagetian, information-processing approaches) and other forms of intelligence or competence

(Commons, Richards, & Armon, 1982; McClelland, 1973; Sternberg & Wagner, 1986). There is no commonly agreed-on definition of practical intelligence. The term has been used to describe areas such as "practical know-how," professional competence in one's work sphere, social judgment, and the layperson's conception of an intelligent person. In gerontology, unique aspects of intellectual aging, such as wisdom, have also been considered (Dixon & Baltes, 1986; Labouvie-Vief, 1982; Schaie, 1978).

Our approach to the study of practical intelligence in later adulthood proceeds from the assumption that there are classes of everyday activities that are critical for adaptive functioning in common life situations (Willis & Schaie, 1986b). Because a major concern in old age is maintenance of independent living, this approach focuses on tasks associated with independent, effective functioning. For example, inability to perform tasks, such as comprehending a medicine bottle label or utilizing information in the yellow pages of a phone directory, may lead to the curtailment of independent living for many elderly. There is no exhaustive taxonomy of real-life tasks. Our research has focused on a subset of tasks that represents categories of common problems experienced by many elderly.

It is difficult, if not impossible, to observe directly the elderly's performance in many real-life situations; thus, prototypical task types have been developed. These task items represent a simulation of how the elderly might perform a task in daily life (Willis & Schaie, 1986b). Although the specific stimuli in the task item may not have been encountered previously, it is assumed that the subject applies the same relevant cognitive skills and information to the task item that he or she would apply in a similar real-life problem. At least two characteristics distinguish the types of tasks we have studied from other forms of practical intelligence. First, these tasks involve the interpretation/comprehension of printed material. Second, the tasks, for the most part, involve logical reasoning, and therefore there are logically "correct" responses.

### The Relationship between Traditional and Practical Intelligence: A Hierarchical Approach

Are the types of cognitive domains studied in training research related to practical intelligence as described above? Some have suggested that the domains of traditional and practical intelligence are independent and often unrelated spheres (Sternberg & Wagner, 1986). There has been little empirical examination of the possible relationships between the two domains. For the types of practical intelligence tasks we are interested in, it has been useful to examine a hierarchical relationship between the domains (Schaie, 1978; Willis & Schaie, 1986c).

In this hierarchical scheme, the most elemental components are ability factors, such as the primary mental abilities represented within a psychometric approach to traditional intelligence (Thurstone, 1938). Examples of ability factors include inductive reasoning, verbal comprehension, and spatial relations. Although our examples of ability factors have been derived from a psychometric approach, such factors could also be derived from a Piagetian or information-processing approach.

Because behavior in real-world contexts is of necessity complex, we assume that no single ability factor can adequately predict performance in a specific real-life situation. Rather, some combination of ability factors is required to best predict performance on real-life tasks. Thus, practical intelligence can be described as involving the expression of that combination of ability factors that, given minimally acceptable levels of motivation, will permit adaptive behavior within a specific situation or class of situations. We do not wish to suggest that all of the variability in real-life task performance can be accounted for by a combination of ability factors, but we believe such factors represent an important first strata in a hierarchical approach to the study of practical intelligence (Schaie, 1978; Willis & Schaie, 1986b).

A series of steps has been undertaken to examine the hierarchical relationship between ability factors and a subset of practical intelligence tasks (Willis & Schaie, 1986b). These steps include: (1) Identification of clusters of practical intelligence tasks that are intercorrelated. The elderly's scores on prototypical tasks representing practical intelligence were entered into an item factor analysis to determine task clusters sharing common variance. Seven task clusters were identified. (2) Examination of the relationship between task clusters and ability factors. The proportion of variance that each task cluster shared with the ability factors in an established structural model of psychometric intelligence was examined via a series of extension analyses. The structural model of psychometric intelligence represented the Thurstonian (1938) primary mental ability factors of verbal meaning, inductive reasoning, spatial orientation, number, and perceptual speed. In an extension analysis for each practical task cluster, a loading of the cluster on each of the five ability factors was obtained.

For a cluster involving tasks such as comprehending labels/directions on bottles (e.g., medications, household substances), the following loadings were obtained: Verbal Meaning, 0.40; Inductive Reasoning, 0.31; Spatial Orientation, 0.14; Perceptual Speed, −0.04; and Number, 0.02. The factor loadings were statistically significant for Verbal Meaning, Inductive Reasoning, and Spatial Orientation. For a cluster involving tasks such as comprehending technical documents (e.g., guarantees) and newspaper editorials, the following loadings were obtained: Inductive Reasoning, 0.55; Verbal Meaning, 0.13; Perceptual Speed, 0.11; Spatial Orientation, 0.02; and Number, 0.02. Only the factor loadings for Inductive Reasoning and Verbal Meaning were statistically significant.

These preliminary data suggest several points regarding the relationship between traditional intelligence factors and tasks of practical intelligence. First, there are significant and reliable relationships between traditional abilities and many tasks of daily living encountered by the elderly; traditional and practical intelligence are not totally unrelated spheres of competence. Second, the relationships between practical and traditional intelligence domains can be empirically determined through procedures such as those described above. Third, tasks of practical intelligence are complex and involve the utilization of several mental abilities. The particular combination of abilities will vary across different types of practical tasks. Moreover, the relative importance of a particular mental ability will vary from task to task. For example, verbal, reasoning, and spatial abilities were all found to be important in comprehending bottle labels and directions. Although verbal ability shared the most common variance with task performance, reasoning ability was also important in interpreting the label directions and determining what dosage of a medication would be appropriate for an individual with certain characteristics (age, weight) as specified in the directions. In interpreting technical documents, the role of reasoning ability was even more salient.

## Cognitive Training and Practical Intelligence

If substantial relationships exist between ability factors and some important tasks of daily living, does cognitive training enhance performance on these practical tasks? There is suggestive evidence that training is effective in improving performance on certain real-life tasks. For example, in our own training research on inductive reasoning, we found significant training effects on the cluster of tasks involving comprehension of technical documents and newspaper editorials. Recall that in the extension analyses above this particular task cluster showed a substantial loading on the inductive reasoning factor.

The critical issue is that for cognitive training to be effective, the practical tasks of interest must share substantial common variance with the cognitive abilities trained. Empirical analyses would need to be undertaken to examine the relative proportion of common variance shared between various cognitive abilities and the subsets of practical tasks in which the elderly exhibit deficiencies. If analyses indicate that more than one ability shares substantial common variance with the practical task of interest, then cognitive training may need to focus on multiple abilities. In this approach, therefore, the particular cognitive abilities targeted for training would be determined by the types of practical tasks that are of interest or in need of enhancement.

Why train on cognitive abilities, rather than on the practical tasks themselves? This is a question that deserves empirical investigation. However, the number of specific tasks of daily living on which training might be useful is very large. Training on cognitive abilities that underlie performance on these tasks may therefore be more efficient and result in broader transfer of training than training that is restricted to a specific practical task. This conclusion is subject to least two conditions: (1) Clusters of empirically related practical tasks must be identified, and (2) a small subset of ability factors must be identified that share significant common variance with the practical task cluster.

## TRAINING RESEARCH AND MODELS OF INTELLECTUAL AGING

Recent conceptions of intellectual aging have focused on the multidimensional and multidirectional nature of the aging process (Willis, 1985; Willis & Baltes, 1981). Intelligence in old age needs to be viewed as a multidimensional phenomenon rather than as a homogeneous or global entity. Various dimensions of intellectual functioning exhibit different patterns of developmental change (Schaie, 1983). Within the classical pattern of aging, abilities and skills requiring abstract reasoning, novel material, and/or highly speeded responding have been shown to have an earlier onset of normative decline, in contrast to overlearned, well-practiced abilities and skills that show relative stability until late old age (Botwinick, 1977).

Findings from cognitive training research suggest that this multidimensional, multidirectional perspective of intellectual aging is further complicated in that issues of plasticity need to be considered, as well as normative patterns of developmental change. In comprehensive theories of developmental aging, it is necessary to consider not only how the elderly perform on average but also to explore the range of potential performance under a variety of contexts (Baltes & Baltes, 1980; Kliegl & Baltes, in press).

As our perspective of intellectual aging expands, the meaning of the well-worn and overextended terms *stability* and *decline* need to be reexamined and refined. Although both terms have come to hold multiple meanings, the term *decline* is of particular concern to intervention researchers. Just as we have come to understand that intellectual aging must be conceptualized and studied, not as a global phenomenon but in terms of differential patterns of developmental change, we believe that those studying intellectual aging must now begin to distinguish between various types of decline.

### Reversible Decline

In earlier research on intellectual aging there was the implicit, if not explicit, assumption that the term *decline* meant an irreversible change in performance. However, it is now quite evident that not all decline in cognitive performance is irreversible. Whether or not a decline is irreversible cannot be determined solely from longitudinal research on age change but must be examined empirically through medical and/or behavior intervention research (Smith, 1980). Language is now needed to differentiate between various types of decline in terms of remediability and/or compensation (Bäckman, in press). The term *remediation* may be used to refer to that type of decline for which there is reversal (or partial reversal) of age-related decline in cognitive performance via behavioral intervention procedures.

There are two types of remediation that should be differentiated. First, there is *remediation-in-kind*. That is, the intervention results in remediation such that the behavior after intervention is qualitatively the same as the behavior prior to decline. This type of remediation appears most likely to occur for simple cognitive skills and processes. For example, several practice studies have demonstrated significant improvement in performance on simple perceptual speed tasks (Hoyer et al., 1973). Assuming that improvement with practice does reflect a reversal of age-related decline for some individuals, then remediation-in-kind would have occurred if the posttraining behavior was qualitatively (e.g., number of attempted items, accuracy rate) like the subjects' performance prior to decline.

For more complex abilities and skills, reversal of decline may be more likely to involve *remediation-with-compensation*. Although intervention may result in significant performance gains, there may be qualitative differences between behavior prior to decline and behavior after intervention. For example, with regard to spatial orientation ability, age-related decline may result in slowing in the rate of mental rotation that is only partially reversible with intervention. However, the effect of intervention may be such that the elder compensates by becoming more accurate. Loss in one aspect of the outcome behavior is compensated for by increases in another aspect.

## Irreversible Decrement

In very old age or in the case of pathologies, irreversible decline in cognitive functioning becomes increasingly likely. In some cases, however, there is the potential for *decrement-with-external-compensation*. Just as prosthetic devices such as eyeglasses and hearing aids have aided the elderly in compensating for some irreversible sensory change, so prosthetic environments can be constructed to enable the impaired elderly to compensate, at least partially, for irreversible cognitive loss (Zarit & Anthony, 1985). Interactive memory devices can aid memory-impaired elderly in self-medication and self-care tasks (Wilson & Moffat, 1984). Wandering devices are being employed to monitor the movements of dementia patients. The technology is currently available for a significant expansion in the types of external compensation systems to assist the impaired elderly.

### Stability

In our training research approximately 45% of the older adults studied had not declined on either inductive reasoning or spatial orientation ability (Willis & Schaie, 1986a). Training improvement for these subjects represented new performance levels beyond those previously exhibited. There is need, then, for further differentiation in the meaning of the term *stability*.

Findings from longitudinal research indicate that for abilities that are regularly exercised and overlearned (e.g., recognition vocabulary), there is considerable stability in performance until the 70s are reached. Indeed, some modest improvement in verbal ability occurs through the early 50s, on average. Although there has been little empirical research, it is likely that functioning on these abilities probably represents *maintenance-in-kind*. That is, there is little qualitative change in the nature of verbal performance in late middle age or early old age.

In contrast, for other overlearned, regularly exercised skills, stable performance with age on an important outcome measure may best be described as *maintenance-with-compensation*. The work of Salthouse (this volume) is particularly relevant to this issue. Salthouse first matched older and younger experienced typists on the outcome measure of typing proficiency. Although older typists were found to be slower on reaction-time measures related to typing speed, the older typists compensated for increased response time by processing larger chunks of information.

Finally, there is an increasing body of research that indicates that older adults can acquire totally new skills and bodies of information. For example, several studies have reported the acquisition of various types of computer skills by the elderly (Clark, Lanphear, & Riddick, 1987; Garfein & Schaie, 1986).

## SUMMARY AND CONCLUDING REMARKS

In this chapter, we began by discussing what were the major questions addressed by cognitive training research. While many researchers and interpreters of the cognitive training literature have assumed that remediation of age-related decline is the central question, we have argued that most cognitive training studies cannot address this issue directly, since prior longitudinal data are not available on the subjects. Given that many subjects who participate in cognitive training studies are in good health, comparatively well educated, and are the young-old, it cannot be assumed that all or most of these subjects have experienced substantial age-related decline. This is not to argue that these subjects will not experience age-related decline (most assuredly will), but that it is the young-old who show the most variability in the timing and rate of decline, even for cognitive variables exhibiting relatively early normative decline. To interpret training effects in terms of age-related decline (without longitudinal data) is problematic. Given that significant cohort effects have been demonstrated for the very abilities of interest to training researchers, young adult comparison groups cannot serve as a proxy for the older age cohorts at younger ages (see Cunningham, this volume). Thus, the central question in cognitive training research can, more accurately, be defined as what is the range of plasticity or variability in cognitive performance in old age, as a function of behavioral intervention. The major concern in examining plasticity is the range or magnitude of change in performance, not whether the change reflects remediation of age-related decline or improvement of performance in subjects showing no prior decline.

Two other questions of concern in training research focus on the types of training procedures shown to be most effective in improving cognitive functioning, and the specific aspects of behavior that are changed as a function of training. More intensive training procedures involving the factors of feedback, and modeling/instruction on specific strategies related to problem solution, have been found to result in the largest training effects. Moreover, recent research suggests that various training delivery systems (e.g., instructor-guided, self-directed, peer tutoring) may be effective, and further research on cost–benefit analyses of these various delivery systems is needed.

While findings from training research have indicated considerable plasticity in the elderly's cognitive functioning, some have questioned the practical significance of such training. Are there implications from training research for maintenance of effective functioning in tasks of daily living? To begin to address this issue, it is first necessary to examine the relationship between traditional models of intelligence and tasks of daily living (i.e., practical intelligence). In the second section of this chapter, we briefly outline one possible approach to studying this issue. A hierarchical relationship between basic mental ability factors and practical tasks is proposed; it is hypothesized that effective functioning on many tasks of daily living requires a combination of several abilities. There is need for much further research examining the relationship between traditional abilities and tasks of daily living. However, recent analyses conducted in our laboratory suggest that when there is a substantial relationship between particular cognitive abilities and specific everyday tasks, transfer of training effects may occur such that improvement of performance on tasks of daily living occurs as a function of training.

In the final section of this chapter, we suggest that our models of intellectual aging are now in need of further differentiation of the concepts of intellectual decline and stability. Findings from recent training studies indicate that intellectual aging researchers need to differentiate between remediable and irreversible intellectual decline. Some may question the need for differentiating the various types of decline and stability in cognitive functioning discussed above. However, at the current stage in the development of models of cognitive aging, it appears particularly important. First, these distinctions serve as a constant reminder that irreversibility is not to be assumed in discussions of decline, and that plasticity as well as normative patterns of intellectual aging must be considered. More importantly, if findings from training research are to contribute to our understanding of intellectual aging, it is necessary to examine for what abilities and under what intervention procedures the behavioral processes of decline and of remediation are qualitatively similar and when they are different. Equally important is our understanding of the mechanisms that the aging individual uses to compensate for and to cope with age-related decrements in functioning, and how the external environment may limit or support the individual's attempts to maintain competence.

## REFERENCES

Bäckman, L. (in press). Varieties of memory compensation of older adults in episodic remembering. In L. Poon, D. Rubin, & B. Wilson (Eds.), *Everyday cognition in adult and late life*.

Baltes, P. B., & Baltes, M. M. (1980). Plasticity and variability in psychological aging: Methodological and theoretical issues. In G. Gurski (Ed.), *Determining the effects of aging on the central nervous system*. Berlin: Schering.

Baltes, P. B., Cornelius, S. W., Nesselroade, J. R., Spiro, A., & Willis, S. L. (1980). Integration versus differentiation of fluid/crystallized intelligence in old age. *Developmental Psychology, 16,* 625–635.

Baltes, P. B., Dittman-Kohli, F., & Dixon, R. A. (1984). New perspective on the development of intelligence in adulthood: Toward a dual-process conception and a model of selective optimization with compensation. In P. B. Baltes & O. G. Brim, Jr. (Eds.), *Life-span development and behavior,* Vol. 6 (pp. 33–76). New York: Academic Press.

Baltes, P. B., Dittman-Kohli, F., & Kliegl, R. (1986). Reserve capacity of the elderly in aging-sensitive tests of fluid intelligence: Replication and extension. *Psychology and Aging, 1,* 172–177.

Baltes, P. B., & Willis, S. L. (1982). Enhancement (plasticity) of intellectual functioning in old age: Penn State's Adult Development and Enrichment Project (ADEPT). In F. I. M. Craik & S. E. Trehub (Eds.), *Aging and cognitive processes* (pp. 353–389). New York: Plenum Press.

Bellucci, G., & Hoyer, W. (1975). Feedback effects on the performance and self-reinforcing behavior of elderly and young adult women. *Journal of Gerontology, 30,* 456–460.

Beres, C., & Baron, A. (1981). Improved digit substitution by older women as a result of extended practice. *Journal of Gerontology, 36,* 591–597.

Berg, C., Hertzog, C., & Hunt, E. (1982). Age differences in the speed of mental rotation. *Developmental Psychology, 18,* 95–107.

Blackburn, J., & Papalia, D. (1986, November). *Modifiability of fluid intelligence: A comparison of two training approaches*. Paper presented at the Meeting of the Gerontological Society, Chicago, IL.

Blieszner, R., Willis, S. L., & Baltes, P. B. (1981). Training research in aging on the fluid ability of inductive reasoning. *Journal of Applied Developmental Psychology, 2,* 247–265.

Botwinick, J. (1977). Intellectual abilities. In J. E. Birren & K. W. Schaie (Eds.), *Handbook of the psychology of aging*. New York: Van Nostrand Reinhold.

Campbell, D., & Stanley, J. (1963). *Experimental and quasi-experimental designs for research*. Chicago: Rand McNally.

Cerella, J., Poon, L., & Fozard, J. (1981). Mental rotation and age reconsidered. *Journal of Gerontology, 35*, 620–624.

Clark, J., Lanphear, A., & Riddick, C. (1987). The effects of videogame playing on the response selection processing of elderly adults. *Journal of Gerontology, 42*, 82–85.

Commons, M., Richards, F., & Armon, G. (1982). *Beyond formal operations: Late adolescence and adult cognitive development*. New York: Praeger.

Coyne, A. C. (1981). Age differences and practice in forward visual masking. *Journal of Gerontology, 36*, 730–732.

Cronbach, L., & Furby, L. (1970). How should we measure "change"—or should we? *Psychological Bulletin, 74*, 68–80.

Denney, N. W. (1979). Problem solving in later adulthood: Intervention research. In P. B. Baltes & O. G. Brim, Jr. (Eds.), *Life-span development and behavior*, Vol. 2. New York: Academic Press.

Denney, N. W. (1980). The effect of manipulation of peripheral, noncognitive variables on the problem-solving performance of the elderly. *Human Development, 23*, 268–277.

Denney, N. W. (1982). Aging and cognitive changes. In B. B. Wolman (Ed.), *Handbook of developmental psychology*. Englewood Cliffs, NJ: Prentice-Hall.

Denney, N. W., & Denney, D. (1974). Modeling effects on the questioning strategies of the elderly. *Developmental Psychology, 10*, 400–404.

Detterman, D. K. (1980). Understand cognitive components before postulating metacomponents. *Behavioral and Brain Sciences, 3*, 589.

Dixon, R., & Baltes, P. B. (1986). Toward life-span research on the functions and pragmatics of intelligence. In R. Sternberg & R. Wagner (Eds.), *Practical intelligence* (pp. 203–235). Cambridge: Cambridge University Press.

Donaldson, G. (1981). Letter to the editor. *Journal of Gerontology, 36*, 634–636.

Englehardt, K., & Leifer, L. (1984). The VA RR&D center: Where computers and robots serve elders. *Generations, Summer*, 38–39.

Erber, T. J. (1976). Age differences in learning and memory on a digit-symbol substitution task. *Experimental Aging Research, 2*, 45–53.

Garfein, A., & Schaie, K. W. (1986, November). *Microcomputer proficiency in later middle-aged adults: Teaching old dogs new tricks*. Paper presented at the meeting of the Gerontological Society, Chicago, IL.

Grant, E., Storandt, M., & Botwinick, J. (1978). Incentive and practice in the psychomotor performance of the elderly. *Journal of Gerontology, 33*, 413–415.

Harris, C. (1963). *Problems in measuring change*. Madison, WI: University of Wisconsin Press.

Hofland, B. F. (1981). *Practice effects in the intellectual performance of the elderly: Retesting as an intervention strategy*. Unpublished doctoral dissertation, The Pennsylvania State University, University Park, PA.

Hofland, B. F., Willis, S. L., & Baltes, P. B. (1981). Fluid intelligence performance in the elderly: Intraindividual variability and conditions of assessment. *Journal of Educational Psychology, 73*, 573–586.

Hornblum, J. N., & Overton, W. F. (1976). Area and volume conservation among the elderly: Assessment and training. *Developmental Psychology, 12,* 68–74.

Hoyer, W., Labouvie, G., & Baltes, P. B. (1973). Modification of response speed and intellectual performance in the elderly. *Human Development, 16,* 233–242.

Kerlinger, F. (1973). *Foundations of behavioral research.* New York: Holt, Rinehart, & Winston.

Kliegl, R., & Baltes, P. B. (1987). Theory-guided analysis of mechanisms of development and aging through testing-the-limits and research on expertise. In C. Schooler & K. W. Schaie (Eds.), *Cognitive functioning and social structure over the life course.* Norwood, NJ: Ablex.

Labouvie-Vief, G. (1982). Dynamic development and mature autonomy: A theoretical prologue. *Human Development, 25,* 161–191.

Labouvie, G., Frohring, W., Baltes, P., & Goulet, L. (1973). Changing relationship between recall performance and abilities as a function of stage of learning and timing of recall. *Journal of Educational Psychology, 64,* 191–198.

Le Breck, D., & Baron, A. (1987). Age and practice effects in continuous recognition memory. *Journal of Gerontology, 42,* 89–91.

McClelland, D. (1973). Testing for competence rather than for "intelligence." *American Psychologist, 28,* 1–14.

Mergler, N., & Hoyer, W. (1981). Effects of training on dimensional classification abilities: Adult age comparisons. *Educational Gerontology, 6,* 135–145.

Nesselroade, J. R., Stigler, S. M., & Baltes, P. B. (1980). Regression toward the mean and the study of change. *Psychological Bulletin, 88,* 622–637.

Nunnally, J. (1982). The study of human change: Measurement, research strategies, and methods of analysis. In B. B. Wolman (Ed.), *Handbook of Developmental Psychology.* Englewood Cliffs, NJ: Prentice-Hall.

Overton, W. F., & Newman, J. (1982). Cognitive development: A competence-activation/utilization approach. In T. Field, A. Houston, H. Quay, L. Troll, & G. Finley (Eds.), *Review of human development* (pp. 217–241). New York: Wiley.

Poon, L. (1985). Differences in human memory with aging: Nature, causes, and clinical implications. In J. E. Birren & K. W. Schaie (Eds.), *Handbook of the psychology of aging* (pp. 427–462). New York: Van Nostrand Reinhold.

Poon, L., Fozard, J., Cermak, L., Arenberg, D., & Thompson, L. (Eds.). (1980). *New directions in memory and aging.* Hillsdale, NJ: Erlbaum.

Reinert, G. (1970). Comparative factor analytic studies of intelligence throughout the human life span. In L. R. Goulet & P. B. Baltes (Eds.), *Life-span developmental psychology: Research and theory* (pp. 468–487). New York: Academic Press.

Rosenberg, G., Greenwald, B., & Davis, K. (1983). Pharmacologic treatment in Alzheimer's disease. In B. Reisberg (Ed.), *Alzheimer's disease: The standard reference* (pp. 329–340). New York: Free Press.

Sanders, J. C., Sterns, H. L., Smith, M., & Sanders, R. E. (1975). Modification of concept identification performance in older adults. *Developmental Psychology, 11,* 824–829.

Schaie, K. W. (1978). External validity in the assessment of intellectual performance in adulthood. *Journal of Gerontology, 33,* 695–701.

Schaie, K. W. (1983). The Seattle Longitudinal Study: A twenty-one year investigation of psychometric intelligence. In K. W. Schaie (Ed.), *Longitudinal studies of adult psychological development* (pp. 64–155). New York: Guilford Press.

Schaie, K. W., & Willis, S. L. (1982). Life span development. In H. E. Mitzel (Ed.), *Encyclopedia of Educational Research* (5th ed.). New York: Macmillan.

Schaie, K. W., & Willis, S. L. (1985, August). *Differential ability decline and its remediation in late adulthood.* Paper presented at the annual meeting of the American Psychological Association, Los Angeles.

Schaie, K. W., & Willis, S. L. (1986). Can decline in adult intellectual functioning be reversed? *Developmental Psychology, 22,* 223–232.

Schaie, K. W., Willis, S. L., Hertzog, C., & Schulenberg, J. (in press). Effects of cognitive training upon primary mental ability structure. *Psychology and Aging, 2.*

Schultz, N. R., & Hoyer, W. J. (1976). Feedback effects on spatial egocentrism in old age. *Journal of Gerontology, 31,* 72–75.

Scogin, F., Storandt, M., & Lott, L. (1985). Memory-skills training, memory complaints, and depression in older adults. *Journal of Gerontology, 40,* 562–568.

Smith, A. (1980). Cognitive issues: Advances in the cognitive psychology of aging. In L. Poon (Ed.), *Aging in the 1980s* (pp. 223–226). Washington, DC: American Psychological Association.

Sternberg, R. (Ed.). (1982). *Advances in the psychology of human intelligence,* Vol. 1. New York: Erlbaum.

Sternberg, R., & Wagner, R. (Eds.). (1986). *Practical intelligence.* New York: Cambridge University Press.

Sterns, H. L., & Sanders, R. E. (1980). Training and education in the elderly. In R. E. Turner & H. W. Reese (Eds.), *Life-span developmental psychology: Intervention.* New York: Academic Press.

Taub, H., & Long, M. (1972). The effects of practice on short-term memory of young and old subjects. *Journal of Gerontology, 27,* 494–499.

Thurstone, L. L. (1938). *Primary mental abilities.* Chicago: University of Chicago Press.

Willis, S. L. (1985). Towards an educational psychology of the adult learner. In J. E. Birren & K. W. Schaie (Eds.), *Handbook of the psychology of aging* (2nd ed.). New York: Van Nostrand Reinhold.

Willis, S. L. (1986, August). *Inductive reasoning: Longitudinal change and cognitive training.* Paper presented at the meeting of the American Psychological Association, Washington, DC.

Willis, S. L. (in press). Improvement with cognitive training: Which old dogs learn what tricks? In L. Poon, D. Rubin, and B. Wilson (Eds.), *Everyday cognition in adult and late life.* New York: Cambridge University Press.

Willis, S. L., & Baltes, P. B. (1980). Intelligence in adulthood and aging: Contemporary issues. In L. W. Poon (Ed.), *Aging in the 1980s.* Washington, DC: American Psychological Association.

Willis, S. L. & Baltes, P. B. (1981). Letters to the editor. *Journal of Gerontology, 36,* 634–638.

Willis, S. L., Blieszner, R., & Baltes, P. B. (1981). Intellectual training research in aging: Modification of performance on the fluid ability of figural relations. *Journal of Educational Psychology, 73,* 41–50.

Willis, S. L., Cornelius, S. W., Blow, F., & Baltes, P. B. (1983). Training research in aging: Attentional processes. *Journal of Educational Psychology, 75,* 257–270.

Willis, S. L., & Schaie, K. W. (1981). Maintenance and decline of adult mental abilities: II. Susceptibility to experimental manipulation. In F. Grote & R. Feringer (Eds.), *Adult learning and development*. Bellingham, WA: Western Washington University.

Willis, S. L., & Schaie, K. W. (1986a). Training the elderly on the ability factors of spatial orientation and inductive reasoning. *Psychology and Aging, 1*, 239–247.

Willis, S. L., & Schaie, K. W. (1986b). Practical intelligence in later adulthood. In R. Sternberg & R. Wagner (Eds.), *Practical intelligence* (pp. 236–270). New York: Cambridge University Press.

Willis, S. L., & Schaie, K. W. (in press). Gender differences in spatial ability in old age: Longitudinal and intervention findings. *Sex Roles*.

Wilson, B., & Moffat, N. (Eds.). (1984). *Clinical management of memory problems*. Rockville, MD: Aspen.

Yesavage, J. (1983). Imagery pretraining and memory training in the elderly. *Journal of Gerontology, 29*, 217–275.

Yesavage, J. (in press). Mnemonics as modified for use by the elderly. In L. Poon, D. Rubin, & B. Wilson (Eds.), *Everyday cognition in adult and late life*. New York: Cambridge University Press.

Yesavage, J., & Rose, T. (1984). The effects of a face–name mnemonic in young, middle aged, and elderly adults. *Experimental Aging Research, 10*, 55–57.

Yesavage, J., Sheik, J., & Lapp, D. (in press). Mnemonics as modified for use by the elderly. In L. Poon, D. Rubin, & B. Wilson (Eds.), *Everyday cognition in adult & late life*. New York: Cambridge University Press.

Yesavage, J., Westphal, J., & Rush, L. (1981). Senile dementia: Combined pharmacologic and psychologic treatment. *Journal of the American Geriatrics Society, 29*, 164–171.

Zarit, S., & Anthony, C. (1985). Interventions with dementia patients and their families. In M. Gilhooly, S. Zarit, & J. Birren (Eds.), *The dementias: Policy and management*. Englewood Cliffs, NJ: Prentice-Hall.

CHAPTER 8

# Personality Development in Adulthood and Old Age: Relationships among Identity Style, Health, and Well-being

SUSAN KRAUSS WHITBOURNE
DEPARTMENT OF PSYCHOLOGY
UNIVERSITY OF MASSACHUSETTS AT AMHERST
AMHERST, MASSACHUSETTS

The purpose of this chapter is to integrate several broad areas of research and theory on personality in adulthood and old age as related to physiological functioning and psychological well-being. The characterization of an individual's stance toward life experiences in terms of *identity style* forms the theme that will be used to integrate these areas. It will be demonstrated that identity style, the individual's characteristic willingness to be exposed to and affected by a variety of life experiences, plays a major role in determining the extent to which the individual is able to maintain healthy functioning into the later years of life.

## IDENTITY STYLES IN ADULTHOOD

### Model of Identity Processes

The identity-style construct is derived from a model of adult identity processes (Whitbourne, 1986a, 1986c) that describes the manner in which individuals interpret and respond to life experiences in adulthood. Briefly, the model postulates a transactional relationship between the individual and life experiences mediated by a Piagetian-like set of processes.

The individual's identity is defined as the uniquely integrated and temporally consistent set of conceptions the person has about the self's physical, psychological, and social attributes. In adulthood this identity is composed of conscious and unconscious self-representations accumulated since the beginning of life.

These self-representations are of the self-as-agent (the "I," or subjective self) and the self-as-object (the "me," or objective self) and are based on interactions with significant objects in the individual's environment (Whitbourne, 1986b).

Identity, then, is assumed to influence and be influenced by the individual's intrapersonal and interpersonal experiences. Identity assimilation is the process proposed to account for the means through which the individual confronts experiences. Assimilation is defined in Piaget's theory (Piaget & Inhelder, 1969) as a conservative attempt by the individual to fit something that is unfamiliar into familiar terms. In the case of identity assimilation, it is the individual's existing identity to which the individual attempts to fit the new experience. The kinds of experiences to which identity assimilation applies are ones that have relevance along one of the many dimensions within the individual's self-representation (Markus & Wurf, in press). Mentally healthy adults with a reasonably high degree of subjective well-being will use identity assimilation to confirm a favorable view of themselves on the dimension to which an experience is relevant (Whitbourne, 1986c). For instance, if "lovingness as a parent" is a relevant dimension of an adult's identity, experiences with children will be processed in ways that are consistent with the view that the adult is a loving mother or father.

However, as in Piaget's model of cognitive development, assimilation is not always possible. Piaget proposed that the impetus for developmental change in the individual's cognitive structure comes from exposure to experiences that cannot be assimilated. These experiences require accommodation by the individual's cognitive schemata. Identity accommodation, similarly, is the proposed process through which adults change their identities in response to new life experiences. To stimulate identity accommodation, an experience must be extremely discrepant from the individual's favorable self-representation. The proposed identity process model operates according to an equilibrium principle of adaptation. For the individual to be adapted, there must be a balance between identity assimilation and identity accommodation. If one process is consistently used more than the other, the individual will experience so much subjective distress that a balance will be sought. As painful as it may be to accommodate to an experience in which one's favorable identity is called into question, the identity-process model proposes that this change will have a more adaptive outcome in the long run than continued efforts to assimilate the experience.

Analyses of interview material in a sample of 94 community adults between 24 and 61 years of age revealed use of a variety of specific forms of identity assimilation and identity accommodation (Whitbourne, 1986c). The forms of identity assimilation were defensive rigidity (unwillingness to change one's identity), identity projection (attributing negative identity attributes to others rather than to oneself), and lack of insight (unwillingness to recognize that a negative identity attribute exists). The forms of identity accommodation were favorable changes in identity (accepting into identity a more positive identity attribute), self-doubts and unfavorable changes in identity (questioning or accepting into identity a negative identity attribute), and looking at alternatives (considering a more neutral change in identity attributes).

The experiences associated with the aging process represent some of the most central challenges to the individual's identity (Rochlin, 1973; Schwartz, 1986; Whitbourne, 1985a). The threatened nonexistence of the self that aging represents makes all other experiences of the adult pale in significance. Each alteration in the functioning of body or mind is a symbol of the individual's progress toward the inevitable end of life that comes with the passage of time. How does the individual react to these changes? Are they gradually integrated into one's identity as a "gracefully" aging person? Or are they vigorously rejected, stamped out with cosmetics, youthful-looking clothes, and refusal to wear bifocals or hearing aids?

Perhaps rejection of the body's aging is adaptive if it is coupled with active attempts to compensate through mental and physical exercise. Denial, on the other hand, may place the individual's life in even greater jeopardy. The sedentary 60-year-old adult who claims to be "as fit as I was 20 years ago" will not take protective measures to avoid overexertion that stresses the cardiovascular, respiratory, or autonomic nervous system. But it is also possible that accommodation to the aging process leads to a self-fulfilling prophecy whereby the individual is so careful not to strain the body's resources that they fail to function at optimal levels (Kreitler & Kreitler, 1970). This is precisely what happens to the postmenopausal woman who avoids going outside in the winter so as not to risk the bone fractures to which she has heard older women are vulnerable. Her bones will actually weaken by virtue of having less muscular stress placed on them (Whitbourne, 1985a). A similar argument could be applied to cognitive functioning. The older man who refuses to play bridge because he feels his memory is "not what it used to be" will block himself off from an important source of cognitive stimulation and hence suffer an even greater decline in memory skills (Whitbourne, 1986a).

It would seem logical that among all of these possibilities there is an optimally adaptive balance between accommodation and assimilation to the changes in identity occasioned by physical and cognitive aging. Before presenting the evidence bearing on this question, it will be necessary to examine in more depth the adaptive potential to aging of the individual's use of the identity processes.

## INDIVIDUAL DIFFERENCES IN IDENTITY PROCESSES

The notion that there is an optimal balance of identity processes leads directly to the question of whether there are individual differences in the tendency to use identity assimilation and identity accommodation. These identity processes were conceptualized originally as developmental mechanisms having no inherent content but determining the way that individuals attach content to their own unique self-representations (Whitbourne, 1986a, c). In this framework, personality traits are considered relevant only insofar as they form part of the content of a person's identity, such as having an "easygoing personality" or being "outgoing" or "stubborn." These personality traits can form the basis for identity assimilation and accommodation but do not represent individual differences in the identity processes per se.

However, by not taking into account the potential for individual differences in the relative use of the identity processes, the identity-process model fails to take advantage of the large body of research on personality and its relationship to adaptation to the aging process. In light of this research, which focuses specifically on individual differences in adaptation to aging, it would seem advantageous to differentiate among adults according to their relative use of the two identity processes. Such a differentiation would be similar to Marcia's (1966) identity status construct as applied to the psychosocial crisis of adolescence.

As applied to adults, an *identity style* will be defined as an individual's characteristic state of equilibrium between identity assimilation and identity accommodation. An individual's identity style would be expected to predict how he or she would adapt to the many physical, psychological, and social changes involved in the aging process throughout adulthood.

## IDENTITY STYLES AND OPENNESS TO EXPERIENCE

In the adult personality literature, growing attention (e.g., Costa & McCrae, 1978, 1980b) is being paid to the trait of openness to experience (Coan, 1972). This trait seems to be directly related to identity style. Thus, a person who is more likely to use identity assimilation than accommodation would fall at the "closed" pole of the openness dimension. An "open" individual would, in contrast, be more likely to use identity accommodation than identity assimilation.

This proposed correspondence between identity processes and openness to experience receives support from an analysis of a subsample of the adults used in the adult identity interview study (Whitbourne, 1986d). Openness to experience was found to be significantly correlated ($r = .44$) with "identity flexibility," the form of identity accommodation called willingness to consider alternatives. Thus, there is a conceptual and empirical basis for establishing a link between the identity processes and a major dimension of personality in adulthood.

The "openness to experience" personality domain would seem to be relevant to the ability to adapt to changes involved in the aging process and possibly to the prevention of deleterious changes in mental and physical health as well. As it was originally conceptualized, openness to experience represents the ability to use "regression in the service of the ego" (Kris, 1952); that is, to let go of a certain amount of one's grip on reality in order to free the ego's creative energies. The experientially open adult should be able, then, to maintain an awareness of changes in the body and also be able to devise innovative strategies to adapt to them. In contrast, the experientially closed adult might try to hold on for as long as possible to the idealized image of the self in the past. When this image can no longer be reasonably maintained (e.g., after a forced retirement), then the individual might shift suddenly to an equally inflexible adoption of the stereotyped qualities of the "old person." Either way, it might be expected that such an individual would be unlikely to take the best advantage of available preventive or corrective measures to help offset functional deficiencies associated with aging.

A lack of data on the functional correlates of openness to experience in adulthood prohibits an empirical answer to the question of how personality openness relates to adaptation to aging. What is known about the openness-to-experience variable is that it is relatively stable during the adult years (Costa, McCrae, & Arenberg, 1983). The correlates of individual differences in openness to experience are beginning to be examined (Costa & McCrae, 1978; Sperbeck, Whitbourne, & Hoyer, 1986) but have not yet received sufficient attention to warrant even tentative conclusions about the possible advantages to adaptation of being on either the open or the closed end of this dimension.

## FORMS OF IDENTITY STYLES

Another way to broaden the applicability of the identity-styles construct to adaptation to aging is to build on the natural relationship between the identity styles and the "neurotic styles" described by Shapiro (1965) as a basis for categorizing forms of personality disorders. The four neurotic styles in Shapiro's scheme are obsessive–compulsive, paranoid, hysterical, and impulsive. These four neurotic styles can be divided into two groups, which share a similar relationship between identity assimilation and identity accommodation. Using Shapiro's clinical descriptions of the neurotic style forms a basis for making predictions concerning the adaptability of the identity styles to the aging process.

At the risk of transforming what is a process variable to a categorization scheme (see Whitbourne, 1986a), the identity styles can be operationalized for descriptive purposes into three predominant forms. These forms represent the three possible kinds of relationships between the two identity processes: assimilation greater than accommodation, assimilation less than accommodation, and assimilation and accommodation in approximate balance. The two imbalanced forms correspond to neurotic styles. The balanced form represents a healthy approach to new experiences. Given the stability of personality traits over the adult years (e.g. Conley, 1985; Costa, McCrae, & Arenberg, 1983), it would be expected that the identity styles would be fairly consistently used as a means of coping with the age changes that the individual encounters with increasing frequency in later adulthood.

### Assimilative Identity Style

The assimilative identity style includes adults who tend to use identity assimilation as a predominant approach to new experiences. Their tendency to try to mold their experiences as much as possible into their existing identity would lead persons with this identity style to show, minimally, the rigidity of thinking characteristic of the obsessive–compulsive neurotic style. In its most extreme form, the assimilative style would resemble the paranoid neurotic style described by Shapiro (1965).

*Obsessive–Compulsive Rigidity.* Shapiro (1965) defined the obsessive–compulsive individual's rigidity as a narrowing of attention to only those features of a new fact or point of view that correspond to the individual's existing beliefs. The obsessive–compulsive individual is unable to "regard the casual impression with a casual attention, to entertain the hunch, to notice the element on the periphery of attention briefly" (Shapiro, 1965, p. 28). Instead, "elements on the periphery of attention, the new or surprising, that which can only be apprehended impressionistically—all these are only potentially distracting and disruptive to the obsessional–compulsive, and they are avoided exactly by the intensity and the fixed narrowness of his preoccupation with his own idea or aim" (Shapiro, 1965, p. 30).

Although rigid concentration to detail can be adaptive for performing certain highly technical tasks, as a general approach to experiences it reduces the individual's enjoyment of "the rich shadings, or . . . real substance of the world" (Shapiro, 1965, p. 52). The individual's inability to see the "big picture," as it were, also leads the person to seek guidance for decision making from a set of dogmatic principles or strict behavioral rituals. When such guidelines are not present, the individual is thrown into so much doubt that an arbitrary decision is made just to resolve the discomfort of being so indecisive.

*Paranoid Thinking.* If the disequilibrium of identity processes favoring assimilation is allowed to progress totally unchecked by the counteracting force of identity accommodation, the individual moves from the obsessive–compulsive toward the paranoid neurotic style. This is the most extreme form of overassimilation. The individual approaches new experiences with a fixed conception of what to expect and will scan the environment seeking confirmation of this expectation. It is virtually impossible to try to persuade paranoid individuals to abandon their prior expectations; they will seek support for them in any counterevidence or arguments that are presented. Indeed, by trying to talk a paranoid person out of his or her beliefs, one is implicated in the "conspiracy" of which the individual is suspicious in the first place. Thus, the paranoid neurotic style is characterized by extreme sensitivity to new experiences, but only for the purpose of receiving confirmation of a set of suspicious ideas. The approach taken to new experiences is "not the careful studying and measuring attention of the obsessive–compulsive, but an actively scanning and searching attention. . . . Nothing out of the ordinary will escape his attention and, certainly, nothing that is even remotely related to his concerns or his preoccupations of the moment" (Shapiro, 1965, p. 58). It is this element of the paranoid's cognitive style that leads to the use of the most common defense mechanism in paranoia: projection. Projection can be seen as the ultimate use of identity assimilation, as described by Shapiro:

> The projective process is completed and a projection may be said to exist when the paranoid person, in a certain state of tension and biased expectancy vis-a-vis the external world, turns his attention toward an object and seizes on a clue the significance of which convinces him of some motive, intention, or the like, and thereby crystallizes his biased expectancy in some concrete shape. . . . Cognition that is as rigidly and narrowly directed as that of the paranoid, as immune to correction, as capable of ignoring the apparent and searching only for signs in it that confirm its bias, a cognition that brings with it a loss of a sense of proportion and appreciation of the plain face value of things—such cognition is liable to interpretive distortions of the wildest kind, that is, distortions of a projective form. (pp. 70–71)

Both the obsessive–compulsive and paranoid styles, then, involve a cognitive style of selectively interpreting experiences to fit a preexisting set of ideas. These two styles fit into the assimilative identity style because both rely so heavily on selective perception of experiences that they do not allow themselves the opportunity to be challenged or confronted. Their identities would not be expected to change over time, as they are being fed continuously with self-confirming features of experiences.

### Accommodative Identity Style

The accommodative identity style describes people who tend to use identity accommodation much more than identity assimilation. Individuals who adopt this style have a weak and incoherent identity and so are easily influenced by new experiences that present what appear to be viable or salient evidence about the self.

*Hysterical Diffuseness.* The hysterical neurotic style, as described by Shapiro (1965), clearly represents one form of the accommodative identity style because of the characteristic "style of cognition" presented in the clinical picture. The primary feature of a hysterical neurosis, as discovered by Freud, is the use of repression to force into the unconscious a thought that would be unacceptable to the conscious ego. Shapiro reasoned that the manner in which the person with the hysterical style originally approaches new experiences is responsible for the subsequent failure to remember potentially troubling features of these experiences. Hysterical thinking is "particularly conducive to forgetting" because it is "global, relatively diffuse, and lacking in sharpness. . . . In a word, it is *impressionistic*" (Shapiro, 1965, p. 111; author's italics). The person who uses this kind of thinking lacks preset categories or ideas in which to store new information. What follows from this general stylistic quality of hysterical cognition are several sequellae that are well-known features of the clinical picture of hysteria. These sequellae include being unable to concentrate for prolonged periods of time so that one is easily distracted or influenced by passing impressions and so that one ends up living in a "nonfactual world" (Shapiro, 1965, p. 113) dominated by these impressions.

Whereas the obsessive–compulsive and paranoid styles search their experiences in great detail, the hysterical style is "struck by things" (Shapiro, 1965, p. 119), things that are often of an emotionally toned, romantic, and vivid quality. These images dominate the individual's thoughts and memories and are as likely to change from moment to moment as does the individual's sensory impressions. The cognitive style of the hysterical individual leads, over time, to a perception of the self as lacking substance. As Shapiro observed,

> They seem to feel as if they were virtually weightless and floating, attracted here, repelled there, captivated first by this and then by that. . . . The hysterical person's emotional behavior or ideas do not seem to the observer to be anchored in a real and deep interest, a long history, or an abiding purpose, and, in fact, they are not. (p. 119)

*Impulsiveness.* The second neurotic style with an extreme tendency toward identity accommodation is the impulsive. The impulsive style borders on the hysterical, to the extent that both form quick impressions that are unintegrated with a stable cognitive or emotional organization. However, the impulsive style is differentiated by a greater willingness to be pulled into action by the dominant impressions experienced at the moment. These impressions take the form of "abrupt, transient, and partial experiences of wanting, choosing, or deciding—experiences of action in which the sense of active intention and deliberateness is markedly impaired" (Shapiro, 1965, p. 137). Externalization is a typical defense when the impulsive behaviors get the individual into trouble. However, this defense is not a deliberate attempt to avoid taking responsibility; it is the reflection of an "attenuated experience of motive" (p. 139). The individual's behavior is, then, a "short-circuiting" (p. 140) of the cognitive processing usually involved in moving from intention to action because there is no well-defined, stable set of constructs to use in evaluating the potential consequences of one's actions. The initial whim is the starting and the ending point of the impulsive person's cognitive processes in moving from thought to action.

Both the impulsive and hysterical styles, therefore, involve a mode of responding to experiences in which the impressions gained from the experiences take priority over any preexisting expectations within the individual. In terms of identity, it would be expected that they allow their identity to be determined by whatever strikes them at the moment. Because it is so dependent on experiences, the identity of the person with the accommodative style would never have the opportunity to develop a stable internal structure.

### Balanced Identity Style

The balanced identity style, neither overly assimilative or accommodative, would be stable enough so that the individual would have a sense of continuity over time. The balanced style would also be flexible enough to change when presented with contradictory information about the self. In his comparisons of the neurotic styles with the "normal" personality, Shapiro (1965) provides further elaboration of how a person with a balanced identity style would approach experiences. A new experience would be evaluated on the basis of a preexisting set of interests and values, but the individual would also be flexible enough to notice and possibly follow up on a novel or unusual feature of the experience. The individual would use the new information gained in this way to disconfirm prior expectations, if necessary, but only after giving the matter careful consideration from a variety of perspectives. As the information is studied, it becomes altered somewhat to fit into the individual's stable cognitive structure, but its essential qualities are retained intact. At the same time, as the new information is being cognitively evaluated, it also gains affective qualities. If it is an idea regarding a possible action to take, the attention devoted to comparing it with existing ideas or expectations gradually transforms it into a more concrete entity with more clearly advantageous and disadvantageous elements.

The balanced individual neither feels pushed by external circumstances nor compelled by inner drives to follow preset regimens of thoughts, actions, and feelings. There is a healthy degree of autonomy, from which the person sustains a sense of pride, competence, and self-esteem. The individual can sustain directed attention and concentration but can also relax and enjoy sensual pleasures. He or she feels "at home" with the self, in body and mind. The high degree of self-knowledge and comfort with this self that is experienced by the individual with a balanced identity style also makes it possible to empathize with other people's feelings and perspectives. The individual does not fear that taking on someone else's position will create the threat of self-annihilation because there is a secure basis of self-control and understanding.

## IDENTITY STYLES AND ADAPTATION TO AGING

If the identity styles represent stable ways that individuals have of reacting to new experiences, then it would be expected that the changes associated with the aging process would be handled in ways similar to the individual's predominant use of identity styles in other areas of life. If anything, an accentuation of the individual's predominant tendencies may be expected because of the heightened importance attached to the meaning of age changes in bodily functioning. Rather than speculate about the fate of individuals having different identity styles, it is possible to make some specific predictions based on a careful reading of the literature on factors that influence adaptation to the aging process.

## Adaptation to Aging as a Function of Personality

The first place to look for predictions regarding the adaptive potentials of each of the identity styles to the aging process is in the literature on age, personality, and well-being. The most simple and direct version of a model on which to base such predictions would link age to psychological well-being through the mediation of stable personality traits. This type of simple model, summarized by Neugarten (1977), is illustrated in Figure 8-1. The current body of research on adaptation to the aging process suggests, however, that these three variables have far more complex relationships with life events, coping strategies, and physical health. A summary of the current research testing the relationships among these variables is shown in Figure 8-2. The relationships outlined in Figure 8–2 have all been studied, at least in terms of the simple relationships between two connected variables, as illustrated. A summary of this research provides some suggestions for making predictions about the adaptive potential of each of the identity styles to the physical, psychological, and social aspects of aging.

*Age, Life Events, and Personality.* Age is negatively related to the number of stressful life events (Masuda & Holmes, 1978), but the events that are experienced by older adults may be of a more cumulative, stressful nature (House & Robbins, 1982). There is some evidence for a relationship between age and coping strategies such that older adults are more likely to use "mature" forms of reducing stress (McCrae, 1982). The relationship between age and personality traits has, in contrast, been shown to be remarkably stable (Conley, 1985). Personality traits are, in turn, related to physical health in such a way that highly neurotic individuals are more likely to report suffering from physical symptoms (Costa et al., 1982).

*Personality, Well-being, Life Events, and Coping.* Personality is related directly to psychological well-being, with extroverts and individuals receiving

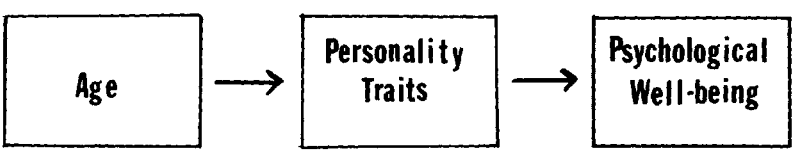


**Figure 8-1.** Simplified model illustrating relationships among age, personality, and well-being.

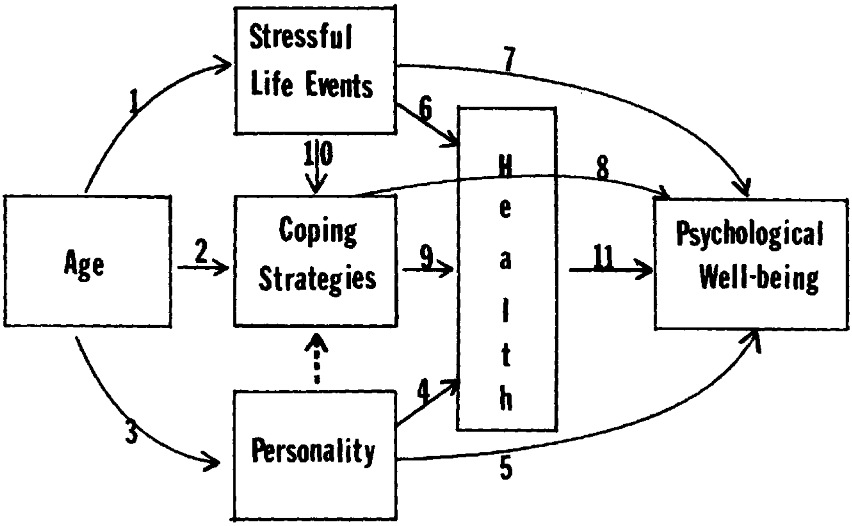


**Figure 8-2.** Multivariate relationships among age, stressful life events, coping strategies, personality, health, and psychological well-being. Representative studies documenting relationships are indicated by numbers. The dotted line indicates a missing link in the literature on stress and aging. 1, Masuda & Holmes, 1978; House & Robbins, 1982; 2, McCrae, 1982; 3, Conley, 1985; 4, Costa, Fleg, McCrae, & Lakatta, 1982; 5, Carp, 1985; 6, Weinberger et al., 1986; 7, Blazer, 1980; 8, Foster & Gallagher, 1986; 9, Lazarus, Cohen, Folkman, Kanner, & Schaefer, 1980; 10, Lazarus & DeLongis, 1983; 11, Deimling & Harel, 1984.

low scores on neuroticism reporting higher levels of happiness (Carp, 1985). Older individuals who are exposed to multiple stressful events do appear to suffer negative effects on their health (Weinberger et al., 1986). Stressful life events also have a negative impact on psychological well-being (Blazer, 1980). The relationship between stressful life events and outcome is, however, mediated by the older individual's use of coping strategies (Lazarus & DeLongis, 1983). Coping strategies in older adults, as related to psychological well-being, have only just begun to be studied. Although the particular form of coping does not seem to be related to mental health, nondepressed elders appear to be more likely than their depressed counterparts to use all forms of coping (Foster & Gallagher, 1986). This finding is probably accounted for by the complex nature of the relationship between coping and health (Lazarus et al., 1980).

*Physical Health and Psychological Well-being.* Physical health has a powerful impact on the psychological well-being of older adults (Deimling & Harel, 1984). This relationship, however, is dependent on the source of physical health ratings. Reflecting the influence of personality on both self-reported physical health and psychological well-being, the relationship between health and well-being is attenuated when it is based on objectively rated physical health (Tessler & Mechanic, 1978).

*Personality and Coping Strategies.* As indicated in Figure 8–2, there is one critical relationship on which the gerontological literature is silent. This is the relationship between personality and coping strategies; that is, whether there are stable dispositional differences in the tendency to use emotional versus cognitive coping strategies. Indeed, the stress and coping literature has in general neglected to address the issue of whether individuals differ in their preference for particular coping strategies (e.g., Monat & Lazarus, 1977). Coping is viewed as being primed by the particular appraisals individuals make of given situations, appraisals that reflect a joint function of person and environmental variables (Lazarus, DeLongis, Folkman, & Gruen, 1985). However, given the consistency of the adult personality (see Figure 8-2) and the preference that individuals show for using social–cognitive strategies that they have used in the past (Taylor & Fiske, 1978), it seems reasonable to propose that over time adults would show a tendency to try a method of coping with which they are at least familiar, even if it is not the most effective one available. One might go even further and propose that there are individual differences in coping flexibility; that is, how open one is to trying a novel strategy, whether cognitive or emotional (Showers & Cantor, 1985). For the present purposes, though, it is sufficient to assume that the preference for cognitive versus emotional coping strategies constitutes a stable individual difference variable. In this regard, the connection between cognitive strategies and an "approach" orientation to stress, and emotional strategies and "avoidance" of stress, is particularly relevant (Roth & Cohen, 1986).

## Adaptation to Aging

Identity styles would play a central role in the model presented in Figure 8-2 by linking the individual's own perception of aging to the impact of aging on well-being. The identity styles would represent the way that stable individual differences in coping strategies influence how health and social role changes in adulthood interact with the individual's self-definition, particularly that component of it that falls along the dimension of age identity (George, Mutran, & Pennybacker, 1980). They bring into the personally relevant, experience-near terms the more abstract, experience-distant changes associated with aging.

The potential adaptive value of each of the identity styles as a way of facilitating psychological adjustment to the aging process will now be examined on the basis of Shapiro's (1965) neurotic style descriptions, discussed above, and the empirical studies on aging, personality, and health. As in the literature on stress and coping, it is not being assumed here that there is one "ideal" way in which to adapt psychologically to the aging process. A point that has been repeatedly emphasized in such literature is that neither the emotional nor the cognitive coping style is "better" in any kind of general terms. Similarly, there are advantages and disadvantages to each of the identity styles as a basis for adapting to the aging process. Following a similar treatment by Roth and Cohen (1986) applied to approach and avoidance coping strategies, the present analysis will contrast the identity styles in terms of "costs" and "benefits" to adaptation that each represents. This approach is summarized in Table 8-1.

## ASSIMILATIVE IDENTITY STYLE

The kind of identity the assimilative identity style would be expected to impose on the experiences associated with aging is the view of the self as a young adult. Although he intended it to be a general statement about aging, Murphy's (1947) description of what happens to the self during the aging process aptly character-

TABLE 8-1
**Benefits and Costs of Identity Styles for Psychological Adaptation to the Aging Process**

| Identity style | Benefits | Costs |
|---|---|---|
| Assimilative | Optimism toward present situation | Use of projection as defensive strategy, leading to social isolation |
| | Self-perception of good health | Depletion of psychological energy required to maintain denial of age changes |
| | Positive evaluation of life accomplishments | Alienation from "real," i.e., aging, self |
| | | Failure to take advantage of mental and physical exercise to strengthen compensatory functions |
| Accommodative | Secure basis of self-definition in identity of "aging person" | Overreaction to physical symptoms of aging and disease that blocks effective remediation |
| Balanced | High motivation to take advantage of preventive as well as therapeutic health practices | Frustration and a sense of helplessness in the face of age changes and events beyond one's personal control |
| | Favorable adjustment to aging that integrates age changes into a consistent sense of the self | Direct confrontation of issues related to loss and mortality |

izes the individual with this identity style: "The self that is achieved in the prime of life is stabilized and held on to tenaciously for years, as one fights a rear-guard action against the recognition of failing powers" (pp. 518–519). The attempt to hold onto a youthful identity would emerge as a belief that the years corresponding to young adulthood were the happiest years of life, a perception reported consistently among older cohorts over a 40-year period (Harris & Associates, 1976; Morgan, 1937). Another form this tendency to hold onto a past identity has taken is that of a reluctance to alter one's self-description from "middle-aged" to "old" (Bultena & Powers, 1978).

## Origins in Childhood

It is generally assumed that negative social stereotypes about aging underlie the individual's desire to maintain as youthful an identity as possible. However, there may be deeper psychological motivations whose roots tap fundamental issues involved in the very formation of the self during early life. Kohut's (1971) theory regarding narcissistic personality disorders postulated that for individuals to feel at one with their accomplishments they need to have had, as children, empathic recognition from significant others of their "grandiose" exhibitionistic fantasies of omnipotence. Children, in other words, need to have their accomplishments mirrored by the encouragement and approval of their parents in order to feel that what they are doing has validity. This narcissistic motivation is what accounts for the child's demands to have its parents "watch me!" perform every new skill he or she acquires during the early years of growth. Development in childhood consists of gradually substituting intrinsic satisfaction in one's accomplishments for the need for extrinsic approval from parents. It is possible that aging represents a renewal of the issues pertaining to the childhood fantasies of omnipotence, long buried in the unconscious layer of identity. To individuals whose identities are not based on a secure conviction of their own potential for competence and mastery, any signs of aging would threaten to destroy the basis for the self's credibility. The only way the individual can still feel competent is by denying as much as possible the importance of all signs of aging.

## Denial of Aging

The model of identity styles would predict that only those aging people who use the assimilative identity style would refuse to adjust their identities to take into account age-related changes in physical and behavioral capacities and social roles. It is not that these individuals do not notice the effects of aging on their bodies, mental capacities, and social status. On the basis of Shapiro's (1965) research, people with an assimilative identity style toward aging would be expected to be sensitized toward detecting any changes in appearance, health symptoms, memory, and social acceptance. Each new wrinkle would be carefully scrutinized, each year's job evaluation would be subjected to an intense search for evidence of age discrimination. The function of identity assimilation would be to distort the way these phenomena are perceived and understood. Any potential sign of aging would be sought, examined, and then set aside as a serious concern so as to retain the individual's youthful identity intact.

The benefits associated with an assimilative identity style would be comparable to the benefits that Roth and Cohen (1986) ascribed to the "avoidance" or emotional coping strategy. Outright denial of health problems makes it possible for the individual to maintain a self-perception of good health despite the presence of one or more chronic health problems. In a 1983 survey by the National Center for Health Statistics (U.S. Senate, 1986), it was reported that two-thirds of elderly persons living in the community described their health as excellent, very good, or good compared to that of others their own age despite the fact that 80% of the elderly in the sample had at least one chronic condition. Thus, denial of the significance of current health problems seems to be a fairly widespread phenomenon, at least as revealed in a survey type of investigation. There may also be a similar tendency for older persons to suppress the existence of mental health problems (Goldney, 1984).

The individual who denies the importance of signs of normal aging, apart from disease, would be able to retain an optimistic view about life in the future without having to think about larger and worrisome issues such as illness, retirement, and death. Like the elderly people in "foreclosed" ego integrity status described by Walaskay, Whitbourne, and Nehrke (1985–86), those who assimilate age changes to a youthful identity can experience a high degree of psychological well-being while remaining unperturbed by existential questions about the deeper meaning of their own aging. Another means of using identity assimilation as a positive coping strategy is to revise continually one's expectations for the future in a downward direction so that capacity and achievement remain in line. This is the strategy that two large surveys found to be used by many older individuals as a means of maintaining high levels of life satisfaction into old age (Andrews & Withey, 1976; Campbell, Converse, & Rodgers, 1976). The revision of one's "life story" so that it matches the individual's conception of what constitutes a desirable life span is another similar coping strategy for adapting to past disappointments that can never be corrected (Whitbourne, 1985b).

## Projection as a Function of Extreme Assimilation

Like the person with the paranoid neurotic style, the aging individual who represents the extreme version of the assimilative identity style would be expected to become hypervigilant and use projection when there is a severe threat to his or her identity as a nonaging person. Faced with an age change that is almost impossible to deny, such an individual will become alerted to scan the social and physical environment for a substitute explanation. This individual may, for instance, refuse to accept the possibility that she needs bifocals because of any change in her own visual ability. Instead, she will blame the people who publish paperback books for trying to economize too much by reducing the size of the print on the pages. Complaints about the "fast pace" of "modern" life would be made by such an individual instead of admitting to having a slower response speed. A similar explanation is offered for the development of frankly paranoid tendencies in elderly persons with multiple losses (Raskin, 1979). An elderly person who suffers from presbycutic hearing loss projects his own negative feelings about aging onto the people around him. He is convinced that these people, knowing he cannot hear their speech, are using the opportunity to criticize and ridicule him. It is less threatening for him to attribute such negative qualities to others than to accept his own sensory deficit.

Projection, then, is an assimilative coping strategy that exacts a greater toll than it contributes to the individual's psychological adjustment. The individual's personal sense of loss is alleviated, but adaptation to the social milieu will suffer considerably. The other assimilative strategies also can incur significant costs. A considerable amount of psychological energy must be devoted to successful denial of aging changes. Effort is required to maintain a vigilant stance toward the physical and behavioral signs of aging. The results of denying the effects of aging are also potentially deleterious to psychological well-being. As each new age change is rejected as having personal significance, the individual's subjective identity as a youthful person becomes increasingly alienated from his or her "real" self, which possesses the objective characteristics of an aging person. Eventually the person would experience this alienation as a painful sense of distancing from the way he or she feels "inside" and the image reflected back in the mirror. There would be a loss of the feeling considered basic to a healthy identity of being at one in body and mind, of having the "psyche" located in the "soma" (Laing, 1960; Winnicott, 1971). It is not implausible that the despair accompanying this alienation accounts, at least in part, for the increased risk of suicide with each succeeding decade in old age (U.S. Senate, 1986).

## Effects of Assimilative Identity Style on Health

In addition to these heavy psychological costs, which can indirectly become life-threatening, the individual who denies the effects of aging on physical and behavioral functioning may risk direct impairments to the integrity of physiological systems. By not taking appropriate therapeutic action when a sign of disease is first noticed, the individual's health is directly jeopardized. This is particularly dangerous when the cardiovascular system is involved (Lazarus et al., 1980). It is not that the symptoms are denied, it is that they are attributed to other causes. The man in his 60s with angina who does not want to give up an active involvement in work calls his chest pains "heartburn" or "backache" and takes antacids or uses a heating pad instead of checking with his physician. He realizes the symptoms are there and indeed is very sensitive to them, but he cannot accept them for what they are. Even if such an individual is told by a health professional to take corrective action, this advice often will not be followed or taken seriously until it is too late and he suffers a myocardial infarction. If the individual manages to survive the infarction, the chances are high that he will suffer from a lowered self-image (McPherson et al., 1967) and serious depression (Hellerstein, 1973).

A similar type of process would apply to other life-threatening disorders, particularly cancer, for which early intervention proves to be so critical. Other areas of physiological functioning that normally change with age may suffer diminished efficiency when the individual fails to take ameliorative steps. To the extent that these changes are reversible, the overall quality of the individual's life will be reduced unnecessarily by failing to take advantage of potential modes of compensation (Whitbourne, 1985a). Reversible age changes may also include the behavioral functions that show "plasticity." These are functions that will show normal age-related losses that can be overcome by continued practice of "expert" skills (Hoyer, 1986) or by the adaptation of other functions not affected by aging that can take over (Baltes, Dittman-Kohli, & Dixon, 1984; Baltes & Willis, 1982). The individual could benefit psychologically from the exercise of these compensatory functions. Instead of the self-alienation that comes from a denial of the body's inability to function as it did in the past, the individual could derive a real sense of competence from the accomplishment of alternate tasks that can be successfully mastered.

## ACCOMMODATIVE IDENTITY STYLE

What is the adaptive potential of the accommodative style to the internal and external changes associated with the aging process? The stance toward age changes taken by the individual with an accommodative identity style can be predicted to be one of overreactivity and overgeneralization. This identity style is marked by a weak and poorly articulated self-representation easily shaped by the individual's exposure to new events and ideas. Whatever happens in the individual's day-to-day life serves as the basis for the individual's current manifestation of an identity.

## Hypersensitivity to Age Changes

The mode of cognition associated with the accommodative identity style is, like the hysterical and impulsive neurotic styles, characterized by a tendency to make sweeping generalizations on the basis of very little actual "objective" information. It is as if the individual were searching for anything from the outside world that would be solid enough to grab onto to make up for the lack of substance within his or her own identity. Even if this substance holds the potential to damage the individual's sense of well-being, it is substance nevertheless. The accommodative adult's intense hunger for external self-referents may be based on a very fundamental emptiness in the self that had its origins in a failure of early development in infancy (Kohut, 1971, 1984; Winnicott, 1971). Without consistent nurturant feedback from a mothering figure in the first days and weeks of life, the individual will perceive the self as a set of disconnected elements rather than as an integrated whole. Although he or she may avoid becoming outrightly psychotic, there will be a "basic fault" (Balint, 1968) in the cohesiveness of the self. External structure is needed to support the individual's identity, to keep it from disintegrating.

The individual with an accommodative identity style would not actively scan the environment in the same way as the assimilative person looks out for evidence of age changes. The accommodative individual would not find such information to be particularly relevant. Shapiro (1965) noted this specific point in describing the person with the hysterical neurotic style, whose lack of concern with objective facts constitutes "one of the reasons why aging so often comes as a sudden shock to these people" (p. 124). However, once the "shock" is encountered, it can take on a powerful, transforming quality, and the individual succumbs to the total sensation of being "old." The identity of the "old" or "aging" person is an attractive one to the accommodative individual because it provides a concrete set of external self-referents. This identity is made even more desirable because it serves as an alternative to what is otherwise a threat of total self-annihilation. Were the individual to acknowledge fully the meaning of the age change as a sign that he or she is moving closer to death, the old unconscious fears of self-fragmentation will be renewed. The identity of the accommodative individual grabs onto anything that will save it from the prospect of the self's destruction. This identity persists because it carries with it rewarding qualities, or secondary gains, that outweigh the discomfort of admitting that one is "old."

## Potential to Gain from Identity as a "Senior Citizen"

From the standpoint of the individual's psychological well-being, the accommodative strategy of coping with the aging process has the advantage of providing a secure basis of self-definition. Indeed, to the extent that the person derives advantages from carrying Golden Ager discount and Medicare insurance cards, there are distinct entitlements associated with this status. The person who is willing to acknowledge that he or she is being affected by the aging process may also be more likely to be influenced by advice from medical authorities to take appropriate preventive or therapeutic measures such as physical fitness training. There is considerable evidence that involvement in an exercise training program improves not only aerobic power and other cardiorespiratory functions but also improves the mood state and self-concept of middle-aged and older adults (Blumenthal, Schocken, Needels, & Hindle, 1982), particularly those who are extremely anxious and distressed about their health at the outset of training (Folkins & Sime, 1981).

### Neurotic Preoccupations with Health

The costs associated with the accommodative identity style as a means of coping with the aging process are a direct function of the individual's tendency to overreact when the signs of aging become evident. Whereas the person with the assimilative identity style is not concerned enough about the deleterious effects of aging or disease, the individual with the accommodative style wants to find out as much as possible from medical authorities. It is perhaps for this reason that there are consistent reports in the literature of an association between neurotic personality tendencies and heightened sensitivity to and distress over physical symptoms (Costa et al., 1982; Costa & McCrae, 1980b; Tessler & Mechanic, 1978). On having a physician verify that there is a physiological basis for the perceived symptoms, the individual with the accommodative identity style may become so distraught that he or she is blocked from taking effective action to correct the disorder or alleviate the symptoms. A similar process may operate in the area of memory functioning, where the average amount of memory loss is regarded with panic as a sign of "senility." In a study on the effectiveness of memory skills training, Scogin, Storandt, and Lott (1985) found that older adults who complained about their poor memory had equivalent memory performance to a group who were not overly concerned about memory loss. The two groups did, however, differ significantly on a measure of metamemory that assessed the individual's perceived effectiveness of various memory strategies. It is possible that the group of memory complainers was reacting with an accommodative identity style that resulted in an exaggerated concern about the seriousness of their memory deficits.

It has been found that neuroticism is related to poor psychological adjustment to aging, both in personal subjective terms (Costa, McCrae, & Norris, 1981; Lawton, 1984) and in terms of social adjustment (Carp, 1985). This finding may be accounted for by the tendency for highly distressed, overly accommodative individuals to fall into a pattern of preoccupation and isolation from others. They are frightened that any physical exertion will make them sicker and weaker than they are already. Participation in social functions threatens to drain their energy so that they have less capacity to carry out their activities of daily life. They are reluctant to tax their mental resources, which they believe to be rapidly diminishing in strength and effectiveness. All of these attitudes toward the use of physical, social, and mental skills lead to a state of avoidance and isolation, which in itself can create further loss and outright pathology.

### Life-style Effects That Influence Health

One very pertinent finding on this point regarding the negative consequences of the accommodative identity style emerged in the longitudinal studies carried out by Schaie and his associates (Hertzog, Schaie, & Gribbin, 1978). A subgroup of the sample was found to be characterized by a "disengaged homemaker" life-style. These women lived at home and had a very limited set of activities and contacts with other people. Their isolation appeared to have been an outcome of cardiovascular disease and, in turn, appeared to have had a negative influence on their intellectual functioning. One might speculate that these women were showing the deleterious effects of overreacting to the presence of a physically limiting condition. Instead of participating in exercise or stimulating social activities, they stayed home and "conserved" their energy. The result was a further diminution of their mental abilities and lack of opportunity to try to overcome their cardiovascular disorders.

### Difference Between Assimilative and Accommodative Identity Styles

It could be argued that without a clearer definition, it is just as likely that findings documenting the greater tendency of "neurotics" to report physical symptoms and take a conservative approach to avoiding exertion could apply to the assimilative, or closed, identity style. The assimilative individual is assumed to have a longstanding tendency to notice physical symptoms of aging and so might fit very well into the pattern of longitudinal results reported by Costa and McCrae (1980a). However, it is more consistent with the definition of the assimilative and accommodative styles to take the present approach of linking neurotic overreactions to aging with the accommodative identity style. The individual with an assimilative style would notice but then deny the significance of an age effect in order to retain as youthful an identity as possible. Therefore, this person would not be likely to endorse self-ratings of either physical symptoms or the seeking of medical treatment, in addition to denying the existence of neuroticism or any other forms of psychological distress (Tessler & Mechanic, 1978). The individual with the accommodative identity style would be much more ready to admit to having both physical and psychological problems. Indeed, rather than retaining an identity as youthful, an identity that they lack, accommodative individuals would be almost relieved to take on the identity of an aging or "mature" adult once the inevitability of their own aging has been made clear to them.

This latter point is extremely important because it is also consistent with the accommodative identity style to prefer the carefree innocence of maintaining a noncommittal attitude about issues pertaining to aging, adulthood, and "maturity." Unlike the assimilative individual, who works hard at retaining a youthful self-image, the accommodative person simply does not notice that time is having an effect on physical appearance, mental capacities, and social status. This person may inadvertently get into a dangerous or overly stressful situation not by a stubborn refusal to avoid admitting to "getting older" but by lack of concern over taking any precautions. All of a sudden, the 50-year-old shortstop on the company softball team, wearing the same clothes and hairstyle of the 20-year-olds on the team, collapses on the field after a particularly strenuous play at second base. This event awakens the individual from the previous state of nonchalance about aging to an unquestioning acceptance of an identity as someone who is growing older. Having been caused to suffer once by unintentional overexertion, the person will avoid at all costs any further risks associated with physical activity.

Thus, the negative consequences for physical health and psychological well-being of the assimilative and accommodative identity styles may appear the same, in that both involve a reluctance to participate in compensatory activities. However, there is a fundamental difference between the two in the route by which each arrives at this state and the motivations behind the lack of involvement in therapeutic measures. Interventions directed at making these individuals more willing to take steps to overcome the losses associated with aging or disease would need to take account of these individual differences in identity styles.

## BALANCED IDENTITY STYLE

By definition, the balanced identity style implies a state of optimal adjustment to aging. It appears that there are indeed adaptive advantages to this identity style. However, there are also some costs that are incurred by the tendency of people with this identity style to confront in a direct fashion issues associated with their own aging and mortality.

### Benefits of the Balanced Identity Style

Individuals who can flexibly adapt their identities to integrate age changes into a cohesive sense of self would seem to be in the best position to adjust physically and psychologically to aging or to take advantage of available therapeutic measures when they cannot. These are the individuals who will join an aerobic exercise training program, for instance, out of a sincere desire to feel better and healthier and to avoid the chances of a heart attack (Heinzelman & Bagley, 1970). Moreover, there is a positive feedback cycle initiated by participation in a program involving active physical exercise that strengthens one's physical capacity and feelings of psychological well-being (Ismail & Young, 1977). Both of these outcomes can contribute positively to the older individual's sense of competence and self-esteem (Perri & Templer, 1984–85). The individual's identity will then be even better prepared to adjust realistically to further signs of aging. As observed by Sonstroem (1984), identity is strengthened by a variety of features associated with exercise apart from the direct effects of training on physical fitness. These identity-enhancing features include reinforcement of the individual's achievements in reaching personally important goals, which in turn allows the individual to feel more competent. Another perspective on the same issue is provided by clinical observations that uncompensated losses of physical strength can be a contributing cause of depression and depleted ego strength in old age (La Rue, Dessonville, & Jarvik, 1985; Shenfield, 1984–85).

Similarly, participation in activities intended to enhance intellectual functioning would also be expected to have a positive impact on identity by giving the older person the skills to compensate for age-related losses, particularly of fluid abilities and memory. This question has only begun to be addressed by controlled studies, however, and thus far has not received encouraging support (Scogin et al., 1985). Conversely, cognitive skills may be enhanced by treatment programs that stimulate the individual's involvement in social activities (Powell, Milligan, & Furchtgott, 1984). Furthermore, interventions that involve cognitive–behavioral therapies for treatment of depression appear to hold promise as a direct means of facilitating psychological adjustment to aging (Leng, 1985).

Short of actively seeking medical or psychological prevention or intervention in response to concerns about one's own aging, the individual may use a balance of identity assimilation and accommodation to integrate, in a gradual manner, changes in bodily and mental functioning into a stable identity. Instead of holding onto to an outdated identity as a young person or swinging to the opposite pole, where an identity as an aged individual is prematurely adopted, the individual can respond to the gradual changes associated with normal aging in a similarly paced, graduated fashion. Social comparisons would be particularly useful in this regard. The individual with a balanced identity style is neither overwhelmed by feelings of inadequacy when making comparisons of the self to younger adults nor overly depressed at the prospect of taking on the characteristics of elderly people. Indeed, the individual may benefit from the nondefensive use of downward social comparisons (Wills, 1981) to bolster a self-image that is realistically adapting to age changes. The individuals who either deny their aging or succumb to a premature acceptance of their fate are seen by the individual with a balanced identity style as being far less fortunate compared to oneself.

## Costs of the Balanced Identity Style

Looking at the negative features associated with the balanced identity style, it is apparent that the costs that people with this identity style may incur are precisely those that are associated with a long history of successful adaptation to life stresses and changes with age in physical and mental functioning. The individual may have come to rely on and even take pride in possessing a capacity to initiate and carry out remedial or preventive measures that offset the negative effects of aging. If, for a reason outside the individual's control, these measures cannot be taken, the person will suffer a damaging blow to his or her sense of personal efficacy. One of the psychological correlates of participation in exercise training programs among middle-aged and older men is the personality trait of self-sufficiency (Buccola & Stone, 1975; Hartley & Farge, 1977). An individual who begins an aerobic exercise program with the full intention of remaining a regular participant will therefore be extremely frustrated when leg cramps, joint pain, or excessive fatigue make it impossible to continue (Shephard, 1978). Similarly, individuals whose identity is based on strong feelings of self-efficacy will also be severely depressed when faced with a series of stressful life events whose occurrence could simply have not been prevented (Simons & West, 1984–85). These people, by virtue of their earlier successes in controlling the pace at which negative changes had to be confronted, will have set themselves up for much larger disappointments than will assimilative people, who have built strong defense mechanisms against change, or accommodative individuals, who have convinced themselves that they are powerless anyway in the face of uncontrollable external forces.

Another cost associated with the balanced identity style is that it does involve admission that the self is changing in ways that will ultimately end in death. In many ways the individual with an assimilative identity style has more to be cheerful about on a day-to-day basis because any concerns about aging are superficially glossed over. Having to come to grips with some of the unpleasant features of the aging process will present more of a constant challenge to the accommodative capacities of the individual who is attempting to maintain a balanced stance toward the experience of aging.

Thus, the balanced identity style has decided advantages over the other two identity styles in terms of promoting the individual's propensity to take useful corrective action against the negative effects of aging. The risks of this identity style nevertheless place a severe strain on the ability of the individual's self-representations to take into account the effects of aging that detract from feelings of personal competence. There is, however, a potential for the individual to emerge from a period of stress in dealing with issues related to loss of control with an even more resilient identity based on a sense of competence in being able to tolerate the "ambiguities and uncertainties of later life" (Mann, 1985, p. 485). The identity of the older person who is able to transcend the limitations imposed by the concrete realities of aging can thus have a broader base on which to assimilate and accommodate to the increasingly stressful experiences to be encountered in the future.

## CONCLUSIONS AND IMPLICATIONS

The identity-style construct has provided a useful way of differentiating among a variety of adaptive stances toward the difficulties and challenges presented by the aging process. This construct has the advantage of being based on a life-span developmental model, but it also takes into account the individual differences in psychological adaptation to aging. Moreover, the identity-style construct fits into the multivariate framework that is crucial to understanding and integrating the broad spectrum of research on aging, personality, health, life events, coping strategies, and well-being.

The difficulties presented by this model pertain to its direct testability. It has proved extremely challenging to obtain reliable quantitative measures of the identity processes (Whitbourne, 1986c) because they often involve very subtle and sensitive rating decisions. Self-report measures that are more easily scored are hopelessly inadequate because the whole point of the scoring procedure is to establish deviations between the respondent's statement of his or her perspective and alternative interpretations of the respondent's positions. A more feasible approach may involve laboratory demonstrations of the difference between the respondent's perceptions of a situation involving the self and the "reality" of what outside observers report. However, such an approach is not without its own limitations, as has been demonstrated in research investigating the negative schemata and attributional judgments of depressed and nondepressed individuals (Coyne & Gotlib, 1983).

It is likely that the identity-style construct can only be investigated through clinical approaches, applied in rigorous fashion with systematic qualitative analyses. For the present, it remains a viable theoretical framework within which the relationship among personality, health, and adaptation to aging can be approached. At the very least, it is possible to expand on Neugarten's (1977) statement that personality is the key to adaptation in later life with some specific suggestions about how the key may be turned.

## REFERENCES

Andrews, F. M., & Withey, S. B. (1976). *Social indicators of well-being: Americans' perceptions of life quality*. New York: Plenum.

Balint, M. (1968). *The basic fault: Therapeutic aspects of regression*. London: Tavistock.

Baltes, P. B., Dittman-Kohli, F., & Dixon, R. A. (1984). New perspectives on the development of intelligence in adulthood: Toward a dual-process conception and a model of selective optimization with compensation. In P. B. Baltes & O. G. Brim Jr. (Eds.), *Life span development and behavior*, Vol. 6 (pp. 33–76). New York: Academic Press.

Baltes, P. B., & Willis, S. L. (1982). Plasticity and enhancement of intellectual functioning in old age: Penn State's Adult Development and Enrichment Project (ADEPT). In F. I. M. Craik & S. Trehub (Eds.), *Aging and cognitive processes* (pp. 353–389). New York: Plenum.

Blazer, D. (1980). Life events, mental health functioning and the use of health care services by the elderly. *American Journal of Public Health, 70,* 1174–1179.

Blumenthal, J. A., Schocken, D. D., Needels, T. L., & Hindle, P. (1982). Psychological and physiological effects of physical conditioning on the elderly. *Journal of Psychosomatic Research, 26,* 505–510.

Buccola, V., & Stone, W. J. (1975). Effects of jogging and cycling programs on physiological and personality variables in aged men. *Research Quarterly, 46,* 134–139.

Bultena, G. L., & Powers, E. A. (1978). Denial of aging: Age identification and reference group orientation. *Journal of Gerontology, 33,* 748–754.

Campbell, A., Converse, P. E., & Rodgers, W. L. (1976). *The quality of American life.* New York: Russell Sage Foundation.

Carp, F. M. (1985). Relevance of personality traits to adjustment in group living situations. *Journal of Gerontology, 40,* 544–551.

Coan, R. W. (1972). Measurable components of openness to experience. *Journal of Consulting and Clinical Psychology, 39,* 346.

Conley, J. J. (1985). Longitudinal stability of personality traits: A multitrait-multimethod-multioccasion analysis. *Journal of Personality and Social Psychology, 49,* 1266–1282.

Costa, P. T., Jr., Fleg, J. L., McCrae, R. R., & Lakatta, E. G. (1982). Neuroticism, coronary artery disease, and chest pain complaints: Cross-sectional and longitudinal studies. *Experimental aging research, 8,* 37–44.

Costa, P. T., Jr., & McCrae, R. R. (1978). Objective personality assessment. In M. Storandt, I. C. Siegler, & M. F. Elias (Eds.), *The clinical psychology of aging* (pp. 119–143). New York: Plenum Press.

Costa, P. T., Jr., & McCrae, R. R. (1980a). Somatic complaints in males as a function of age and neuroticism. *Journal of Behavioral Medicine, 3,* 245–258.

Costa, P. T., Jr., & McCrae, R. R. (1980b). Still stable after all these years: Personality as a key to some issues in adulthood and old age. In P. B. Baltes (Ed.), *Life-span development and behavior,* Vol. 3 (pp. 65–102). New York: Academic.

Costa, P. T., Jr., McCrae, R. R., & Arenberg, D. (1983). Recent longitudinal research on personality and aging. In K. W. Schaie (Ed.), *Longitudinal studies of adult psychological development* (pp. 222–265). New York: Guilford.

Costa, P. T., Jr., McCrae, R. R., & Norris, A. H. (1981). Personal adjustment to aging: Longitudinal prediction from neuroticism and extraversion. *Journal of Gerontology, 36,* 78–85.

Coyne, J. C., & Gotlib, I. H. (1983). The role of cognition in depression: A critical appraisal. *Psychological Bulletin, 94,* 472–505.

Deimling, G. R., & Harel, Z. (1984). Social integration and mental health of the aged. *Research on Aging, 6*, 515–527.

Folkins, C. H., & Sime, W. E. (1981). Physical fitness training and mental health. *American Psychologist, 36*, 373–389.

Foster, J. M., & Gallagher, D. (1986). An exploratory study comparing depressed and nondepressed elders' coping strategies. *Journal of Gerontology, 41*, 91–93.

George, L. K., Mutran, E. J., & Pennybacker, M. R. (1980). The meaning and measurement of age identity. *Experimental Aging Research, 6*, 283–298.

Goldney, R. D. (1984). Factors associated with "masked" psychological illness in the elderly. *Psychopathology, 17*, 228–232.

Harris, L., & Associates (1976). *The myth and reality of aging in America.* Washington, DC: National Council on Aging.

Hartley, G. H., & Farge, E. J. (1977). Personality and physiological traits in middle-aged runners and joggers. *Journal of Gerontology, 32*, 541–548.

Heinzelman, F., & Bagley, R. W. (1970). Response to physical activity programs and their effects on health behavior. *Public Health Reports, 85*, 905–911.

Hellerstein, H. K. (1973). Exercise therapy in coronary disease. Rehabilitation and secondary prevention. In J. H. de Haas, H. C. Hemker, & H. A. Snellen (Eds.). *Ischaemic heart disease* (pp. 406–429). Baltimore: Williams & Wilkins.

Hertzog, C., Schaie, K. W., & Gribbin, K. (1978). Cardiovascular changes in intellectual functioning from middle to old age. *Journal of Gerontology, 33*, 872–833.

House, J. S., & Robbins, C. (1982). Age, psychosocial stress, and health. In M. W. Riley, B. Hess, & K. M. Bond (Eds.), *Aging in society* (pp. 175–197). Hillsdale, NJ: Erlbaum.

Hoyer, W. J. (1986). Aging and the development of expert cognition. In T. M. Shlechter, & M. P. Toglia (Eds.), *New directions in cognitive science.* Norwood, NJ: Ablex.

Ismail, A. H., & Young, R. J. (1977). Effects of chronic exercise on the personality of adults. *Annals of the New York Academy of Science, 301*, 958–969.

Kohut, H. (1971). *The analysis of the self.* New York: International Universities Press.

Kohut, H. (1984). *How does analysis cure?* Chicago: University of Chicago Press.

Kreitler, H., & Kreitler, S. (1970). Movement and aging: A psychological approach. In D. Brunner & E. Jokl (Eds.), *Physical activity and aging* (*Medicine and Sport*, Vol. 4, pp. 302–306). Baltimore: University Park Press.

Kris, E. (1952). *Psychoanalytic explorations in art.* New York: International Universities Press.

Laing, R. D. (1960). *The divided self.* Chicago: Quadrangle Books.

LaRue, A., Dessonville, C., & Jarvik, L. F. (1985). Aging and mental disorders. In J. E. Birren & K. W. Schaie (Eds.), *Handbook of the psychology of aging* (2nd ed.), (pp. 664–702). New York: Van Nostrand Reinhold.

Lawton, M. P. (1984). Psychological well-being in the aged: Factorial and conceptual dimensions. *Research on Aging, 6*, 67–97.

Lazarus, R. S., Cohen, J. B., Folkman, S., Kanner, A., & Schaefer, C. (1980). Psychological stress and adaptation: Some unresolved issues. In H. Selye (Ed.), *Selye's guide to stress research*, Vol. 1 (pp. 90–117). New York: Van Nostrand Reinhold.

Lazarus, R. S., & DeLongis, A. (1983). Psychological stress and coping in aging. *American Psychologist, 38*, 245–254.

Lazarus, R. S., DeLongis, A., Folkman, S., & Gruen, R. (1985). Stress and adaptational outcomes: The problem of confounded measures. *American Psychologist, 40,* 770–779.

Leng, N. (1985). A brief review of cognitive-behavioural treatments in old age. *Age and Aging, 14,* 257–263.

Mann, C. H. (1985). Aging—a developmental reality ignored by psychoanalytic theory. *Journal of the American Academy of Psycho-analysis, 13,* 481–487.

Marcia, J. E. (1966). Development and validation of ego-identity status. *Journal of Personality and Social Psychology, 3,* 551–558.

Markus, H., & Wurf, E. (in press). The dynamic self-concept: A social psychological perspective. *Annual Review of Psychology, 38.*

Masuda, M., & Holmes, T. H. (1978). Life events: Perceptions and frequencies. *Psychosomatic Medicine, 40,* 236–261.

McCrae, R. R. (1982). Age differences in the use of coping mechanisms. *Journal of Gerontology, 37,* 454–460.

McPherson, B. D., Paivio, A., Yuhasz, M. S., Rechnitzer, P. A., Pickard, H. A., & Lefcoe, N. M. (1967). Psychological effects of an exercise program for post-infarct and normal adult men. *Journal of Sports Medicine, 7,* 95–102.

Monat, A., & Lazarus, R. S. (Eds.). (1977). *Stress and coping.* New York: Columbia University Press.

Morgan, C. M. (1937). The attitudes and adjustments of recipients of old age assistance in upstate and metropolitan New York. *Archives of Psychology,* No. 214.

Murphy, G. (1947). *Personality: A biosocial approach.* New York: Harper & Brothers.

Neugarten, B. (1977). Personality and aging. In J. E. Birren & K. W. Schaie (Eds.), *Handbook of the psychology of aging* (pp. 626–649). New York: Van Nostrand Reinhold.

Piaget, J., & Inhelder, B. (1969). *The psychology of the child.* New York: Basic Books.

Perri, S., 2nd, & Templer, D. I. (1984–85). The effects of an aerobic exercise program on psychological variables in older adults. *International Journal of Aging and Human Development, 20,* 167–172.

Powell, D. A., Milligan, W. L., & Furchtgott, E. (1984). Interaction of physio-medical and psychosocial variables in age-related functional impairments. *International Journal of Aging and Human Development, 19,* 235–252.

Raskin, A. (1979). Signs and symptoms of psychopathology in the elderly. In A. Raskin & L. Jarvik (Eds.), *Psychiatric symptoms and cognitive loss in the elderly* (pp. 3–18). Washington, DC: Hemisphere.

Rochlin, G. (1973). *Man's aggression: The defense of the self.* Boston: Gambit.

Roth, S., & Cohen, L. J. (1986). Approach, avoidance, and coping with stress. *American Psychologist, 41,* 813–819.

Schwartz, M. M. (1986). Introduction. In K. Woodward & M. M. Schwartz (Eds.), *Memory and desire: Aging—literature—humanities.* Bloomington, IN: Indiana University Press.

Scogin, F., Storandt, M., & Lott, L. (1985). Memory-skills training, memory complaints, and depression in older adults. *Journal of Gerontology, 40,* 562–568.

Shapiro, D. (1965). *Neurotic styles.* New York: Basic Books.

Shenfield, M. E. (1984–85). The developmental course of defense mechanisms in later life. *International Journal of Aging and Human Development, 19,* 55–71.

Shephard, R. J. (1978). *Physical activity and aging*. Chicago: Yearbook Medical Publishers.

Showers, C., & Cantor, N. (1985). Social cognition: A look at motivated strategies. *Annual Review of Psychology, 36*, 275–305.

Simons, R. L., & West, G. E. (1984–85). Life changes, coping resources, and health among the elderly. *International Journal of Aging and Human Development, 20*, 173–189.

Sonstroem, R. J. (1984). Exercise and self-esteem. *Exercise and Sports Sciences Reviews, 12*, 123–155.

Sperbeck, D. S., Whitbourne, S. K., & Hoyer, W. J. (1986). Openness to experience and autobiographical memory in adulthood. *Experimental Aging Research, 12*, 169–172.

Taylor, S. E., & Fiske, S. T. (1978). Salience, attribution, and attention: Top of the head phenomena. *Advances in Experimental Social Psychology, 11*, 250–288.

Tessler, R., & Mechanic, D. (1978). Psychological distress and perceived health status. *Journal of Health and Social Behavior, 19*, 254–262.

U.S. Senate (1986). *Developments in aging: 1985*, Vol. 3. Washington, DC: U.S. Government Printing Office.

Walaskay, M., Whitbourne, S. K., & Nehrke, M. F. (1983–84). Construction and validation of an ego integrity status interview. *International Journal of Aging and Human Development, 18*, 61–72.

Weinberger, M., Darnell, J. C., Martz, B. L., Hiner, S. L., Neill, P. C., & Tierney, W. M. (1986). The effects of positive and negative life changes on the self-reported health status of elderly adults. *Journal of Gerontology, 41*, 114–119.

Whitbourne, S. K. (1985a). *The aging body: Physiological changes and psychological consequences*. New York: Springer-Verlag.

Whitbourne, S. K. (1985b). The life-span construct as a model of adaptation in adulthood. In J. E. Birren & K. W. Schaie (Eds.), *Handbook of the psychology of aging* (2nd ed.). New York: Van Nostrand Reinhold.

Whitbourne, S. K. (1986a). *Adult development* (2nd ed.). New York: Praeger.

Whitbourne, S. K. (1986b). *In search of the I: Identity and object relations theory*. Unpublished manuscript, University of Massachusetts at Amherst.

Whitbourne, S. K. (1986c). *The me I know: A study of adult identity*. New York: Springer-Verlag.

Whitbourne, S. K. (1986d). Openness to experience, identity flexibility, and life change in adults. *Journal of Personality and Social Psychology, 50*, 163–168.

Wills, T. A. (1981). Downward comparison principles in social psychology. *Psychological Bulletin, 18*, 66–88.

Winnicott, D. W. (1971). *Playing and reality*. London: Tavistock.

CHAPTER 9

# Perceptions of Aging and the Elderly

WALTER H. CROCKETT
GERONTOLOGY CENTER
UNIVERSITY OF KANSAS
LAWRENCE, KANSAS

MARY LEE HUMMERT
DEPARTMENT OF COMMUNICATION STUDIES
UNIVERSITY OF KANSAS
LAWRENCE, KANSAS

Whether elderly people are the targets of widespread negative stereotyping has been a topic of controversy. Butler (1969) proposed that they are; he coined the term *ageism* to refer to such attitudes and to the discriminatory actions that presumably accompany them. More recently, Palmore (1982) agreed that "there is abundant evidence of widespread ageism in our culture, including negative stereotypes and attitudes" (p. 333). Similarly, Nuessel (1982), after reporting that the English language has many more negative terms to describe the elderly than positive ones, asserted that the "dearth of agreeable vocabulary is symptomatic of the deep-rooted nature of individual and institutional ageism in our society" (p. 273). And two recent books (Barrow & Smith, 1979; Levin & Levin, 1980) have proceeded from the premise that negative stereotypes guide most Americans' views and actions toward the elderly.

Nevertheless, three recent reviews of research into attitudes toward aging and the elderly (Green, 1981; Kogan, 1979; Lutsky, 1980) have all concluded that widespread negative stereotypes of the elderly do not exist. The most vigorous expression of that conclusion was made by Schonfield (1982) in a paper immediately preceding Nuessel's in *The Gerontologist*. Schonfield charged that the term *ageism* is a value-laden slogan that calls for political advocacy on behalf of the elderly, not a concept that reflects an objective, scientific analysis of social processes.

How is it that reasonable people can reach such extremely incompatible conclusions? One reason is that the two positions rest on somewhat different evidence. Those on one side support the charge of ageism with historical, economic, and cultural evidence, as well as with evidence about individuals' perceptions of the elderly. Thus, historical analyses such as Fisher's (1978) show that the general status of elderly Americans has declined over the last 250 years. Similarly, blatant discrimination against the elderly in the workplace (e.g., Nelson, 1986) provides powerful evidence that advanced age, by itself, can be a major handicap in the contemporary world.

Those on the other side would doubtless concede that age is often the cause of institutional discrimination. What they would question is whether such institutional discrimination necessarily implies that individual perceivers are guilty of negative stereotyping of the elderly. They can find little evidence of wholesale age stereotyping by individuals in the research literature.

In addition to this differential reliance on cultural factors in drawing their conclusions, the two sides call on different sources of support in the research literature. They are able to do so because two different lines of research have yielded two sets of results with somewhat different implications. On the one hand, studies of perceptions of the elderly as a group consistently find that the elderly are viewed more negatively than young and middle-aged adults (though seldom do judgments of the elderly fall at the extreme negative end of the scale). On the other hand, just as consistently, studies of how specific elderly individuals are perceived find that they are viewed at least as positively as younger adults, and sometimes more positively.

In this chapter we will attempt to account for this discrepancy between the relatively negative perceptions of the elderly as a group and the relatively positive perceptions of specific elderly individuals. Several explanations of this disparity have been advanced. Some of them invoke methodological flaws in the research; others call on motivational causes; still others rely on cognitive processes. Our own favored explanation grows out of recent research in cognitive social psychology. It proposes that, instead of holding global stereotypes of the elderly as a group, perceivers differentiate several subcategories of the elderly. Some of these subcategories are evaluated positively; others are evaluated negatively. The evaluation of a particular individual will depend on the subcategory to which the person is assigned. Before considering these theoretical explanations, it is necessary to review the two sets of research results. We will first consider the results of studies of perceptions of the elderly in general, then those of perceptions of specific elderly individuals.

## PERCEPTIONS OF THE ELDERLY IN GENERAL

The literature on this topic through the late 1970s is reviewed in at least four sources: Kogan (1979), Lutsky (1980), Green (1981), and Palmore (1982). Of these four, only Palmore finds clear evidence of general stereotyping of the elderly, and his analysis rests heavily on historical and economic evidence. The other three conclude that the case for stereotyping of the elderly has not been proven. Nevertheless, as will be seen, the results do indicate that people hold mixed, positive-and-negative views of the typical elderly person. And the mix contains more negative attributes than positive ones.

It is convenient to review this literature by dividing it into research on beliefs about aging and the elderly, studies of the traits that are attributed to the elderly, and studies of general attitudes toward the elderly.

## Beliefs about Aging and the Elderly

The distinction between beliefs and attitudes rests on the observation that beliefs deal with matters of fact; their truth can be checked against objective evidence. By contrast, attitudes are subjective evaluations; they refer to likes and dislikes of people, objects, or events, and their truth or falsity cannot be determined. To be sure, a belief will often imply a positive or negative evaluation of the target of the belief. Thus, to the extent that loneliness is a negative condition, a belief that most old people are lonely implies a negative evaluation of old age. Nevertheless, the correlation between beliefs and attitudes is much less than perfect, so the distinction between them is worth maintaining. That distinction has not always been observed in the literature under review. In particular, many widely used attitude scales (e.g., Tuckman & Lorge, 1953) have been criticized because they include both items that address beliefs and belief-free items (Kogan, 1979).

Early research on beliefs about aging and the elderly was reviewed by McTavish (1971) and Bennett and Eckman (1973). It suggested that negative beliefs about aging and the elderly are widespread. These include beliefs that health, sensory capacities, intelligence, sexuality, and physical attractiveness decline with age; that the elderly need help and assistance from others; and that they are depressed, fear death, and dislike their juniors. Much of this early research is subject to criticism on methodological grounds, as discussed below.

More systematic research into beliefs about aging was initiated by Harris's (1975) national-sample survey of beliefs about old age. The research design made it possible to compare respondents' beliefs with self-reports of behavior from a subsample of elderly individuals. Respondents overestimated (1) the proportion of the elderly who spent much of their time watching television, sitting, and thinking; (2) the proportion with economic, social, and health problems; and (3) the proportion who live in fear of crime. Elderly respondents' beliefs were less in error than those of younger adults, but even the elderly overestimated the proportion that experienced these problems.

Palmore (1977) developed his "Facts on Aging Quiz" specifically to study beliefs about aging. It contains a set of true–false statements whose correctness can be determined objectively. The ratio of negative to positive statements in this quiz is about 3 to 1. The proportion of correct answers to the quiz has ranged from 56%, or just above chance, in a random sample of the population of

Birmingham, Alabama (Klemack, Roff, & Durand, 1980) to 90% among faculty members in human development (Palmore, 1977). Subjects consistently endorse a higher proportion of incorrect negative statements than incorrect positive statements, indicating a negative bias in their beliefs. Scores on the quiz increase with socioeconomic status, whereas negative bias decreases with socioeconomic status. The items on this quiz that are most consistently missed include the percentage of elderly in long-term care institutions, the amount of poverty among the elderly, their boredom, and the alleged increase in religiosity with age. As Lutsky (1980) has pointed out, a majority of respondents also reject many incorrect statements, including beliefs that most old people have no interest in sex, are senile, and cannot learn new things.

Rubin and Brown (1975) asked subjects to sketch the curve of intellectual ability in adulthood. The typical respondent produced an inverted-U curve, with a sharp drop in ability predicted for the elderly. Fitzgerald and Hyland (1980) replicated these results for judgments of three types of intellectual performance; in addition, their subjects also predicted that individual morality would *increase* linearly with age.

### Personality Traits Attributed to the Elderly in General

The attribution of a personality trait to the typical elderly peson implies a belief about what the elderly are like. But the validity of most trait attributions cannot be determined in the same way as the validity of most beliefs about the state of the world. Therefore, research on trait attributions is discussed separately from that on beliefs. In most studies of trait attribution, subjects are asked to think of a typical old person (and perhaps a typical young or middle-aged person) and to rate each such person on a number of personality traits. The results commonly show that the elderly are rated more negatively than young or middle-aged adults on some traits and more positively on others, with the direction of the difference more often negative than positive.

Harris (1975) reported that the elderly were seen as less good at doing things, less bright and alert, and less open-minded and adaptable than younger adults but also as wiser, warmer, and friendlier. Rosen and Jerdee (1976a) found that the elderly were judged as less capable of development than young adults but more stable. Labouvie-Vief and Baltes (1976) found that the elderly were judged as more aggressive, more dominant, and less achievement-oriented than the young but more nurturant. Similar mixed positive and negative trait attributions to the elderly in general, with negative attributions outnumbering positive, were reported by Crockett, Press, and Osterkamp (1977).

Instead of having subjects compare young and old targets on experimenter-generated trait lists, Schmidt and Boland (1986) asked them to list all of the traits they could think of that had been attributed to the elderly. Of the 99 traits that were left when synonyms were discarded, 8 had to do with physical qualities, 69 fell in a negative cluster, and 32 fell in a positive cluster.

In other research, ratings on checklists have been factor-analyzed to yield two or more dimensions of judgment about aging and the elderly. These studies commonly discover one or more evaluative dimensions; therefore, they will be analyzed in the next section.

## Attitudes toward the Elderly in General

Clearly, the traits that are attributed to the elderly carry implications about how they are likely to be evaluated (Anderson, 1968). Similarly, the beliefs a person holds about aging and the elderly have clear evaluative implications (Petty, Cacioppo, & Kasmer, in press). Nevertheless, as mentioned above, there is no one-to-one relationship between the evaluations that are implied by one's beliefs about an object and the direction of one's attitudes toward that object. In this section our attention is restricted to research that specifically assesses affective responses to aging and the elderly. As will be seen, the trend of these results shows that attitudes toward the elderly are less favorable than those toward the young but are not usually on the negative side of neutral.

Representative research includes that of Cameron and Cromer (1974), who reported that respondents to a national-sample survey said they would be less likely to associate with elderly persons than with middle-aged or young ones. Similarly, Kidwell and Booth (1977) reported that subjects expressed greater social distance from the elderly than from younger adults. Naus (1973) found that college students rated the elderly below young adults on three factors: evaluation, decisiveness, and instrumental behavior. It should be noted, as Lutsky (1980) has pointed out, that the mean evaluation of the elderly in most of these studies was not markedly negative; indeed, it was often on the positive side of the scale's midpoint, though less positive than the mean evaluation of younger adults.

Other studies have reported mixed positive and negative attitudes toward the elderly. Thus, Braithwaite (1986) had different groups of Australian adolescents rate, on a series of scales, a typical person who was either old or young, male or female. Responses were reduced to three factors. Old people were seen as more concerned for others and more responsible than young ones but less active and sociable. Similar mixed-to-positive attitudes toward the elderly have been reported for children by Thomas and Yamamoto (1975), Jantz, Seefeldt, Galper, and Serock (1977), Ivester and King (1977), Trent, Glass, and Crockett (1979), and Weinberger (1979) (but see Seefeldt, 1984, for somewhat more negative results).

## Some Comments on the Quality of this Research

A decade ago Carp and Nydegger (1975) remarked on the sterility of much of the research on perceptions of the aged. Although the quality of this work has improved during the intervening years, for a significant number of studies the charge of sterility can still be justified on theoretical, practical, and methodological grounds. A good bit of this research seems to have little bearing on any theoretical issue. One has the feeling that a number of studies were conducted more because they were easy to carry out than because they had any general theoretical or practical importance. Consequently, it is not surprising that much of this work has serious methodological flaws as well.

One flaw lies in the transparency of purpose of much of this research. When a subject is asked to rate a "typical old person" on a number of scales, it is clear what the researcher is up to. Furthermore, if no characteristics are given about a person or group except age, then age probably becomes a more salient factor in a subject's judgments than is ordinarily the case. This suggests that cooperative subjects are likely to make more stereotyped judgments of the elderly than they would if they were not primed to call on age stereotypes in their responses. That is, some of the negativity in these results may reflect how respondents think they should feel instead of how they do feel.

As Kogan (1979) pointed out, the demand characteristics in such research are magnified when the experimenter employs within-subjects research designs, asking respondents to rate "old people" and "young people," in turn, on the same items. Such procedures further emphasize the salience of age in subjects' judgments and alert them to the researcher's interest in age comparisons. Indeed, Wingard, Heath, and Himelstein (1982) have demonstrated that more extreme attitudes toward aging and the elderly are expressed when within-subject comparisons are made than when each respondent rates only one group.

At least two other methodological criticisms can validly be made of much of this research. One is that the psychometric properties of many of the questionnaires are unknown (Green, 1980; Kogan, 1979; Palmore, 1982). This means that the generality of the results of studies using those measures is also unknown. The other criticism is that in only a handful of cases (e.g., Cameron & Cromer, 1974; Harris, 1975; Klemack, Roff, & Durand, 1980) have researchers obtained representative samples of respondents from the population at large. Most of the research has been conducted using college students or other captive populations. Fortunately, as Lutsky (1980) pointed out, where responses of college students have been compared to those of other populations, there is little evidence of bias in the former group.

### Does This Research Reveal Widespread Negative Stereotyping of the Elderly?

No. As we have seen, a number of studies have observed no differences between attitudes toward the elderly and attitudes toward other age groups. Even when differences in favor of the young were found, ratings of the elderly often fell on the positive side of neutral. Furthermore, a considerable number of studies have reported the attribution of positive traits, as well as negative ones, to the typical older person. Mixed results of that sort simply cannot support the conclusion of wholesale negative stereotyping of the elderly.

That being said, it must also be concluded that people's views of the elderly are more negative than their views of younger adults. Unfavorable beliefs about the nature of old age exceed favorable ones. Studies of trait attribution find that the typical elderly person is rated less favorably than the typical younger adult more often than the reverse. That pattern characterizes too many studies, many quite well designed, to be dismissed on methodological grounds. In short, the pattern of results shows that individual perceivers identify both positive and negative aspects of aging and of the typical old person; the negative aspects (for instance, negative trait attributions) often outnumber the positive ones.

## IMPRESSIONS OF SPECIFIC INDIVIDUALS

If stereotyping of the elderly is a general phenomenon, then people should form more negative impressions of an old adult than of a young one, even when the two people are alike in everything except their age. This should be true because the age cue would elicit negative, stereotyped inferences about the old person but not the young one. Those inferences, combined with whatever information was common to both characters, would yield a relatively negative impression of the elderly person.

The first test of that hypothesis was conducted in two experiments by Kogan and Shelton (1962). In one experiment they asked subjects to record their impressions of a man, either 33 or 74 years old, who was employed either as a steelworker, a factory manager, or a college professor. Subjects' impressions showed strong effects for differences in the man's occupation but no effects for differences in his age. In a second experiment, these authors used a within-subjects design: Subjects made comparative ratings of a young and old worker in the three occupations. These ratings showed age effects, with the older worker receiving more stereotypically negative ratings. Kogan (1979) later concluded that the significant effects of age in the second experiment were produced by the within-subjects design, which, he asserted, increased the salience of age in subjects' judgments.

The methods of these experiments departed in two important ways from those used to study general attitudes toward the elderly. First, they used what Lutsky (1980) called an "age-embedded" design. That is, they varied the critical independent variable, the target person's age, in such a way that it was not obviously made salient for the subjects. Second, the method induced subjects to consider the target persons as individuals who happened to be old or young, not as representatives of all 74- or 33-year-old men.

This methodology lay dormant until the mid-1970s. Since that time, however, 20 or more papers have used it to test the stereotyping hypothesis. It will be convenient to discuss this research under three headings: experiments that focus principally on the effects of age alone on person perception of age; experiments that study the effects of age combined with other social categories, such as sex; and experiments that study the effects of age on actual or predicted behavior toward the target person.

## Research That Focuses Principally on Age Differences

Bell and Stanfield (1973a, b) had subjects evaluate a speaker who delivered a brief, tape-recorded talk on ecology. The speaker was described as a journalist who was either 25 or 65 years old. Contrary to the stereotyping hypothesis, the speaker's age had no significant effect on subjects' ratings on most of the dependent variables; differences on the few variables for which age effects were significant favored the old speaker over the young one.

Ryan and Capadano (1978) employed a within-subjects design in which subjects listened to tape recordings made by men and women of different ages, then rated each speaker on a number of traits. Most ratings showed no age effects; however, older women were rated less favorably than young ones on four traits—reserved, passive, "out of it," and flexible—whereas older men were rated less favorably on only one trait, flexible.

Reno (1979) had subjects predict the success or failure of young or old entering-college students. Age of the applicant had no effect on predictions of success, although projected failure was attributed to internal, stable factors for the elderly applicants but not for the young ones.

The preceding studies varied only the age of the target person while holding the remaining stimulus information constant. A stricter test of the stereotyping hypothesis would also vary the relevance of the person's activities to the age stereotype. When the activities conform to the alleged stereotype, one would expect an elderly adult to be perceived less favorably than a young one. At least five experiments have tested this form of the hypothesis. None of them supported it.

Weinberger and Millham (1975) had subjects read biographical sketches of a person. For different groups of subjects, the target person was described as old or young; in addition, the quality of the person's behavior varied from condition to condition. On five of eight dependent variables, ratings of the old person were *more* favorable than those of the young one; on the other three variables, there was no significant effect for age. However, when asked to choose one of two subsequent activities, interacting with the old target person or reading about another target person, most subjects chose the latter option.

Sherman, Gold, and Sherman (1978) and Crockett, Press, and Osterkamp (1977) had subjects read about young or old target persons who were described as performing in either a stereotypic or a nonstereotypic manner. In both experiments main effects were found for both age and type of behavior but, contrary to the stereotyping hypothesis, the elderly were rated more favorably than the young. However, both sets of authors suggested that their basic situation might unintentionally have presented the elderly in a nonstereotypic manner. If so, the experiments did not provide a fair test of the stereotyping hypothesis. Fortunately, two other experiments have been reported that were not subject to such confounding; neither of them provided support for the hypothesis.

Stier and Kline (1980) varied age of the target person and whether or not the person was a healthy, active, productive achiever. They obtained main effects for age, opposite in direction, on two dimensions of the Rosenkranz and McNevin (1969) Aging Semantic Differential: The elderly were rated more positively than the young on the autonomy dimension and less positively on the instrumentality dimension.

Braithwaite (1986) crossed age with type of ability, physical or mental, and level of ability, high or low. He found strong effects of ability on subjects' evaluations of the target person but no effects at all for age.

## Research Combining Age with Other Social Categories

Half a dozen experiments have varied information about other social categories (for instance, gender) along with age in their stimulus information. Thus, O'Connell and Rotter (1979) had subjects form impressions of target persons who varied in age and sex. In support of the stereotyping hypothesis, subjects evaluated the old target persons less favorably than young or middle-aged persons; they also rated the elderly lower in autonomy and effectiveness. However, once again, ratings of the elderly persons did not fall on the negative side of any of these dimensions.

Walsh, Connor, and their associates carried out a series of experiments that varied age, sex, and the quality of the target person's performance. In one, Walsh and Connor (1979) had subjects read an article that varied in quality and in the putative age and sex of its author. As they report, "within essay quality levels, females were never evaluated significantly differently from their male counterparts, nor were the old ever evaluated significantly differently from their youthful equivalents" (p. 566). One interaction was observed between age and sex of the target person, but it did not affect the quoted generalization and has not appeared in their subsequent experiments.

Connor, Walsh, Litzelman, and Alvarez (1978) obtained measures of subjects' attitudes toward the elderly several weeks before their experiment was carried out. They then crossed subjects' attitudes (pro or con) with age and sex of the target person, the quality of the target person's performance on an employment interview, and whether the person was hired or not. Effects of the person's age on subjects' judgments were trivial. In addition, subjects' general attitudes toward aging had no effect on any measure.

In a similar experiment, Locke-Connor and Walsh (1980) asked subjects both to rate the target person on various scales and to judge whether internal or external factors were responsible for the outcome of the interview. Except that the elderly person was rated as less active than the young one, age of the person affected subjects' impressions on only one subsidiary trait: The elderly persons were rated as less active than the young ones. Stable factors were judged as more important causes of the failure of unsuccessful elderly applicants than of unsuccessful young ones. In the authors' view, this indicates that subjects expected the older people to fail.

Puckett, Petty, Cacioppo, and Fisher (1983) had subjects read persuasive essays that varied in quality and in the age and social attractiveness attributed to the essay's author. Attractiveness and quality of the argument produced significant effects on subjects' evaluations of the essay, their perceptions of the author, and their opinions on the issue. However, age effects appeared only on scales evaluating the author and, contrary to the stereotyping hypothesis, favored the elderly person over the young one.

Perry and Varney (1978) had subjects rate workers who differed in age and competence. The target person's competence had widespread effects on subjects' judgments, but effects for age were obtained on only two variables: the older person was seen as less quick to learn and likely to remain with the company a shorter time than the younger one.

### Predictions of Behavior toward the Target Person

Half a dozen experiments have placed subjects in real or simulated situations and observed their judgments of, or actions toward, a target person. For example, Rosen and Jerdee (1976b) asked undergraduate business students to take the role of a manager and to evaluate workers in a number of different situations. Age of employees was varied in a within-subjects design. In agreement with the stereotyping hypothesis, older employees were evaluated less favorably than young ones. Schwab and Heneman (1978) proposed that the methods Rosen and Jerdee used may have made age an especially salient cue. Therefore, they had subjects (personnel officers in real life) read the dossiers of four secretaries; to minimize the salience of age, only one dossier presented a secretary whose age was markedly different from the others. In this case, age had no effect on subjects' judgments.

Kucharski, White, and Schratz (1979), using a within-subjects design, asked physicians to make simulated referrals for eight cases of behavior problems. For some of the problems, older patients were less likely than young ones to be referred for psychotherapy.

Levin and Levin (1981) asked students to read a résumé of an industrial sociologist and then to indicate whether they would attend a talk given by that person and an after-talk informal discussion. Age and socioeconomic status of the target person were varied systematically across groups. Neither age nor socioeconomic status affected subjects' intentions to attend the talk, but the two variables interacted in affecting whether they would attend the subsequent discussion: Subjects who read about the low-status elderly expert were less likely to attend the discussion than those in the other five experimental groups.

Flynn (1978) presented experienced nurses with realistic accounts of the physical ailments and hospital behavior of four patients. For each case, subjects (1) judged the level of nursing care the patient would require, (2) evaluated the criticalness of the patient's condition, and (3) recorded their impressions of the patient. Two independent variables were varied: age of the patient and whether the patient was complaining or cooperative. The four protocols were systematically rotated so that each subject was paired equally often with each combination of age and patient behavior. Contrary to the stereotyping hypothesis, age did not affect judgments of the level of care patients would need or the criticalness of their cases. The only systematic effect of age was that, again contradicting the hypothesis, subjects said they would feel more softhearted, more compassionate, and warmer toward the old patients than toward the young ones.

This research has been replicated in unpublished work in our laboratories using two additional samples of nurses. We varied the age of the patients and whether their conditions were chronic or acute. The results confirm Flynn's (1978): (1) age did not affect the nurses' professional judgments, and (2) contradicting the stereotyping hypothesis, nurses formed more favorable impressions of old patients than of young ones.

Weinberger (1981) carried out three field experiments on the effects of a target person's age and sex on the willingness of New Yorkers to help that person. In the first two experiments, confederates of different ages asked for assistance from individuals whom they approached on the street. (They had a plausible reason for needing help; e.g., that their eyes had recently been dilated by a physician and they could not read some printed street directions.) More help was given to elderly confederates than to young and middle-aged ones. In a third experiment, confederates whose voices reflected their ages requested help over the telephone instead of face-to-face; this time, the age of the caller had no effect on whether help was given. Weinberger concluded that a nonthreatening elderly person is more likely to receive assistance in the perilous streets of Manhattan than is a potentially dangerous middle-aged or young person; however, when a telephone line separates the potential helper from the supplicant, the advantage of being old disappears.

### Implications for Understanding How the Elderly Are Perceived

The hypothesis that stereotypes about old age impart a negative tinge to perceptions of specific elderly individuals receives little support in this research. In most of the experiments, impressions of the elderly did not differ much from those of the young. When age differences did appear, they favored the elderly as often as the young. And two-thirds of the experiments in which subjects formed negative impressions of the elderly increased the salience of age by using within-subjects designs.

Age effects were notably absent from research that combined age of the target person with other categorical information. Whereas variables such as the person's attractiveness, ability, or success consistently produced substantial effects on subjects' impressions, age seldom did so. One explanation for this outcome is that when age is embedded in a network of other information, inferences from the other variables overwhelm those from age, rendering age stereotypes inoperative (Lutsky, 1980). Note that this interpretation, if true, implies that age stereotypes contribute much less to people's impressions than do other kinds of expectations (and also contribute much less than has been assumed in social gerontology for 30 years or more).

These results, combined with those from research on attitudes toward the elderly in general, cast doubt on the charge that our society is plagued by wholesale negative stereotyping of the elderly. Still, even if we reject that charge, the data do show that advanced age frequently affects the impressions that are formed of a person. The effects may be favorable to the elderly as well as unfavorable—that is, age stereotypes may not be exclusively negative—but the fact that there are such effects requires explanation. We turn now to a review of such explanations.

## ACCOUNTING FOR THE EFFECTS OF AGE ON PERCEPTIONS

Kogan (1979) indicated the within-subjects research design as a major source of age effects on impressions. He coined a maxim: "If you want to be sure of obtaining age stereotypes from your subjects, make sure that you use a within-Ss design; if you wish to preclude age stereotypes, use a between-Ss design" (p. 26). The reason, he said, is that within-subjects designs "push age to the foreground as a salient characteristic," whereas in the normal course of events, "age is but one of a host of characteristics" that influence people's impressions.

Certainly, within-subjects designs are likely to enhance the salience of age as a cue in impression formation. But Kogan's maxim fails as a general principle because, as we have seen, age effects were observed in many of the studies that used between-subjects designs (e.g., Bell & Stanfield, 1973a, b; Braithwaite, 1986; Crockett et al., 1979; Puckett et al., 1983; Sherman et al., 1978). Therefore, it is necessary to examine other explanations of these results. We will consider three kinds of explanations: those calling on motivational factors, those emphasizing attributional processes, and those implicating multiple categorization of the elderly.

## Motivational Explanations

Scheier, Carver, Schulz, Glass, and Katz (1978) proposed that the elderly, like the physically or mentally handicapped, constitute a stigmatized group in our society. They cite abundant evidence from research on the effects of handicaps that people feel sympathy for individual members of stigmatized groups whom they encounter. This sympathy makes people's evaluation of a stigmatized person more favorable than it would be otherwise, canceling or even reversing the negative bias from the stereotypes.

Except in the work by Scheier et al. (1978), this hypothesis has not been tested with the elderly as the "stigmatized" group. However, there is research that has an indirect bearing on the hypothesis. Weinberger and Millham (1975) provided subjects who had just produced relatively favorable impressions of an elderly person with a chance either to interact personally with that person or to take part in another, solitary experimental task. As Scheier et al. would predict, most subjects chose the task over the elderly companion, suggesting that they rejected the elderly person in deed if not in word. Unfortunately, Weinberger and Milham did not offer subjects the same choice between interacting with a young target person and performing the task; consequently, it is unclear whether their preference for the task over the companion resulted from discrimination against the elderly or simply from a preference for a reasonably interesting task over association with a stranger.

Whether old age actually is viewed as a stigma comparable to physical and social handicaps, as Scheier et al. (1978) assume, has been the topic of at least three studies. Tringo (1970) asked 455 individuals of varied backgrounds to evaluate 21 different kinds of "disability" on a social distance scale. Old age fell exactly at the median of social distance, behind ulcer, arthritis, asthma, diabetes, heart disease, amputation, blindness, deafness, stroke, and cancer but ahead of paraplegia, epilepsy, dwarfism, cerebral palsy, hunchback, tuberculosis, ex-convict, mental retardation, alcoholism, and mental illness.

Norby (1979, cited in Austin, 1986) replicated this study with a sample of graduate students who reported less social distance from old age than from any other condition. Austin (1986) replicated the study yet again, this time with both graduate and undergraduate subjects. Old age ranked second in social distance (behind deafness) among graduate students and was tied for fifth among all respondents. Austin thinks these results support Tibbitts's (1979) contention that attitudes toward old age have become more favorable over the years. Whether or not one accepts that conclusion, the results do suggest that old age is not as stigmatizing as many physical and social disabilities.

Braithwaite (1986) proposed an explanation somewhat similar to that of Scheier et al. (1978) to account for the absence of age effects on impressions of specific individuals. Braithwaite carried out two experiments with the same set of subjects. In the first, subjects formed an impression of a specific person who was either young or old, male or female, and who behaved positively or negatively. Age had no effect on those impressions. In the second experiment, subjects rated a "typical" person who was either male or female and young or old. The typical old people were rated as more responsible but less active and sociable than the typical young people. Braithwaite reported that clear evidence of age stereotypes was found in the written comments (most of them negative) that subjects made about the old man or the old woman.

To account for these divergent results, Braithwaite (1986) proposed that stereotyped views of the elderly were, indeed, common among his subjects, but those views were countered by a "concern with antidiscrimination, with viewing the stigmatized group with sympathy, making allowances for expected failings, or even verbalizing a positive stereotype" (p. 359). When subjects were asked to form an impression of a specific elderly individual, Braithwaite argued, these positive and negative forces canceled each other out, so no overall effects for age appeared in the impressions.

This conflict between opposing forces could take place in one of two ways; it is not clear which one Braithwaite favors. On the one hand, the competing responses might occur in the same individual, producing ratings that cluster around the neutral point of the scales. That outcome would result in lower variability among ratings of elderly individuals than among ratings of young ones. Such a difference has not been reported in the literature. On the other hand, different sets of respondents might hold the two reactions: one set subscribing to the age stereotype, the other reacting against the stereotype. The two sets of impressions would then be polarized in opposite directions, producing high variability in the total group's ratings but a moderate mean score. In this case, subjects' general attitudes toward old people should correlate with their impressions of specific individuals. Such a correlation between general attitudes and specific impressions has not been observed in the literature (Connor et al., 1978; Weinberger & Milham, 1975).*

*However, Kahana and Kiyak (1984) found that scores on a scale of general attitudes toward aging were significantly correlated with the quality of care staff members of a nursing home gave to their patients.

To summarize, both of these explanations propose that people are motivated, whether by sympathy or by a backlash against the act of stereotyping, to form moderate-to-positive impressions of specific older individuals. Although both explanations are plausible, there is evidence that casts doubt on both of them. Neither has been studied enough to pass final judgment on its adequacy.

### An Attributional Explanation

Shaver (1978) set out to account for the huge disparity that Harris (1975) reported between (1) the estimates respondents made of the incidence of problems among the elderly population and (2) the proportion of the elderly who actually reported that they faced those problems. Shaver proposed that people overestimate the incidence of such problems because they hold a generally negative stereotype of the elderly. How do they maintain that stereotype when it is so far from the truth? Shaver believes the answer lies in differential attributions: When people meet someone who confirms the stereotype, they attribute that person's condition to old age; when they meet someone who contradicts the stereotype, they attribute the absence of problems to unique qualities of that individual. Because people think the counterstereotypic person is untypical, their impressions of such a person will be favorable ones; meanwhile, they retain, intact, their stereotyped views of the typical elderly person.

Obviously, this interpretation can account for the relatively favorable impressions that result when the information about an elderly person is mostly positive and counterstereotypical. It has been invoked by other authors (e.g., Crockett et al., 1979; Sherman et al., 1978), as well as by Shaver. But it is not clear that the hypothesis serves as well when the information is negative and stereotypical.

Suppose, for example, that an old person is described as inactive and in ill health. By Shaver's analysis, perceivers should attribute those qualities to the person's age and then ascribe to the target person other qualities (such as dull, fearful, or lonely) that are part of the age stereotype. Presumably, those additional inferences would not be made about an inactive, unhealthy young person, to whom the age stereotype would not apply. Therefore, impressions of the old person should be more negative than those of the young one. Several studies (e.g., Braithwaite, 1986; Flynn, 1978) set out to test that hypothesis. None of them confirmed it. Instead, they found either no differences in impressions as a function of age or differences that favored the elderly over the young.

A little reflection suggests why negative information about a young person produces impressions that are at least as negative as those of an old person. Inactivity and ill health are not expected in the young. Therefore, inactive, unhealthy young people receive ratings that are as unfavorable as those of similar old people, even on traits that are part of the alleged stereotype of old age. But the reasons for devaluing the young person may be different from those for devaluing the old. In fact, several recent papers have found that behavior by an old person is sometimes attributed to different causes than the same behavior by a young person. For example, Reno (1979) reported that subjects attributed failure by an old man to stable causes (ability and task difficulty), as did Walsh and Connor (1979); Reno's subjects attributed failure by a young man to an unstable cause (lack of effort).

More recently, Banzinger and Drevenstedt (1982) had subjects read information about a young (or old) woman who did well (or poorly) on a course examination (or on a driver's license test). Subjects rated the likelihood that each of five causes (effort, ability, age, luck, and task difficulty) was responsible for the woman's success or failure. As was expected, subjects attributed failure by the old woman to her age. However, contrary to the hypothesis, subjects did not attribute success by the old woman to unusual ability. Also, subjects unexpectedly attributed success by the young woman to her age. No support was obtained for Reno's (1979) finding that failure was attributed to stable factors for the old person and to unstable factors for the young.

To sum up, age has been shown to affect systematically the causes that subjects invoke to account for a target person's behavior. Although Shaver's (1978) position seems to imply that the stereotype of old age is more negative and more widely held than our review of the literature would indicate, it provides a plausible explanation for some of the differences between the results of studies of general attitudes toward old people and the results of research into impressions of specific individuals. Shaver pointed out that this attributional analysis has a number of other points in its favor. For one thing, it proposes that perceptions of the elderly are not determined simply by general attitudes but by the interaction between such attitudes and the behavior of the target individual. In addition, this approach explains how a general stereotype may persist even when its holder associates with elderly individuals who contradict it. And the approach brings a coherent body of theory and research to bear on the study of a topic that has suffered lamentably from an absence of theory.

## MULTIPLE CATEGORIES FOR THE ELDERLY

Brewer, Dull, and Lui (1981) proposed that general social categories, such as age and sex, are "too large and amorphous to capture adequately the nature of social perception." They argued that people differentiate those general categories into meaningful subcategories; the subcategories, not the larger ones, then become the basis for expectations about the traits and actions of individuals. In this view, people do not hold detailed stereotypes about the elderly as a homogeneous group but have different sets of expectations for different types of elderly people.

This analysis was rooted in Rosch's (1978) account of how systems of classification affect cognition. Classification systems consist of nested sets of categories that lie at different levels of generality. At the highest level in a hierarchy are superordinate concepts (for instance, the concept *vehicles*), which are so broad that only a few, very general characteristics are true of all of the individual members of the category. Near the bottom of a hierarchy are low-level, specific categories (for example, *Ford Escort, Honda Civic, Volkswagen Beetle*). These categories convey a great deal of information about the characteristics of their members, but the information from one such category overlaps substantially with that from the others (all of the above examples have four wheels, a windshield, doors, a motor, a common shape, and so on). Somewhere in the middle of a hierarchy are what Rosch called *basic-level categories* (for example, *cars, trucks, airplanes*, etc.). These convey a large amount of information about the elements they subsume (the concept *car*, for example, duplicates most of the information in lower-level categories like *Ford* and *Honda*); at that same time, the content of one basic-level category does not overlap much with that of other basic-level categories.

Brewer, Dull, and Lui (1981) argued that, for most people, the concept *elderly* represents a superordinate category that is differentiated into smaller, basic-level categories. To test this hypothesis, the authors identified three types of elderly people that, by hypothesis, should represent basic-level categories: *grandmother*, a nuturant, family-oriented woman; *elder statesman*, a distinguished, conservative man; and *senior citizen*, an inactive, isolated person of either sex. They selected pictures of elderly people that they judged represented each of the three categories and asked subjects (college students) to sort those pictures into groups they thought went together. A cluster analysis of the aggregate of these judgments showed that the empirically derived groupings matched the hypothesized three-category model. Other subjects then rated photographs from the three categories on a trait checklist. The traits that were ascribed to a photograph varied in the expected way with the category that the photograph represented.

Brewer, Dull, and Lui also borrowed from Rosch (1978) the concept of *prototypicality*. Rosch had shown that some members of a basic-level category are viewed as especially typical of the category as a whole. For instance, a robin is considered a better example of birds than is a wren; Ford Escorts are better examples of cars than are Volkswagen Beetles. Rosch used the term *prototype* to designate the best representative of a category. She showed that category members could be sorted according to how prototypical they are of the category as a whole. Applying this idea to impressions of the elderly, Brewer, Dull, and Lui observed that photographs differed in the consensus with which they were assigned to one of the three categories. The authors defined photographs that nearly all subjects assigned to a category as prototypes of that category and showed that subjects assigned category-relevant behaviors to prototypical photographs more than to nonprototypical ones.

Finally, Brewer, Dull, and Lui examined the effects of category membership on how subjects process information about the photograph of a person. Subjects were given information that was attributed to an elderly person whose photograph was prototypical of one of the categories. This verbal information consisted of behavioral and personality traits that represented either the same basic-level category as the photograph or a different category. Subjects spent significantly more time studying inconsistent pairings (e.g., sickliness paired with a grandmotherly photograph) than consistent ones. Subsequently, in a surprise memory test, subjects were required to recall the information associated with each photograph; they did as well on statements from consistent pairings as on statements from inconsistent ones even though they had spent significantly less time studying the former pairings than the latter.

Brewer and Lui (1984) extended this work to a sample of elderly respondents. Subjects sorted photographs that had been categorized in the preceding study as prototypical of grandmothers, elder statesmen, or senior citizens. As in the preceding study, respondents clearly distinguished among the different categories of photographs. However, elderly subjects grouped the photographs of old people into significantly more categories than had the young, indicating that they differentiated among those photographs more complexly than young respondents.

A subset of elderly female respondents also took part in a second phase of this study. First, they selected from the female photographs the one they thought was most like themselves. All but 2 of 34 subjects selected a grandmotherly picture. They also sorted into groups 54 statements that had been shown to represent the three categories. Elderly subjects showed significantly greater complexity in these judgments than a control group of young subjects. This extra complexity was restricted to judgments of "grandmotherly" photos, the category subjects had said was most like themselves; their sortings of stimuli that represented the "senior citizen" category were no more complex than those of younger subjects.

Schmidt and Boland (1986) set out to identify categories of elderly people empirically instead of intuitively, as had Brewer, Dull, and Lui (1981). First, they identified 99 nonredundant personality traits by having a group of subjects (college students) enumerate a list of traits or other qualities they thought were "typically associated with the elderly." Another set of subjects then sorted these traits into as many groups as seemed appropriate to them. The number of such groupings varied across subjects from 2 to 16. These similarity judgments were then aggregated, and a cluster analysis was carried out on the resulting matrix.

Three high-level clusters of traits were identified: a general cluster of traits, most of them physical characteristics, that apply to all old people; a large positive cluster containing 32 traits; and a large negative cluster containing 59 traits. Within the last two clusters, the authors identified 12 middle-level categories. The nature of these categories is suggested by their titles. The four positive categories were labeled *John Wayne Conservative*, *Liberal Matriarch/Patriarch*, *Perfect Grandparent*, and *Sage;* the eight negative categories were labeled

*Dependent, Mildly Impaired, Vulnerable, Severely Impaired, Shrew/Curmudgeon, Recluse, Nosy Neighbor,* and *Bag Lady/Vagrant.*

As is obvious from their titles, even categories of the same valence differed markedly in content. They also differed in the attitudes people expressed toward them. Schmidt and Boland (in press) prepared descriptions of a dozen individuals, each incorporating the traits from one of the categories. An additional group of subjects rated each of these persons on a semantic differential scale. The four positive categories all received ratings above the midpoint of the scale; the *Perfect Grandparent* and *Sage* were rated significantly above the other two. Similarly, the 12 negative categories were all rated below the midpoint; *Shrew/Curmudgeon, Bag Lady/Vagrant,* and *Dependent* were rated noticeably below the others.

## SOME COMMENTS

It should be clear that these studies mark a change in the way perceptions of the elderly are conceived. Previously, the category "elderly" was viewed as a unitary, if complex, concept toward which people were positively or negatively disposed. But this research shows that subjects identify many different subcategories of elderly people and hold quite different attitudes toward them. The subcategories are related to one another both by their membership in the same superordinate category and by their possession of a few common characteristics (chronological age, wrinkled skin, graying hair, and the like); nevertheless, different subcategories subsume different, even contradictory, characteristics. Let us sketch out half a dozen implications of this viewpoint for research and theory on perceptions of the elderly.

**1.** Perceivers sometimes attribute ambivalent, if not downright contradictory, qualities to "the elderly" in general. The elderly have been viewed as both wise and senile (Barrow & Smith, 1979), both kind and grouchy (Crockett & Press, 1981), both concerned for others and inactive and unsociable (Braithwaite, 1986). Such outcomes may be explained by supposing that a subject's attention often shifts from one subcategory to another in the process of responding to a trait checklist. Because different subcategories subsume quite different attributes, it is to be expected that ambivalent, potentially inconsistent qualities may be ascribed to the elderly in general.

**2.** For the most part, attitudes toward the elderly in general have been shown to possess a mildly negative tone. This may occur because when subjects are required to evaluate the superordinate category they respond with a rough average of their attitudes toward the constituent subcategories. Since more of the subcategories are negative than positive, the overall attitude will reflect that disproportion. Alternatively, subjects' ratings of the elderly as a group may be based on the subcategory (or subcategories) they consider to be most common in the population as a whole. Again, given the ratio of positive to negative categories in the study by Schmidt and Boland (1986), the evaluation would be more often negative than positive.

**3.** These subcategories of the elderly are bounded units, composed of elements (physical characteristics, interests, traits, abilities, and the like) that are tied together by implicational and other relations. That is, the subcategories meet the definition of *schemas* (Crockett, in press; Rumelhart, 1980; Rumelhart & Ortony, 1978), and their use in cognition should show the characteristics of schematic processing. Thus, which subcategory a particular person is assigned to should depend on the match between the person's observed characteristics and the qualities that are prototypical for the various subcategories. Ordinarily, such an assignment will be based on observation of a small fraction of the qualities that a subcategory subsumes; other properties of the subcategory will then be attributed to that individual by default. These default inferences should provide expectations about future behavior that are held as confidently as those drawn from observed characteristics.

The observation by Brewer, Dull, and Lui (1981) that subjects devoted more time to studying inconsistent pairings of statements with photographs than consistent ones conforms to a common observation that schema-consistent information requires less processing time than inconsistent information (Hastie, 1980; O'Sullivan & Durso, 1984; Sentis & Burnstein, 1979; White & Carlston, 1983). In addition, schema-consistent information is more accurately recalled than inconsistent information (Picek, Sherman, & Shiffrin, 1975), especially as the interval between acquisition and recall increases (Crockett, 1979).

In short, once a stimulus person has been assigned to a subcategory, the schema (1) directs a perceiver's attention to aspects of the person's behavior that fit with the schema, (2) provides default inferences about qualities of the person that are not observed directly, (3) yields expectancies about how the person is likely to behave in other situations, and (4) affects the storage and recall of information about the person.

**4.** The fact that elderly subjects sorted information about old people more complexly than did young subjects (Brewer & Lui, 1984) appears to be an instance of a more general principle: People differentiate more complexly within domains of knowledge with which they are familiar than within unfamiliar domains. Thus, Linville and Jones (1980) found that subjects applied personality traits more complexly to members of their own racial group than to members of a different group. Similarly, Linville (1982) found that college students made more differentiated assignments of personality traits to young adults than to the elderly. No doubt, the operation of this principle reflects the amount of contact perceivers have with diverse representatives of different groups; the wider the variety of experiences one has with members of some category, the more complexly one will conceive of such individuals.

Despite this overall developmental trend, experience with a wide variety of elderly people—grandparents, other relatives, neighbors—probably begins at an early age for most children. Consequently, the kinds of undifferentiated stereotypes that sometimes characterize children's views of ethnic or socioeconomic outgroups are not so likely to occur for the elderly. Instead, one would expect most children to distinguish several distinct subcategories among the elderly. The number and variety of those subcategories are then likely to increase monotonically as the perceiver grows older.

**5.** The fact of multiple categorization of the elderly raises the question of whether analogous subcategories can be identified for other age groups. No research comparable to that by Schmidt and Boland (1986) has been conducted to answer that question, though O'Sullivan and Durso (1984) have identified a number of different subcategories for a college student population. It will be worthwhile to explore whether the ratio of positive to negative subcategories changes across age groups; whether there are continuities in the content of subcategories from one age group to another, with the subcategories at one age providing a framework that also underlies the subcategories of later ages; and whether such continuities enable people to envision what kind of young person a particular elderly individual must have been, or what kind of old person a particular young adult is likely to become.

**6.** The practical implications of this point of view lead in different directions from those of the past. Instead of setting out to change the attitudes of the young toward the elderly in general, one might more profitably try to expand the range of their contacts with elderly individuals who will promote the earlier differentiation of the positive subcategories. The viewpoint also has implications for self-presentation by the elderly; namely, that they emphasize those qualities that fit the positive subcategories and minimize the others.

Finally, a few words about the relationship between this point of view and the two previous ones. Clearly, the three orientations are not mutually exclusive. For example, out of sympathy for a despondent elderly person, or a vulnerable one, a perceiver might provide an unusually favorable verbal impression of that person but act so as to avoid the person completely. That is, the categorization model and the motivational theory of Scheier et al. (1978) can complement one another. Similarly, if a perceiver expects most elderly people to fall into one of the negative subcategories, then the recognition that a particular individual represents one of the positive categories may, as Shaver (1978) predicted, bring about the attribution of unusually positive qualities to that individual. Thus, the different kinds of explanations are compatible with one another, adding to the range of plausible hypotheses about how the elderly are perceived.

All three orientations introduce a touch of theory into a field that has been largely devoid of theorizing. By doing so, they provide a systematic set of hypotheses about the nature and consequences of attitudes and perceptions of the elderly. These hypotheses may be expected to guide future research on the topic in directions that are both more fruitful theoretically and more applicable practically than has been the case with this research in the past.

## REFERENCES


Anderson, N. H. (1968). Likeableness ratings of 555 personality-trait words. *Journal of Personality and Social Psychology, 9,* 272–282.

Austin, D. R. (1986). Attitudes toward old age: A hierarchical study. *The Gerontologist, 25,* 431–434.

Banziger, G., & Drevenstedt, J. (1982). Achievement attributions by young and old judges as a function of perceived age of stimulus person. *Journal of Gerontology, 37,* 468–474.

Barrow, G. M., & Smith, P. A. (1979). *Aging, ageism, and society.* St Paul, MN: West.

Bell, B. D., & Stanfield, G. G. (1973a). The aging stereotype in experimental perspective. *The Gerontologist, 13,* 341–344.

Bell, B. D., & Stanfield, G. C. (1973b). Chronological age in relation to attitudinal judgments: An experimental analysis. *Journal of Gerontology, 28,* 491–496.

Bennett, R., & Eckman, J. (1973). Attitudes toward aging: A critical examination of recent literature and implications for future research. In C. Eisdorfer & M. P. Lawton (Eds.), *The psychology of adult development and aging.* Washington, DC: American Psychological Association.

Braithwaite, V. A. (1986). Old age stereotypes: Reconciling contradictions. *Journal of Gerontology, 41,* 353–360.

Brewer, M. B., Dull, V., & Lui, L. (1981). Perceptions of the elderly: Stereotypes as prototypes. *Journal of Personality and Social Psychology, 41,* 656–670.

Brewer, M. B., & Lui, L. (1984). Categorization of the elderly by the elderly. *Personality and Social Psychology Bulletin, 10,* 585–595.

Butler, R. N. (1969). Age-ism: Another form of bigotry. *Gerontologist, 9,* 243–246.

Cameron, P., & Cromer, A. (1974). Generational homophyly. *Journal of Gerontology, 29,* 232–236.

Carp, F. M., & Nydegger, C. (1975). Recent gerontological developments in psychology and social sciences. *The Gerontologist, 15,* 368–370.

Connor, C. L., Walsh, R. P., Litzelman, D. K., & Alvarez, M. G. (1978). Evaluation of job applicants: The effects of age versus success. *Journal of Gerontology, 33,* 246–252.

Crockett, W. H. (1979). Inferential rules in the learning and recall of patterns of sentiments. *Journal of Personality and Social Psychology, 47,* 658–676.

Crockett, W. H. (in press). Schemas, affect, and communication. In H. E. Sypher, L. Donohew, & E. T. Higgins (Eds.), *Communication, social cognition, and affect.* Hillsdale, NJ: Erlbaum.

Crockett, W. H., & Press, A. N. (1981). Relationships among generations. In F. Berghorn & D. Schafer (Eds.), *The dynamics of aging.* Boulder, CO: Westview.

Crockett, W. H., Press, A. N., & Osterkamp, M. (1977). The effect of deviations from stereotyped expectations upon attitudes toward older persons. *Journal of Gerontology, 12,* 163–167.

Fischer, D. H. (1978). *Growing old in America*. New York: Oxford University Press.

Fitzgerald, J. M., & Hyland, D. T. (1980). Perceptions of development: A comparison of role-taking and attitudinal measures. *Research on Aging, 2*, 351–366.

Flynn, J. H. (1978). *Effects of patients' age and personal disposition upon charge nurses' attitudes and assignments*. Unpublished doctoral dissertation, University of Kansas.

Green, S. K. (1981). Attitudes and perceptions about the elderly: Current and future perspectives. *International Journal of Aging and Human Development, 13*, 99–119.

Harris, L. (1975). *The myth and reality of aging in America*. Washington, DC: National Council on Aging.

Hastie, R. (1980). Memory for behavioral information that confirms or contradicts a personality impression. In R. Hastie, T. M. Ostrom, E. B. Ebbeson, R. S. Wyer, D. L. Hamilton, & D. Carlston (Eds.), *Person memory: The cognitive basis of social perception*. Hillsdale, NJ: Erlbaum.

Ivester, C., & King, K. (1977). Attitudes of adolescents toward the aged. *The Gerontologist, 17*, 85–89.

Jantz, L., Seefeldt, C., Galper, A., & Serock, K. (1977). Children's attitudes toward the elderly. *Social Education, 41*, 518–523.

Kahana, E. F., & Kiyak, H. A. (1984). Attitudes and behavior of staff in facilities for the aged. *Research on Aging, 6*, 395–416.

Kidwell, I. J., & Booth, A. (1977). Social distance and generational relations. *The Gerontologist, 17*, 412–420.

Klemack, D. L., Roff, L. L., & Durand, R. M. (1980). Who knows how much about aging? *Research on Aging, 2*, 432–444.

Kogan, N. (1979). Beliefs, attitudes, and stereotypes about old people: A new look at some old issues. *Research on Aging, 1*, 11–36.

Kogan, N., & Shelton, F. C. (1962). Differential cue value of age and occupation in impression formation. *Psychological Reports, 7*, 203–216.

Kucharski, L. T., White, R. M., & Schratz, M. (1979). Age bias, referral, for psychological assistance, and the private physician. *Journal of Gerontology, 34*, 423–428.

Labouvie-Vief, G., & Baltes, P. (1976). Reduction of adolescent misperceptions of the aged. *Journal of Gerontology, 31*, 68–71.

Levin, J., & Levin, W. C. (1980). *Ageism: Prejudice and discrimination against the elderly*. Belmont, CA.: Wadsworth.

Levin, J., & Levin, W. C. (1981). Willingness to interact with an old person. *Research on Aging, 3*, 211–217.

Linville, P. W. (1982). The complexity-extremity effect and age-based stereotyping. *Journal of Personality and Social Psychology*, 42, 193–211.

Linville, P. W., & Jones, E. E. (1980). Polarized appraisals of outgroup members. *Journal of Personality and Social Psychology, 38*, 689–703.

Locke-Connor, C., & Walsh, R. P. (1980). Age, success, and evaluations. *Journal of Gerontology, 35*, 920–927.

Lutsky, N. S. (1980). Attitudes toward old age and elderly persons. In C. Eisdorfer (Ed.), *Annual review of gerontology and geriatrics*, Vol. 1 (pp. 287–336). New York: Springer Publishing Co.

McTavish, D. (1971). Perceptions of old people: A review of research methodologies and findings. *The Gerontologist, 11*, 90–101.

Naus, P. (1973). Some correlates of attitudes toward old people. *International Journal of Aging and Human Development, 4*, 229–243.

Nelson, L. E. (1986, August 5). Get old, get fired. *Kansas City Times*, p. 19.

Nuessel, F. H. (1982). The language of ageism. *Gerontologist, 22*, 273–276.

O'Connell, A. N., & Rotter, N. G. (1979). The influence of stimulus age and sex on person perception. *Journal of Gerontology, 34*, 220–228.

O'Sullivan, C. S., & Durso, F. T. (1984). Effects of schema-incongruent information on memory for stereotypical judgments. *Journal of Personality and Social Psychology, 47*, 55–70.

Palmore, E. B. (1977). Facts on aging: A short quiz. *The Gerontologist, 17*, 315–320.

Palmore, E. B. (1982). Attitudes toward the aged: What we know and need to know. *Research on Aging, 4*, 333–348.

Perry, J. S., & Varney, T. L. (1978). College students' attitudes toward workers' competence and age. *Psychological Reports, 42*, 1319–1322.

Petty, R. E., Cacioppo, J. T., & Kasmer, J. (in press). The role of affect in the elaboration likelihood model of persuasion. In H. E. Sypher, L. Donohew, & E. T. Higgins (Eds.), *Communication, social cognition, and affect*. Hillsdale, NJ: Erlbaum.

Picek, J. S., Sherman, S. J., & Shiffrin, R. M. (1975). Cognitive organization and the encoding of social structures. *Journal of Personality and Social Psychology, 31*, 758–768.

Puckett, J. M., Petty, R. E., Cacioppo, J. T., & Fisher, D. L. (1983). The relative impact of age and attractiveness stereotypes on persuasion. *Journal of Gerontology, 38*, 340–343.

Reno, R. (1979). Attribution for success and failure as a function of perceived age. *Journal of Gerontology, 34* 709–715.

Rosch, E. (1978). Principles of categorization. In E. Rosch & B. Lloyd (Eds.), *Cognition and organization*. Hillsdale, NJ: Erlbaum.

Rosen, B., & Jerdee, T. H. (1976a). The influence of age stereotypes on managarial decisions. *Journal of Applied Psychology, 61*, 428–432.

Rosen, B., & Jerdee, T. H. (1976b). The nature of job-related age stereotypes. *Journal of Applied Psychology, 61*, 180–183.

Rosenkranz, H., & McNevin, T. (1969). A factor analysis of attitudes toward the aged. *The Gerontologist, 9*, 55–59.

Rubin, K. H., & Brown, I. D. R. (1975). A life-span look at person perception and its relationship to communicative interaction. *Journal of Gerontology, 30*, 461–468.

Rumelhart, D. E. (1980). Schemata: The building blocks of cognition. In R. Spiro, B. Bruce, & W. Brewer (Eds.), *Theoretical issues in reading comprehension*. Hillsdale, NJ: Erlbaum.

Rumelhart, D. E., & Ortony, A. (1978). The representation of knowledge in memory. In R. C. Anderson, R. J. Spiro, & W. E. Montague (Eds.), *Schooling and the acquisition of knowledge*. Hillsdale, NJ: Erlbaum.

Ryan, E. B., & Capadano, H. L. (1978). Age perceptions and evaluative reactions toward adult speakers. *Journal of Gerontology, 33*, 98–102.

Scheier, M. F., Carver, L. B., Schulz, K. R., Glass, K. D., & Katz, L. A. (1978). Sympathy, self-consciousness, and reactions to the stigmatized. *Journal of Applied Social Psychology, 8*, 270–282.

Schmidt, D. F., & Boland, S. M. (1986). The structure of impressions of older adults: Evidence for multiple stereotypes. *Psychology and Aging, 1*, 255–260.

Schonfield, D. (1982). Who is stereotyping whom and why? *Gerontologist, 22*, 267–272.

Schwab, D. P., & Heneman, H. G. III. (1978). Age stereotyping in performance appraisal. *Journal of Applied Psychology, 63*, 573–578.

Seefeldt, C. (1984). Children's attitudes toward the elderly: A cross-cultural comparison. *International Journal of Aging and Human Development, 19*, 319–328.

Sentis, K. P., & Burnstein, E. (1979). Remembering schema-consistent information: Effects of a balance schema on recognition memory. *Journal of Personality and Social Psychology, 37*, 2200–2211.

Shaver, K. G. (1978). Attributional error and attitudes toward aging: A view of the NCOA National Attitude Survey. *International Journal of Aging and Human Development, 9*, 101–113.

Sherman, N., Gold, J., & Sherman, M. (1978). Attribution theory and evaluations of older men among college students, their parents, and grandparents. *Personality and Social Psychology Bulletin, 4*, 440–442.

Stier, D. L., & Kline, D. W. (1980). Situational determinants of attitudes toward the elderly. *Research on Aging, 2*, 489–498.

Thomas, E., & Yamamoto, K. (1975). Attitudes toward age: An exploration in school-age children. *International Journal of Aging and Human Development, 6*, 117–129.

Tibbitts, C. (1979). Can we invalidate negative stereotypes in aging? *The Gerontologist, 19*, 10–20.

Trent, C., Glass, J. C., & Crockett, J. (1979). Changing adolescent 4-H Club members' attitudes toward the aging. *Educational Gerontology, 4*, 33–48.

Tringo, J. L. (1970). The hierarchy of preference toward disability groups. *Journal of Special Education, 4*, 295–306.

Tuckman, J., & Lorge, I. (1953). Attitudes toward old people. *Journal of Social Psychology, 37*, 249–260.

Walsh, R. P., & Connor, C. L. (1979). Old men and young women: How objectively are their skills assessed? *Journal of Gerontology, 34*, 561–568.

Weinberger, A. (1979). Stereotyping of the elderly: Elementary school children's responses. *Research on Aging, 1*, 113–136.

Weinberger, A. (1981). Responses to old people who ask for help. *Research on Aging, 3*, 345–368.

Weinberger, L. E., & Milham, J. (1975). A multi-dimensional, multiple method analysis of attitudes toward the elderly. *Journal of Gerontology, 30*, 343–348.

White, J. D. & Carlston, D. E. (1983). Consequences of schemata for attention, impressions, and recall in complex social interactions. *Journal of Personality and Social Psychology, 45*, 538–549.

Wingard, J. A., Heath, R., & Himelstein, S. A. (1982). The effects of contextual variation on attitudes toward the elderly. *Journal of Gerontology, 37*, 475–482.

*This page intentionally left blank*

CHAPTER 10

# Industrial Gerontology: The Aging Individual and Work

HARVEY L. STERNS
DEPARTMENT OF PSYCHOLOGY AND INSTITUTE FOR LIFE-SPAN DEVELOPMENT AND GERONTOLOGY
THE UNIVERSITY OF AKRON
AKRON, OHIO
OFFICE OF GERIATRIC MEDICINE AND GERONTOLOGY
NORTHEASTERN OHIO UNIVERSITIES COLLEGE OF MEDICINE
ROOTSTOWN, OHIO

RALPH A. ALEXANDER
DEPARTMENT OF PSYCHOLOGY AND INSTITUTE FOR LIFE-SPAN DEVELOPMENT AND GERONTOLOGY
THE UNIVERSITY OF AKRON
AKRON, OHIO

Industrial gerontology is the study of aging and work focusing on the employment and retirement issues of middle-aged and older workers. Major areas include social policy and law, stereotypes of the older worker, selection, job performance and appraisal, training and retraining, career progressions and development, motivational factors and organizational design, reentry workers, alternative work patterns, safety, plant closings, and layoff and retirement decisions (Sterns & Alexander, 1986).

The Age Discrimination in Employment Acts of 1967, 1978, and 1986 now define older workers as individuals 40 years old and above. Throughout this chapter the term *older adult worker* will be used to describe individuals in that age group.

A primary purpose of this chapter is to examine issues, theory, and research relating to industrial gerontology in the 1980s. The work environment is continuing to undergo dramatic change, with plant closings, reductions in force, and the introduction of new technology. The initial and continuing career choices made by workers are considered within the context of life-span development. Major opportunity for career growth and continuing skills enhancement comes from training and development. We focus here on job-relevant training and older-adult-specific training. The development of effective training continues to be a major concern.

In addition, we will focus on issues that continue to be of major concern under the Age Discrimination and Employment Act, such as selection, interviews, and selection testing. Perception of age bias, measurement of job performance, job attitudes, and absenteeism are also addressed.

Industrial gerontology in Great Britain began more than three decades ago to address issues in aging and work. This early research focused on the capability of older adult workers and on concerns regarding technological change and automation and their effects on the older worker (Davies & Sparrow, 1985; Welford, 1976).

There have been a number of important recent reviews that provide well-done summaries of past research and current issues (Birren, Robinson, & Livingston, 1986; Davies & Sparrow, 1985; Doering, Rhodes, & Shuster, 1983; Havighurst, 1982; Rhodes, 1983; Robinson, Coberly, & Paul, 1985; Rosen & Jerdee, 1985; Stagner, 1985), and policy reviews and innovative programs (*Future of Older Workers*, 1980; *Generations*, 1982; Jacobson, 1980; *Older Worker Employment*, 1985; Ragan, 1980).

Multiple forces are affecting older adult workers in terms of work opportunities, layoffs, retirement, and reentry. Older workers are a diverse group and respond in different ways. Workers displaced from jobs with little prospect of being reemployed may have labor market problems that are different from minority, female, or health-impared workers. Workers getting close to retirement age who face pressures and incentives to retire because of skill obsolescence and pension policies may be different from retirees seeking to be reemployed (*Older Worker Employment*, 1985).

Extension of work life or early retirement should come about by choice on the part of the older adult worker. An older worker should be judged on his or her merit, not by chronological age. Opportunities should be made available to older adult workers that are the same as those for any other worker of similar competence, vigor, and ambition. Age-neutral policies need to be part of current personnel policies to assure that older persons who elect to continue working will have access to career opportunities consistent with their aspirations, abilities, and potential (*Future of Older Workers*, 1980).

The major issue for the present is how aging research is being presented and applied in the work place and how corporate leadership is dealing with age issues. Challenges for the effective management of older adult workers result from the changing nature of work and changing social, economic, and legal environments (Rosen & Jerdee, 1985).

A number of different dimensions of aging take place within a work organization. Workers age in the usual sense of biological, psychological, and social aging (Birren & Cunningham, 1985). Workers age in an organizational sense as the period of their employment with the company or organization increases.

Workers age in their jobs as their tenure is extended. An organization grows older or younger through internal demographic processes—for example, hiring, firing, outplacement, plant closings, and retirement—that affect age composition. Organizations themselves grow older as they develop and continue over time (Schrank & Waring, 1981).

These aging dimensions need to be seen in dynamic interaction. Aging and work need to be seen in the context of age-graded, history-graded and nonnormative life events (Doering, Rhodes, & Shuster, 1983). The changing individual in a changing environment has been a major theme in life-span development, and the workplace is a prime example. Decisions to change jobs or careers, losing a job, or decisions to engage in career development and retraining may come about as a result of changes within the individual, the employment environment, or an interaction of both. Adult and older adult workers are imbedded in employment roles that may be changing at different rates due to economic, societal, and technological forces (Sterns, 1986).

## CAREER DEVELOPMENT

Vondracek and Schulenberg (1986) emphasize the need for a developmental–contextual approach to career development. Super (1980, 1985) presents career development with an emphasis on the individual and his or her environment. Occupational choice or assignment is not something that happens once in a lifetime. People and situations develop, and career decisions become a series of minidecisions. These minidecisions add up to a series of occupational choices that appear to be one maxidecision (Super, 1984).

Discussions of adult development and work need to take into account the sequential nature of such decision making. Super (1984) states that readiness for adult career-decision making might better be called career adaptability rather than career maturity. Reexploration and reestablishment of careers have thus attracted a great deal of attention, and the concepts of transition and crisis are now used to describe these processes.

A focus on individual developmental changes, as well as a more rapidly changing technology and economy, highlights issues of transition for certain older adult workers. According to Super (1984), the timing of transition is a function of the individual's personality, attributes, and the situation; it is not tied to age. He also feels that established models of career may continue to be valid in this period of increasing ethnic, social, and sexual equality, changing technology, and changing occupations. The frequency of different types of career patterns may change. Stable and conventional patterns of career may be the norm for a small number of highly educated, capable individuals. Instability, multiple jobs, and full-time leisure (by choice, displacement, or failure to be hired or rehired) may become the dominant career pattern for others.

Ginzberg (1984), in his most recent formulation, also sees career development as coextensive with a person's working life. Three factors are seen as important in this lifelong choice process: the original choice, the feedback between the original choice and later work experience, and economic and family circumstances.

Occupational choice processes can be reopened in a person's mature years as well as after retirement in a second or third career. The concept used here is optimization. People seek to find the best fit between changing interests and goals, their changing circumstances, and the realities of the world of work. Occupational choice becomes a lifelong process of decision making for those who seek major satisfactions from their work (Ginzberg, 1984).

A life-span approach to career development needs to emphasize the fact that behavior change processes can occur at any point in the life course. Older adult workers have developed a knowledge base and abilities that continue to grow (Sterns, 1986). However, individuals are faced with several kinds of changes as they grow older. These are internal, subjective responses and cognitive processes as well as external, environmental changes. Internal barriers may include changes in performance, adaptation, energy level, and productivity, which may involve aging-related change. External barriers concern ease of access to occupations and promotion once in them, stereotyping, prejudice, family constraints, economic constraints, and temporal constraints (Osipow, 1986). The ability of older adult workers to cope with health and work-related issues, as discussed above, can also include issues such as plateauing—when individuals perceive their careers to be blocked and adapt or fail to adapt in occupational roles that may not fit their expectations (Bardwick, 1986; Katz, 1980).

It is clear that general statements regarding older adult workers that do not emphasize large individual differences in people and large differences in work demands continue to perpetuate the negative valence for older adult career development. Normal aging does not mean major changes in ability to work.

Life-cycle and stage theories of career development have been criticized for using younger male workers as the basis for their development. Life-cycle and stage approaches have also been criticized for failure to test propositions adequately. Particularly lacking is longitudinal research using subjects over age 50. A criticism of stage and within-job theories is that they tend to ignore the interaction of work and nonwork aspects of life (Sonnenfeld & Kotter, 1982). Another issue that may apply here relates to how cohort-specific the career models are.

Sterns and Patchett (1984), Patchett and Sterns (1984), and Sterns (1986) have advanced a model of adult and older adult career development that is non-age-specific. The model assumes that transitions in work life may occur many times throughout a career (see Figure 10-1).

According to this model, the decision to change jobs or careers or to exit the

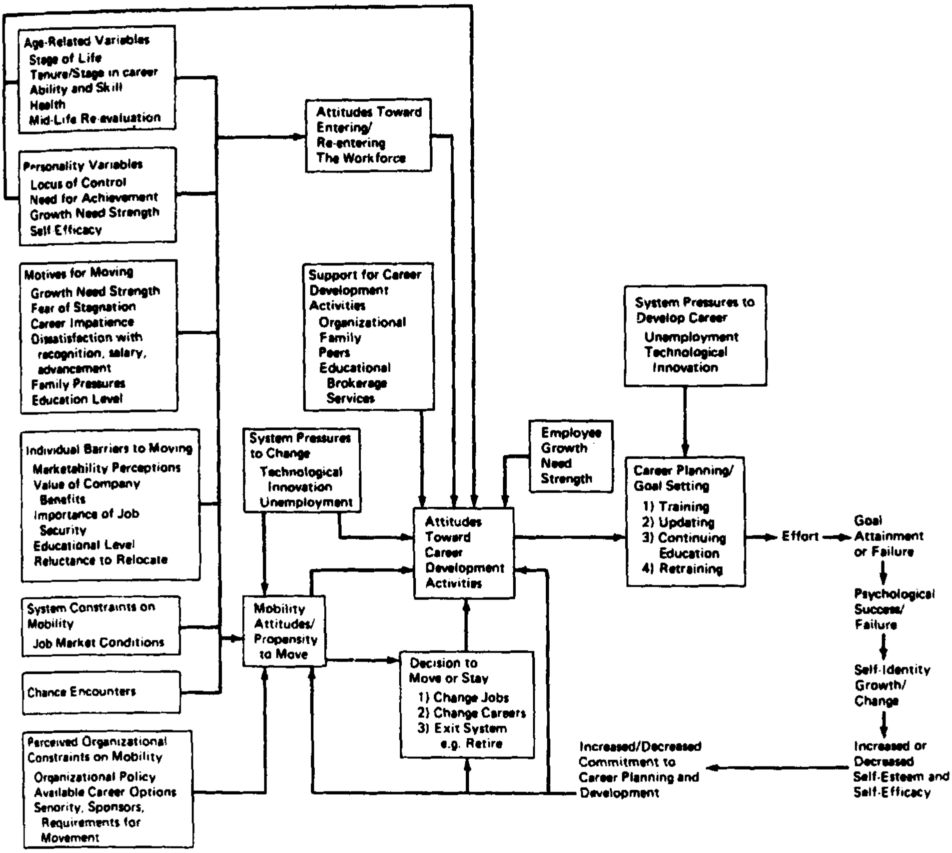


**Figure 10-1.** Career progression in middle and later adulthood (from Sterns, 1986).

system is directly influenced by attitudes toward mobility and success or failure in previous career-development activities. Numerous factors are hypothesized to affect mobility attitudes, such as employment, tenure or stage in career, growth need, fear of stagnation, marketability perceptions, job market conditions, and chance encounters. The decision to change jobs or careers also may affect one's attitude toward entering or reentering the work force. Any of these variables could be indicated by the effects of various personality variables.

The model incorporates Hall's (1971) model of career growth, which conceptualizes career planning from a goal-setting perspective. When a career-goal decision, such as the decision to engage in training or retraining, is made, the resulting outcome can lead to identity growth and enhanced self-esteem. The enhancement of self-esteem may then in turn lead to greater commitment to future career-development goals. Goal attainment enhances self-esteem, which may increase perceptions of self-efficacy (Bandura, 1977, 1981, 1982) and future commitment to career-development activities. Decisions to engage in future retraining may be enhanced as well. A negative experience could easily result in a decision to drop out of a training program as well as future programs, jeopardizing future career growth opportunities and decisions.

Age and/or life stage are important determinants of behavior. Many career models suggest that mobility rates of younger persons (up to approximately age 30) are much higher than those of older persons (Hall & Nougaim, 1968; Super, 1957; Viega, 1973). Viega (1983) found that age correlated significantly with propensity to change jobs. Tenure (seniority) or stage in one's career has been a variable of interest in the mobility literature. Schein (1971) describes three stages in a career: socialization, performance, and obsolescence versus the development of new skills. In this third stage, the obsolete person may be retained as "deadwood" with no options for mobility. Another option is that he or she may be retrained, transferred into a lateral position, or forced into early retirement. Persons who are mobile early in their careers are most likely to favor career-development programs later in their careers (Rosenbaum, 1979; Viega, 1981, 1983).

Individual barriers to moving are related to age and seniority. Viega (1983) states that perceptions of one's own marketability may strongly influence one's effort to explore alternative career opportunities. The longer a person remains with a company and the older the person becomes, the more likely it is that a person will be conservative about risking benefits accrued through the years in order to move to a new organization.

Viega (1983) identifies five motivations for moving that significantly influence propensity to leave a job: fear of stagnation, career impatience, and dissatisfactions with one's salary, recognition, and/or advancement. A number of additional personality variables are hypothesized to affect mobility and career development attitudes: need for achievement and locus of control. A very recent review by Hoff and Hohner (1986) focuses on a number of empirical studies in which locus of control is considered in connection with occupational careers, working conditions, employees" perceptions, and employees' evaluations of their work. Locus of control appears to be a weak but consistent dimension in career decision making (Neopolitan, 1980).

Adults make multiple career transitions throughout the life span. There are people 60, 70, or older who are still interested in working, changing jobs, and further development of their careers. Past gerontological discussions have almost exclusively focused on the decision to retire. A great deal more attention needs to be given to multiple career transitions that may occur within a working life. This leads to a renewed emphasis on the important role that training and retraining can play in career development.

## TRAINING AND DEVELOPMENT

A common theme in gerontology for a good many decades has been the training and retraining of older adult workers. The growing awareness that older adults can be trained and retrained in both the laboratory and industrial settings has led to the development of training principles and methods that recognize the unique attributes of the older adult worker (Sterns, 1986; Sterns & Sanders, 1980; Willis, 1985).

Education and training can offer new opportunities as well as optimization of individual development across the life span. As workers continue to learn and change, education and training is an important opportunity to facilitate career development at all periods in the work life. The need to integrate work and learning continues to be a major challenge (Cross, 1981; O'Toole, 1978; Peterson, 1983).

### Job-Relevant Training

Many of today's older adult workers who are in need of training are casualties of a failure of industry, over many decades, to carry out appropriate responses to future training needs. A recent review of private-sector training (Lillard & Tan, 1986) reports that postschool training is pervasive. Close to 40% of both men and women in the *Current Population Survey* reported having taken training to improve skills on the current job, a proportion that rises with time on the job. When Lillard and Tan averaged across job tenure, they found the training in company programs, on-the-job training, and training in regular schools was reported 10 to 15% of the time as a source of job-relevant training. Data from the National Longitudinal Surveys, for a 2-year period, indicate that the percentage of young men, career women, and mature men (45–59) reporting some training were 30, 24, and 10% respectively. For these groups the employer was the single most important source of training.

The likelihood of receiving training was found to increase for men and women with level of school attainment, with the exception of the most educated workers (postgraduate). Lack of formal education was found to limit access to postschool investments in most kinds of job training. Likelihood of training was found to rise with time on the job. Inability to develop enduring job attachment increasingly reduces the likelihood of getting training, especially for older workers.

The major issue today is assuring equitable access to training opportunities for older adult workers. Policies and practices regarding training may be influenced by informal age restrictions, standards, and assumptions, which may exclude older employees. In-service training and retraining provides older adult workers with the opportunity to strengthen knowledge and skills (Rosen & Jerdee, 1985).

The payoff period for training costs is often quite short (Barrick, Alexander, & Towner, 1987). A worker's age may not be relevant. Rather, the need for maintenance or improvement of skills should be the primary focus. The life of a training investment will likely be the same for most older workers as for younger workers. Very often the return is better for older workers because they are more likely to stay with the organization (Doering et al, 1983; Tucker, 1985).

*Older-Adult-Specific Training.* Training of older adult workers may require changes in traditional training methods to accommodate special needs and limitations of some individuals (Barkin, 1970; Sheppard, 1976). Training techniques directed to the needs of the older worker have existed for more than two decades. Belbin (1965, 1970) and Belbin and Belbin (1972) have used a number of training approaches: the discovery method, activity learning, and programmed instruction (Belbin & Downs, 1964; Neale, Toye, & Belbin, 1968). Sterns (1986) provides a more detailed review of these techniques, which are important precursors to designing present training approaches. Particularly important are a thorough task analysis and training-needs analysis (Goldstein, 1974).

Siemen (1976), using programmed material, studied age-related differences in learning. There was significant improvement in pretest versus posttest performance by both younger and older groups. There were no significant differences in the mastery of the material between the two age groups using programmed instruction. This program was self-paced, with older subjects taking more than twice as long to complete the modules as did the younger group. Training sessions were designed to reduce anxiety in the older adults by making the learning situation as nonthreatening as possible. This study is a good example of the research comparing trainability of older adults.

*Training Principles.* The adult and older adult training and retraining literature documents a number of dimensions for successful training programs. All involve principles of learning that apply to well-designed training at any age.

Valasek and Sterns (1981) and Sterns (1986) focus on five major areas that should be considered when designing training programs:

1. *Motivation.* The desire to participate and learn is important for all trainees; however, the older trainee may need to overcome fear of failure or the fear of an inability to compete against better-educated trainees. For older adult workers who have been out of school for many years and/or who have had little formal education, motivation and self-concept can influence participation and success in the program (Belbin, 1965; Belbin & Belbin, 1972).

Building on the important work of the Belbins, today's discussions of adult and older adult education and training can now draw on Bandura's (1977, 1981, 1982) self-efficacy theory in education and training situations.

2. *Structure*. The design of training should be structured so that the material is relevant, provides positive feedback, and encourages the self-confidence of the trainee. Providing structure should aid in eliminating fear of failure.

Training material should be based on a job analysis (Goldstein, 1974, 1980, 1982; Wexley, 1984; Wexley & Latham, 1981). A careful task analysis should then be carried out to determine the sequence of the training. It has been found that an effective training procedure is to arrange the training sequence according to increasing complexity. The task or material to be learned is then carefully introduced. After mastery of the basic skill, more difficult aspects are then introduced until the task is mastered (Gagne & Briggs, 1974; Gagne, Mayor, & Paradise, 1962; Willis, 1985).

The use of a task-analysis approach appears to be a strong predictor of the success of the training program. In addition, the assurance of task mastery of each component prior to the introduction of the next component allows the older trainee to be successful in the training and increases self-confidence. The program structure should allow for varying amount of time needed by individual trainees.

3. *Familiarity*. The use of familiar elements in a training program is very important. The use of former skills on a new task facilitates new training when appropriate. Training programs should be built on past knowledge and abilities, whenever possible using relevant, meaningful material from the perspective of the trainee (Johnson & White, 1980; McGhee & Thayer, 1961; Mullen & Gorman, 1972; Welford, 1959).

4. *Organization*. Many older adult workers have been found to have difficulty organizing information adequately (Belbin, 1965; Belbin & Belbin, 1972). At a different level of analysis and task, research on memory has examined organizational processes in depth and has found that older adults can improve performance by the use of appropriate learning strategies and the organization of material on memory tasks (Hulicka & Grossman, 1967; Hultsch, 1975; Schmidt, Murphy, & Sanders, 1981; Treat & Reese, 1976).

The extension of this research is that the training program should be organized so that the knowledge can be built on at each step in the program. Providing organized structure should also assume comprehension and retention. Older adult trainees need training in the use of organized information and memory techniques (Blum & Naylor, 1968; Czaja & Drury, 1981).

5. *Time*. Older adult workers often take longer to learn a new task. When given sufficient time, older adult workers usually perform as well as younger workers. The older trainee may need a slower presentation rate and longer periods of study, as well as instructions on the efficient use of time. Longer training time may be needed for organization and memory for strategy training. Older adults may show slower reaction time for new tasks, although well-practiced tasks may not show an age-related difference (Salthouse, 1984; Salthouse & Somberg, 1982). A training program for older adult workers should,

when possible, allow for variability in the time needed to complete the training segment.

There is a critical demand for new training studies in the workplace to further refine our understanding of the training of older adult workers. The issue is not, can older adult workers be retrained, but rather, what is the best approach? For many people the workplace is the locus for continued learning, either on the job or by formal training programs. As Cross (1981) has pointed out, the largest provider of adult education in middle and older adulthood is industry, not higher educational institutions.

## SELECTION

Given the prohibition against age discrimination in employment, the possibility of age-related bias in employee selection is quite important. The research literature on employee selection has grown substantially over the past 20 years. Two areas of primary interest for older workers are interviews and selection testing.

Before proceeding with a discussion of selection, it should be pointed out that every employee selection system must begin with a competently performed, comprehensive job analysis. A careful specification of the tasks, duties, and responsibilities to be performed on the job and the knowledge, skills, abilities, and characteristics necessary for the incumbent to perform that job are the essential first step. Such an analysis will go a long way toward reducing much of the potential for bias or discrimination in selection.

### Interviews

Although the interview is the most widely used selection device, relatively little research has been done on age bias in the interview. Most of the research that has been done has been in laboratory settings rather than in actual organizations. In a recent report, Avolio and Barrett (1987) argue that the past laboratory research has been confounded, making it difficult to draw conclusions. They found that when these confounds are controlled, the interview bias appears to be more a bias in favor of younger applicants rather than a negative bias against older people. Further, the bias accounts for a very small percentage of the variance in hiring recommendations. It must be emphasized, though, that research using real organizational decision makers in actual job interview settings is badly needed. Until such research is done, only the most general conclusions about *potential* interview bias are possible.

Until that research is done, it is likely that the potential for bias and the perception of bias in interviews can be greatly reduced by assuring that the selection interviewer is well and carefully trained and that the interview is carefully designed to gather only that information that is clearly relevant to the applicant's future job performance (Avolio, Barrett, & Sterns, 1984).

### Selection Testing

The use of ability or aptitude tests in selection raises the possibility that such selection procedures may be biased against older job applicants. Such discussions are usually predicted on observations about average test scores and average job performance. Studies showing that older adults score, on average, lower than younger workers on selection tests, with no average age differences in performance (Robertson & Downs, 1979; Salvendy, 1974), are often cited as evidence for potential age bias in selection tests (Doering et al, 1983). Occasionally, simple mean differences on tests as a function of age are deemed sufficient to suggest that selection tests are biased against older persons (Salthouse, 1986). Such analyses are both inadequate and inappropriate for assessing age discrimination in selection testing. The relevant question is whether or not the selection system predicts job performance as well for older workers as for younger workers (technically referred to as differential validity). Very little research has yet been reported on this topic. In one such study, Arvey and Mussio (1973) found that the selection tests were actually more valid for older workers.

Given the substantial recent evidence against such differential validity or selection test bias in the context of race and sex (Doering et al., 1983), we would frankly be surprised if carefully developed selection tests based on comprehensive job analysis showed age discrimination. A final conclusion, however, must wait for the research to be done.

One other aspect of selection testing deserves comment. Salthouse (1986) claims that general assessment instruments are not likely to be of much value in employment selection settings because no measure is likely to be relevant for more than a small number of jobs. The substantial research of the past decade shows that Salthouse has badly overgeneralized. The accepted wisdom of the past was that selection instruments were situation-specific in their validity for predicting job performance. Recent research indicates that the validity of selection tests is much more generalizable than had been believed (Hunter & Hunter, 1984).

## AGE DISCRIMINATION IN EMPLOYMENT ACT

The Age Discrimination in Employment Act (ADEA) of 1967 (29 U.S.C. 623) specified protection of workers from age discrimination between the ages of 40 and 65 and promotion of employment opportunities for older workers capable of meeting job requirements. In 1974 the act was amended to include coverage of government employees at the local, state, and federal level. In 1978 it was amended to change coverage to age 70 and to abolish mandatory retirement altogether for federal employees. In 1986 the act was further amended to remove the maximum age limitation, with certain exceptions. It is a violation for employers to fail or refuse to hire, to discharge, or in other ways to discriminate against any individual with respect to compensation or other terms or conditions of employment because of age. Workers cannot be limited, segregated, or classified in a way that might deprive any individual of employment opportunities or adversely affect his or her status as an employee because of age. It is a violation to reduce the wage rate of any employee because of age.

From its inception the ADEA has allowed employers to consider an individual's age in employment decisions when the employer can show that age is a *bona fide occupational qualification* (B.F.O.Q.), reasonably necessary to the normal operations of a business. Such an exception is determined on the basis of all pertinent facts surrounding each situation. The establishment of this exception is difficult. Organizational practices such as the setting of maximum age limits on hiring must be substantiated with proof that age requirements are essential for the protection of the public or on the basis of some other reasonable business necessity. Differentiation of employees based on reasonable factors other than age, such as physical fitness, is allowed. The employer may observe the terms of a bona fide seniority system or a bona fide employment benefit plan that is not a subterfuge to evade the purposes of the act. The act does not preclude the discharge or discipline of an older worker for good cause. Good general discussions of the ADEA are included in Edelman and Siegler (1978), Doering, Rhodes, and Schuster (1983), and Rosen and Jerdee (1985).

Given the 1986 amendments, B.F.O.Q. will continue to be a central issue in aging and work. There has been extensive litigation resulting from B.F.O.Q. mandatory retirement ages by private and public employers. Suits have been brought by individuals affected by B.F.O.Q. mandatory retirement rules. Individual suits and class actions have been brought by the Equal Employment Opportunities Commission against employers, private and public, to remove local and state laws mandating early retirement.

The 1986 amendments call for two specific studies to be conducted regarding (1) firefighters and law enforcement officers and (2) tenured faculty. These groups are excluded from the removal of mandatory retirement. For the first group, the Secretary of Labor and the Equal Opportunity Commission are to jointly conduct a study to determine whether physical and mental fitness tests are valid measurements of ability and competency, to determine which particular types of tests most effectively measure such ability and competency, and then to recommend with respect to the specific standards that such tests and the administration of such tests should satisfy. A second study is to focus on the mandatory retirement of tenured faculty at age 70. The Equal Employment Opportunities

Commission will enter into an agreement with the National Academy of Science for the conduct of a study to analyze the potential consequences of the elimination of mandatory retirement on institutions of higher education. These reports are to be available to provide relevant information to Congress. If no action is taken, these exceptions will expire in 1993.

The issues in B.F.O.Q. cases and the special studies concern the question of whether there are age-related changes in the behavior of all or most individuals that would impair their adequate performance on a job beyond a certain chronological age.

An example of a similar approach is the evaluation by the National Institute on Aging (1981) of the scientific evidence relevant to the age 60 rule for pilots. As part of this process, a major study on this issue was conducted by the National Academy of Sciences Institute on Medicine (1981).

## JOB PERFORMANCE

The anticipated continuation of such recent trends as changes in the age composition of the work force, improvements in the health and education of older adults, elimination of mandatory retirement, and major economic and technological changes requiring substantial organizational restructuring will become increasingly important to organizational staffing decisions involving older workers (Stewman, 1986). Individual job performance plays a central role in staffing decisions such as hiring, training, promotion, retention, job assignment, career progression and planning, job design, layoff, and termination.

Although the research on job performance has been extensive over the past half-century, a number of issues take on particular importance in the context of the older employee. These generally involve one or more of four general topics: the perception that employers discriminate against older workers; potential age bias in performance appraisals; the question of whether or not there are reliable and systematic age differences and/or age changes in job performance; and age differences in other factors that may be related to job performance.

### Perception of Age Bias

The first problem is that of perceived bias against older workers. A recent national work force survey reported that more than 80% of American workers believe that employers discriminate against older employees (U.S. House Select Committee on Aging, 1982). Much of the literature also assumes or supports the notion that there is a generalized negative stereotype against older workers (Rhodes, 1983). This apparently persistent belief that older persons are at an unfair disadvantage in the workplace has been a substantial factor for more than

20 years in both social and legal institutions that aim to eliminate such (perceived) discrimination. To the extent that the perception is accurate, steps clearly are needed to remedy such practices even if they are not deliberate (intentional discrimination). On the other hand, if this general perception is not accurate, the question becomes, how can such a pervasive misperception be corrected?

The problem of perceived bias will also impact on organizational functioning by such mechanisms as decreased employee acceptance of organizational decisions, increased internal conflict, and decreased employee effectiveness. Of central concern to our discussion here, however, is whether such biases exist, and if so, their extent and etiology.

## Job-Performance Measurement

Organizational measures of job performance are generally of two types: "objective" measures such as number of units produced or number of errors, so labeled because they presumably are less subject to bias and judgmental interpretation; and "subjective" measures such as performance ratings by a supervisor. If measures of job performance show consistent and reliable negative or curvilinear relationships with age, then we would have evidence that older workers perform less effectively then their middle-aged or younger co-workers. On the other hand, if only the subjective measures showed such age-related differences and the objective measures did not, we would have evidence for age bias in evaluation of job performance.

## Age Differences and Job Performance

Recently two major reviews of the research literature have appeared in an attempt to summarize what is known regarding age differences in job performance and age differences in the appraisal of job performance (Rhodes, 1983; Waldman & Avolio, 1986). On cursory examination both reviews appear to show very little consistent relationship between age and objective job performance evaluation. A more careful analysis of the research literature cited by these reviews, however, indicates that it really is not possible to draw any substantive conclusions from the available evidence.

First, there is simply a serious lack of data. Rhodes (1983) found 25 studies covering a 30-year period, and Waldman and Avolio (1986) found 13 using a more rigorous inclusion criterion. Not only is the existing data base too small to draw general conclusions, it is also seriously deficient in the quality of available information.

As has been noted by others, drawing conclusions regarding age *changes* in performance from cross-sectional data is highly questionable. Such cross-sectional data is completely confounded by cohort effects. That is, there is no way of determining whether the observed differences are age-related or are the result of the differential histories of the age cohorts. Virtually none of the available data are based on longitudinal studies of behavioral or job performance *change* with age. In addition, none of the research to date has successfully separated the age/experience effects on performance. In most (if not all) occupations, age and experience are highly correlated. Seldom is an attempt made to control for this confound. This is particularly important not only for understanding the age–performance relationship but also for organizational decision making. If age–performance relationships are substantially moderated by either job experience or organizational tenure, this may significantly impact on organizational selection and placement decisions for older workers.

An additional serious deficiency in the research to date is the failure to recognize that age–performance relationships may differ substantially as a function of occupation or of job requirements. The few studies that do exist cover a wide range of jobs, including clerical, professional, skilled trades, and blue collar. It is apparent that extreme examples can be found of jobs in which virtually no one over the age of 40 is capable of adequate performance (e.g., most professional sports). Beyond general statements that most jobs are not sufficiently demanding to present a serious disadvantage to older workers (Laufer & Fowler, 1971), little attention and virtually no research effort has been given to the potential differences among jobs that may lead to differential age–performance relationships.

In addition, there is the problem of studying age bias in performance evaluation. Both the Rhodes (1983) and Waldman and Avolio (1986) reviews had as one of their goals the assessment of such bias. In neither case were conclusions possible because it is quite unusual to find both objective and subjective measures of job performance for the same sample. In the existing literature we are more likely to find objective performance measures for clerical and some manual occupations, and subjective measures for managers and professionals. Thus, existing differences between objective and subjective criteria in the age–performances relationship (e.g., Waldman & Avolio, 1986) may reflect occupational differences rather than performance appraisal bias.

*Job Attitudes.* Two other issues relevant to the older worker may be considered under the topic of job performance. These are job attitudes and attendance/absenteeism. The extensive research history on attitudes toward work, organizational commitment, and job satisfaction consistently shows that such work-related attitudes are progressively more positive with increasing age (Rhodes, 1983). The difficulty with interpreting these findings is similar to the problem mentioned earlier of separating the effects of age and job experience that are highly correlated. The research to date has not succeeded in separating the effects on worker attitudes of age, experience, or what is more likely the combined effects of the two influences.

*Absenteeism.* The research on absenteeism begins by attempting to disaggregate the data into avoidable and unavoidable absence from work. For men, avoidable (casual) absenteeism tends to decrease slightly with increasing age, although there is little evidence for any consistent relationship for women. Unavoidable absence (due to illness or accidents, for example) tends to show a much more variable pattern of relationship with age and is likely to be a function of the job performed. Accident rates for most occupations tend to decrease for older employees; but when illness or injury do occur, they are likely to be associated with longer-term absence (Newquist, 1986; Rhodes, 1983; Sterns, Barrett, & Alexander, 1985).

In conclusion, some researchers on aging (e.g., Salthouse, 1986) have cautioned against using standardized aptitude or ability measures to assess job performance. If any organization needs a measure of job performance (regardless of the age of the job incumbent), then job performance is what should be measured; particularly, paper-and-pencil aptitude tests (such as those criticized by Salthouse) are not reasonable surrogates.

## CONCLUSION

The emphasis in this chapter has been to focus on a changing older adult worker in a changing employment environment. McFarland and O'Doherty (1959), three decades ago, emphasized that the nature of the occupation is the most important determining factor in whether someone continues in a particular job. Another key point made at the time was that the age of the individual is only incidental to the fact that a person is a good, passable, or poor worker. The work an individual can do is limited by his or her abilities and capacities. These in turn are affected by, among other things, the aging process:

> The mature old man or woman is, however, the product of a lifetime of habits, beliefs, understandings and disciplines or lack of them and the pattern of aging is always individual. We must be careful in ascribing to age as such defects or assets which may be rooted in development. (McFarland & O'Doherty, 1959, p. 454)

Our conclusions today remain very much the same. However, in the intervening 30 years major conceptual developments have occurred. The above discussions have led to a continuing attempt to define and explore the concept of "functional age" (McFarland & O'Doherty, 1959; Salthouse, 1986; Schaie & Parr, 1981; Stafford & Birren, 1986). In short, this was an attempt by gerontological researchers to shift the emphasis from age-based decision making to "function-based" evaluation. The idea was that an individual could be evaluated on the basis of level of functioning rather than on the basis of age per se.

We believe that the error in this conceptualization was continuing the logic to an age-normed grading of that functional level. More recent discussions of this issue argue for the abandoning of the "functional age concept," particularly in the context of work-related activities, and replacing it with a focus on task demands and relevant individual abilities, disregarding age to the maximum extent possible (Avolio et al., 1984).

Evaluation of individual workers in unique job situations needs to be done on an individual basis. Today we should focus on the nature of job demands and whether an individual older adult worker has the ability, background, and expertise to continue in a job, take on a new job, or be removed from a job.

## REFERENCES

Arvey, R. D., & Mussio, S. (1973). Test discrimination, job performance and age. *Industrial Gerontology, 16,* 22–29.

Avolio, B. J., & Barrett, G. V. (1987). The effects of age stereotyping in a simulated interview. *Psychology and Aging, 2,* 56–63.

Avolio, B. J., Barrett, G. V., & Sterns, H. L. (1984). Alternatives to age for assessing occupational performance capacity. *Experimental Aging Research, 10*(2), 101–105.

Bandura, A. (1977). Self-efficacy: Toward a unifying theory of behavioral change. *Psychological Review, 84,* 191–215.

Bandura, A. (1981). Self-referent thought: A developmental analysis of self-efficacy. In J. H. Flavell & L. Ross (Eds.), *Social cognitive development: Frontiers and possible futures* (pp. 200–239). Cambridge, England: Cambridge University Press.

Bandura, A. (1982). Self-efficacy mechanisms in human agency. *American Psychologist, 37,* 122–147.

Bardwick, J. M. (1986). *The plateauing trap.* New York: American Management Association.

Barkin, S. (1970). Retraining and job redesign: Positive approaches to the continued employment of older persons. In H. L. Sheppard (Ed.), *Toward an industrial gerontology,* Cambridge, MA: Schenkman.

Barrett, G. V. (1986, February). *Legal issues related to the use of visual functioning as a bona fide occupational qualification: Driving as an example.* Paper presented at the Invitational Conference on Work, Aging and Vision, National Research Council of National Academy of Sciences, Washington, DC.

Barrick, M. R., Alexander, R. A., & Towner, T. B. (1987). *Establishing the utility and efficacy of one quality circle intervention.* Manuscript submitted for publication.

Belbin, E., & Belbin, R. I. (1972). *Problems in adult retraining.* London: Heineman.

Belbin, E., & Downs, S. M. (1964). Activity learning and the older worker: *Ergonomics, 7,* 429–437.

Belbin, R. M. (1965). *Training methods for older workers.* Paris: Organization for Economic Co-operation and Development.

Belbin, R. M. (1970). The discovery method in training older workers. In H. L. Sheppard (Ed.), *Toward an industrial gerontology* (pp. 56–60). Cambridge, MA: Schenkman.

Birren, J. E., & Cunningham, W. R. (1985). Research on the psychology of aging: Principles, concepts and theory. In J. E. Birren & K. W. Schaie (Eds.), *Handbook of the psychology of aging* (pp. 3–34). New York: Van Nostrand Reinhold.

Birren, J. E., Robinson, P. K., & Livingston, J. E. (Eds.). (1986). *Age, health and employment*. Englewood Cliffs, NJ: Prentice-Hall.

Blum, M. L., & Naylor, J. C. (1968). *Industrial psychology*. New York: Harper & Row.

Cross, K. P. (1981). *Adults as learners: Increasing participation and facilitating learning*. San Francisco: Jossey Bass.

Czaja, S. J., & Drury, C. G. (1981). Aging and pretraining in industrial inspection. *Human Factors, 23,* 485–494.

Davies, D. R. & Sparrow, P. R. (1985). Age and work behavior. In N. Charness (Ed.), *Aging and human performance* (pp. 293–332). New York: Wiley.

Doering, M., Rhodes, S. R., & Schuster, M. (Eds.). (1983). *The aging worker: Research and recommendations*. Beverly Hills, CA: Sage Publications.

Edelman, C. D., & Siegler, I. C. (1978). *Federal Age Discrimination in Employment law: Slowing down the gold watch*. Charlottesville, VA: Michie.

*The future of older workers in America: New options for an extended working life*. (1980). New York: Work in America Institution.

Gagne, R. M., & Briggs, L. I. (1974). *Principles of instructional design*. New York: Holt, Rinehart & Winston.

Gagne, R. M., Mayor, J. R., & Paradise, N. E. (1962). Factors in acquiring knowledge of a mathematical task. *Psychological monographs, 76,*(Whole No. 526).

Ginzberg, E. (1984). Career development. In D. Brown, L. Brooks, and Associates (Eds.), *Career choice and development* (pp. 169–191). San Francisco: Jossey-Bass.

Goldstein, I. I. (1974). *Training: Program development and evaluation*. Monterey, CA: Brooks/Cole.

Goldstein, I. I. (1980). Training in work organizations. *Annual review of psychology*. Palo Alto, CA: Annual Reviews.

Goldstein, I. I. (1982). Training in the 1970's: A view toward the 1980's. In R. A. Kasschau, R. Lachman, & K. R. Laughery (Eds.), *Information technology and psychology: Prospects for the future* (pp. 133–147). New York: Praeger.

Hall, D. T. (1971). Potential for career growth. *Personnel administration, 34,* 18–30.

Hall, D. T., & Nougaim, K. (1968). An examination of Masiow's need hierarchy in an organizational setting. *Organizational behavior and human performance, 3,* 12–35.

Havighurst, R. J. (1982). The world of work. In B. B. Wolman (Ed.), *Handbook of developmental psychology* (pp. 771–787). Englewood Cliffs, NJ: Prentice-Hall.

Hoff, E. H., & Hohner, H. U. (1986). Occupational careers, work and control. In M. M. Baltes & P. B. Baltes (Eds.), *The psychology of control and aging* (pp. 345–372). Hillsdale, NJ: Erlbaum.

Hulicka, I. M., & Grossman, J. L. (1967). Age group comparison for the use of mediators in paired-associate learning. *Journal of Gerontology, 22,* 46–51.

Hultsch, D. F. (1975). Adult age differences in retrieval: Trace-dependent and cue-dependent forgetting. *Developmental Psychology, 11,* 197–201.

Hunter, J. E., & Hunter, R. F. (1984). Validity and utility of alternative predictors of job performance. *Psychological Bulletin, 96*(1), 72–98.

Jacobson, B. (1980). *Young programs for older workers*. New York: Van Nostrand Reinhold.

Johnson, D. F., & White, C. B. (1980). Effects of training on computerized test performance in the elderly. *Journal of Applied Psychology, 65,* 357–358.

Katz, R. (1980). The influence of job longevity on employee reactions to task characteristics. *Human Relations, 31,* 703–725.

Laufer, A. C., & Fowler, W. M., Jr. (1971). Work potential of the aging. *Personnel Administration, 34*(2), 20–25.

Lillard, L. A., & Tan, H. W. (1986). Private sector training: Who gets it and what are its effects? Santa Monica, CA: Rand Corporation (for the U.S. Department of Labor).

McFarland, R. A., & O'Doherty, B. M. (1959). Work and occupational skills. In J. E. Birren (Ed.), *Handbook of aging and the individual* (pp. 452–500). Chicago: University of Chicago Press.

McGhee, W., & Thayer, P. W. (1961). *Training in business and industry.* New York: Wiley.

Mullen, C., & Gorman, L. (1972). Facilitating adaptation to change: A case study in retraining middle-aged and older workers at Aer Lingus. *Industrial Psychology, 15,* 23–29.

National Academy of Sciences. (1981). *Airline pilot age, health and performance: Scientific and medical considerations.* Report of a Study by the Committee to Study Scientific Evidence Relevant to Mandatory Retirement for Airline Pilots, Division of Health Sciences Policy. Washington, DC.: National Academy of Sciences, Institute of Medicine.

National Institute on Aging. (1981). *Report of the panel on the experienced pilots study.* Washington, DC.: Department of Health and Human Services, Public Health Service.

Neale, J. G., Toye, M. N., & Belbin, E. (1968). Adult training: The use of programmed instruction. *Occupational Psychology. 42,* 23–31.

Neopolitan, J. (1980). Occupational change in mid-career: An exploratory investigation. *Journal of Vocational Behavior, 16,* 212–225.

Newquist, D. D. (1986). Toward assessing health and functional capacity for policy development on work-life extension. In J. Birren, P. Robinson, & J. Livingston (Eds.), *Age, health, and employment* (pp. 27–44). Englewood Cliffs, NJ: Prentice-Hall.

*Older Worker Employment Comes of Age: Practice and Potential.* (1985). Washington, DC: The National Commission for Employment Policy. (DOL 99-2-3132-50-31)

O'Toole, J. (1978). *Work, learning and the American Future.* San Francisco: Jossey-Bass.

Osipow, S. H. (1986). *Theories of career development.* Englewood Cliffs, NJ: Prentice-Hall.

Patchett, M. B., & Sterns, H. L. (1984 February). *Career progression in middle and later adulthood.* Paper presented at the Tenth Annual Meeting of the Association for Gerontology in Higher Education, Indianapolis, IN.

Peterson, D. A. (1983). *Facilitating education for older learners.* San Francisco: Jossey-Bass.

Ragan, P. K. (Ed.). (1980). *Work and retirement: Policy issues.* Los Angeles: University of Southern California Press.

Rhodes, S. R. (1983). Age-related differences in work attitudes and behavior: A review and conceptual analysis. *Psychological Bulletin, 93*(2), 328–367.

Robertson, I., & Downs, S. (1979). Learning and the prediction of performance: Development of trainability in the United Kingdom. *Journal of Applied Psychology, 64*(1), 42–50.

Robinson, P. K., Coberly, S., & Paul, C. E. (1985). Work and retirement. In R. H. Binstock & E. Shanas (Eds.), *Handbook of aging and the social sciences* (pp. 503–527). New York: Van Nostrand Reinhold.

Rosen, B., & Jerdee, T. H. (1985). *Older employees: New roles for valued resources.* Homewood, IL: Dow-Jones-Irwin.

Rosenbaum, J. E. (1979). Tournament mobility: Career patterns in a cooperation. *Administrative Science Quarterly, 24,* 220–241.

Salthouse, T. A. (1984). Effects of age and skill in typing. *Journal of Experimental Psychology: General, 113*(3), 345–371.

Salthouse, T. A. (1986). Functional age. Examination of a concept. In J. Birren, P. Robinson, & J. Livingston (Eds.), *Age, health & employment* (pp. 78–92). Englewood Cliffs, NJ: Prentice-Hall.

Salthouse, T. A., & Somberg, B. L. (1982). Skilled performance: The effects of adult age and experience on elementary processes. *Journal of Experimental Psychology: General, 111,* 176–207.

Salvendy, G. (1974). Discrimination in performance assessments against the aged. *Perceptual and Motor Skills, 39,* 1087–1099.

Schaie, K. W., & Parr, J. (1981). Functional age: Concept and criteria for functional age. In J. E. Birren (Ed.), *Aging: A challenge to science and social policy* (pp. 249–264). Oxford England: Oxford University Press.

Schein, E. H. (1971). The individual, the organization, and the career: A conceptual scheme. *Journal of Applied Behavioral science, 7,* 401–426.

Schmidt, F. A., Murphy, M. D., & Sanders, R. E. (1981). Training older adults free recall rehearsal strategies. *Journal of Gerontology, 36,* 329–337.

Schrank, H. T., & Waring, J. M. (1981, March). Aging and work organizations. In B. B. Hess & K. Bond (Eds.), *Leading edges: Recent research on psychosocial aging* (pp. 91–118). Washington, DC: U.S. Department of Health and Human Services, National Institute on Aging.

Sheppard, H. L. (1976). Work and retirement. In R. H. Binstock & E. Shanas (Eds.), *Handbook of aging and the social sciences.* New York: Van Nostrand Reinhold.

Siemen, J. R. (1976). Programmed material as a training tool for older persons. *Industrial Gerontology, 3,* 183–190.

Sonnenfeld, J., & Kotter, J. P. (1982). The maturation of career theory. *Human Relations, 35,* 19–46.

Staff. (1982). The older worker: Employment and retirement. *Generations, 6,* 1–80.

Stafford, J. L., & Birren, J. E. (1986). Changes in the organization of behavior change: Implications of functional age. In J. E. Birren, P. K. Robinson, & J. E. Livingston (Eds.), *Age, health and employment* (pp. 1–26). Englewood Cliffs, NJ: Prentice-Hall.

Stagner, R. (1985). Aging in industry. In J. E. Birren & K. W. Schaie (Eds.), *Handbook of the psychology of aging* (pp. 789–817). New York: Van Nostrand Reinhold.

Sterns, H. L. (1986). Training and retraining adult and older adult workers. In J. E. Birren, P. K. Robinson, & J. E. Livingston (Eds.), *Age, health and employment* (pp. 93–113). Englewood Cliffs, NJ: Prentice-Hall.

Sterns, H. L., & Alexander, R. A. (1986). Industrial gerontology. In G. L. Maddox (Ed.), *Encyclopedia of aging* (pp. 349–351). New York: Springer Publishing Co.

Sterns, H. L., Barrett, G. V., & Alexander, R. A. (1985). Accidents and the aging individual. In J. E. Birren & K. W. Schaie (Eds.), *Handbook of the psychology of aging* (pp. 703–724). New York: Van Nostrand Reinhold.

Sterns, H. L., & Patchett, M. (1984). Technology and the aging adult: Career development and training. In P. K. Robinson, J. E. Livingston, & J. E. Birren (Eds.), *Aging and technological advances* (pp. 261–278). New York: Plenum.

Sterns, H. L., & Sanders, R. E. (1980). Training and education in the elderly. In R. R. Turner & H. W. Reese (Eds.), *Life-span development psychology: Intervention* (pp. 307–330). New York: Academic Press.

Stewman, S. (1986). Labor markets, aging and health. In J. Birren, P. Robinson, & J. Livingston (Eds.), *Age, health and employment* (pp. 114–157). Englewood Cliffs, NJ: Prentice-Hall.

Super, D. E. (1957). *The psychology of careers.* New York: Harper & Row.

Super, D. E. (1980). A life span, life-space approach to career development. *Journal of Vocational Behavior, 16,* 282–298.

Super, D. E. (1984). Career and life development. In D. Brown, L. Brooks, and Associates (Eds.), *Career choice and development,* (pp. 192--234). San Francisco: Jossey-Bass.

Super, D. E. (1985). Coming of age in Middletown: Careers in the making. *American Psychologist, 40,* 405–414.

Treat, N. J., & Reese, H. W. (1976). Age imagery and pacing in paired-associate learning. *Developmental Psychology, 12,* 119–124.

Tucker, F. D. (1985). A study of the training needs of older workers: Implications for human resources development planning. *Public Personnel Management Journal, 14,* 85–95.

U.S. House Select Committee on Aging. (1982). *Age discrimination in employment: A growing problem in employment.* Washington, DC: U.S. Government Printing Office.

Valasek, D. L., & Sterns, H. L. (1981, November). *Task analysis and training: Applications from lab to the field.* Paper presented at the 34th Annual Scientific Meeting of the Gerontological Society of America, Toronto.

Vondracek, F. W., & Schulenberg, J. E. (1986). Career development in adolescence: Some conceptual and intervention issues. *The Vocational Guidance Quarterly, 34,* 247–254.

Viega, J. F. (1973). The mobile manager at mid-career. *Harvard Business Review, 51,* 115–119.

Viega, J. F. (1981). Plateaued versus non-plateaued managers: Career patterns, attitudes, and path potential. *Academy of Management Journal, 24,* 566–578.

Viega, J. F. (1983). Mobility influences during managerial career stages. *Academy of Management Journal, 26*(1), 64–85.

Waldman, D. A., & Avolio, B. J. (1986). A meta-analysis of age differences in job performance. *Journal of Applied Psychology, 71*(1), 33–38.

Welford, A. T. (1959). Psycho-motor performance. In J. E. Birren (Ed.), *Handbook of aging and the individual* (pp. 562–613). Chicago: University of Chicago Press.

Welford, A. T. (1976). Thirty years of psychological research on age and work. *Journal of Occupational Psychology, 49,* 129–138.

Wexley, K. N. (1984). Personnel training. *Annual Review of Psychology, 35*, 519–551.

Wexley, K. N., & Latham, G. P. (1981). *Developing and training human resources in organizations*. Glenview, IL: Scott, Foresman.

Willis, S. L. (1985). Towards an educational psychology of the older adult learner: Intellectual and cognitive bases. In J. E. Birren & K. W. Schaie (Eds.), *Handbook of the psychology of aging* (pp. 818–847). New York: Van Nostrand Reinhold.

CHAPTER 11

# Applications of Structural Equation Models in Gerontological Research

CHRISTOPHER HERTZOG
SCHOOL OF PSYCHOLOGY
GEORGIA INSTITUTE OF TECHNOLOGY
ATLANTA, GEORGIA

The past several years have been marked by an accelerating rate of increase in sophisticated new methods for conducting valid and informative empirical research on nonexperimental data (e.g., Blalock, 1985a, b; Nesselroade & Baltes, 1979). Some of the more important advances have been in the domain of *structural equation models* (SEM). Traditionally, SEM usually refers to complex regression models (e.g., path analysis) that analyze causal relations among unobserved (latent) variables. An important component of SEM, therefore, is that part of the model maps the latent variables onto variables we actually measure empirically (the observed or manifest variables). This part of SEM is usually termed the *measurement model*. The SEM measurement model is, essentially, a confirmatory factor analysis in which the observed variables are specified to be a linear combination of latent variables (factors). The part of the SEM specifying regression relationships among latent variables is the *structural regression model*.

In this chapter I describe SEM applications, often consisting only of confirmatory factor analyses without a structural regression model, that address research questions of critical importance to gerontologists. Most of these applications are in the domain of psychometric intelligence and cognition, but they illustrate SEM techniques that can be used in other domains as well. This review avoids equations, derivations, or proofs and does not discuss extensively the philosophy and methodological rationale for SEM in developmental research (see Campbell & Mutran, 1982; Hertzog, 1985a, in press; Horn & McArdle, 1980; Nesselroade & Baltes, 1984; Rogosa, 1979; Schaie & Hertzog, 1982,

Preparation of this manuscript was supported in part by a Research Career Development Award (1 K04 AG00335-02) from the National Institute on Aging. I thank Timothy Salthouse for helpful comments on an earlier draft of this review.

1985). Here the style is to emphasize concepts, not mathematics, and the goal is to discuss substantive implications as well as methodological advances.

## INDIVIDUAL DIFFERENCES IN INFORMATION PROCESSING SPEED

One of the best-documented findings in the gerontological literature is the age-related slowing in the speed of information processing (e.g., Salthouse, 1985). As humans grow older, the speed of elementary and complex cognitive processes slows. This slowing is independent of age changes in the peripheral nervous system and in psychomotor movement time, and it has been argued to be a function of a primary aging process in the central nervous system itself (Birren, 1965). Most of the gerontological research has focused on *mean age differences* on tasks thought to assess different domains of information-processing speed. There is little question that, on average, older persons demonstrate slower information-processing rates even though the process of information analysis is usually found to be qualitatively similar in young and old persons (e.g., Petros, Zehr, & Chabot, 1983).

Studies of the age-related slowing phenomenon have typically not examined issues of individual differences in the rate of slowing. This omission is curious, for even though primary aging, by definition, affects *all* individuals (Birren, 1965), the rate of aging may differ across individuals. Thus, even if one adopts the harsh view of age-related change as consisting solely of decrements caused by primary aging, accurate measurement of individual differences in rates of aging is important for scientific knowledge and applied problems (e.g., assessing pilot fitness after age 55). Assessment of the individuals must take into account the variation in aging rates, not just the average performance of individuals at a given chronological age.

To illustrate the features and advantages of an SEM measurement model, we will consider a study designed to measure individual differences in information-processing speed (Hertzog, Raskind, & Cannon, 1986). Data were collected on reaction time (RT) measures of elementary verbal and nonverbal processes. The study used three RT tasks that had been used in the gerontological literature to study age differences in how quickly individuals accessed meanings of familiar nouns stored in semantic memory. The three tasks were (1) Category Matching—subjects match a category noun label with an instance that is or is not a member of the category (e.g., *fruit–apple* vs. *fruit–chair*); (2) Semantic Matching—subjects match two nouns that are or are not members of the same category (e.g., *apple–pear* vs. *apple–chair*); and (3) Synonym Matching—subjects match two nouns that do or do not have the same meaning (e.g., *thief–burglar* vs. *thief–dancer*). Both Category Matching and Semantic Matching had two levels of nouns—those of high or low typicality as instances of the category (e.g., *apple* is a high-typicality fruit, whereas *kiwi* is a low-typicality fruit). For all of these variables, the score for an individual was his or her median RT for all correct judgments on Same (matching) trials. Data were collected on 55 persons (30 old, 25 young).

The purpose was to address several questions about these three RT tasks. First, do they measure the same latent variable of semantic information-processing speed? If so, then it can be argued that we have measured a latent variable of how rapidly individuals retrieve information from semantic memory (Semantic Memory Access speed, or SMA). Second, is this SMA variable distinct from latent variables measured by other RT tasks? Third, is SMA measured equally well for young and old subjects by these three RT tasks?

Why would one conduct the correlational analysis using the SEM model, instead of just inspecting the correlations among the RT tasks themselves? There are several reasons. First, one can have more confidence in the result if it is replicated across multiple tasks and can be shown in a latent variable model for the tasks. There is less risk that the phenomenon is illusory, a product of statistical chance or of a peculiar task characteristic. In essence, the latent variables are a better operational definition of the construct of interest (Messick, 1981) than any individual indicator of that construct. Second, use of latent variable SEM models corrects estimates of magnitudes of relationships among constructs by adjusting for the degree of unreliability in the observed variables. It does so by modeling the observed variables as being determined both by latent variables and by a component specific to the observed variable itself. This approach allows the unreliable variance to be modeled as residual variance (in the usual connotation of residual variance in regression models). Because of this, estimates of correlations among latent variables are purged (disattenuated) for measurement error. In cases where the communalities (variance in observed variables predicted by latent variables) are only moderate, the disattenuated correlations among factors can be considerably higher than the correlations among any pair of observed variables. Disattenuation for measurement error is especially important in comparisons of different age groups. In SEM analysis of multiple groups, the estimates of group differences in variance and covariances among latent variables are not influenced by group differences in reliability, and differences in correlations among variables are not influenced by relative differences in reliability.

A third reason for conducting SEM is that the approach allows one to evaluate objectively the adequacy of a theoretical model in terms of its fit to a set of variables (as predicted by theory). In addition to general indices of model fit to an entire data matrix, it is possible to formulate and test specific hypotheses regarding patterns of correlations (e.g., age group equivalence of factor correlations) and other SEM model parameters.

Figure 11-1 shows a factor model for the three semantic tasks, plus two other tasks (simple RT and two-choice RT). In the simple RT, individuals pressed a

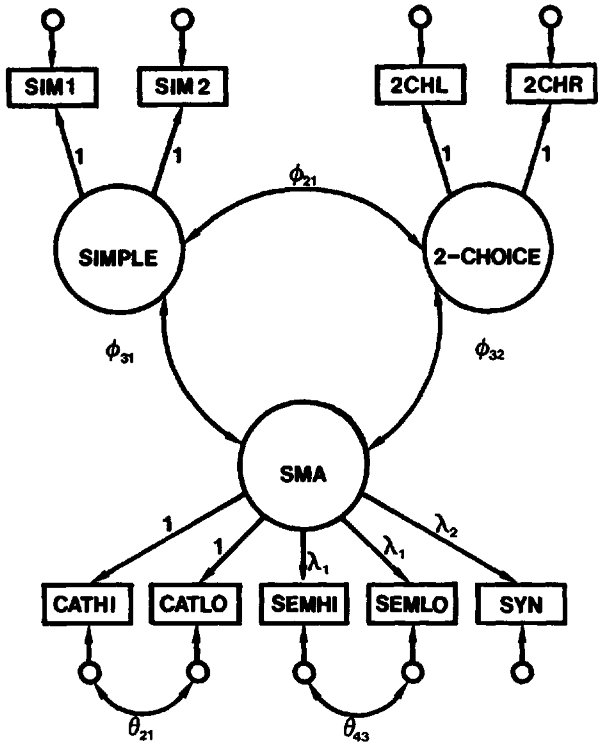


**Figure 11-1.** Structural model for individual differences in three RT factors. SMA is a semantic memory access speed factor that determines covariances among five semantic RT task/task conditions: Category Matching (high and low typicality), Semantic Matching (high and low typicality), and Synonym Matching.

button whenever a symbol appeared on the screen. In the two-choice task, subjects either pressed a button with the left hand if a left arrow appeared or pressed a button with the right hand if a right arrow appeared. Three latent variables were modeled (simple RT, two-choice RT, and semantic RT). These latent variables are depicted by the large circles. Their covariances are graphed as curved arrows ($\phi$). Note that each latent variable (circle) has an arrow from it to the rectangles (labeled CATHI, CATLO, etc.). These rectangles represent each of the observed variables (RT tasks). The SMA factor has arrows pointing to the high- and low-typicality variables for Category Matching (CATHI, CATLO), the high- and low-typicality variables for Semantic Matching (SEMHI, SEMLO), and Synonym Matching (SYN). These arrows represent regression coefficients for equations describing each observed variable as a weighted function of the latent variables. In standard factor analysis terms, they are factor pattern weights, or factor loadings. In our case, each observed variable is determined by only one latent variable, although this need not be the case. Note that each observed variable also has another circle pointing toward it. These circles represent unique components specific to the variable itself. The variances of these unique components include variance due to unreliable measurement error, as well as reliable variance not in common with other indicators of the latent variables. In the case of the Category Matching and Semantic Matching tasks, the model assumes that the high- and low-typicality variables will have a component specific to the type of matching task itself and shared between the high- and low-typicality conditions. This assumption leads to specifying a residual covariance ($\theta$) between these pairs of residuals.

Thus, this model illustrates the three ways that observed variables can correlate with each other in SEM measurement models: they can correlate because (1) they are measures of the same latent variables, (2) they are measures of different latent variables that are correlated with each other, or (3) they have residual components (with respect to the latent variables actually in the model) that correlate with each other. What SEM models do is to attempt to estimate the values of the parameters in the SEM equations—that is, the regression coefficients, covariances, and variances in the model—by using the sample variances and covariances among the observed variables.

Before evaluating the results of the model, a comment on the values of the regression coefficients (factor loadings) is in order. Note that several have a fixed value of 1.0 by hypothesis. Others (denoted by $\lambda$) are not fixed to a value but instead are freely estimated by the computer program. Note also that the loadings for SEMHI and SEMLO have the same subscript (indicating that these are constrained equal to each other). These factor-pattern coefficients can be quite confusing to someone familiar with standard factor analysis. Because the model is designed for explaining the variances and covariances among the observed variables, a single 1.0 loading is needed as an arbitrary constant that defines the units of measurement on the latent variable. This makes it possible to measure *the variances of the latent variables* themselves. The fact that more than one factor loading is fixed to 1.0 for each latent variable implies the additional assumption that these measures have equal relationships to the latent variables (as do SEMHI and SEMLO to SMA).

We estimated the model specified in Figure 11-1 by fitting it to the sample covariance matrix using the LISREL VI program (Joreskog & Sorbom, 1984). What did the analysis tell us about the research questions identified above? First, there are reliable individual differences in the semantic memory access speed (SMA) factor. The analysis provided us with three different ways of testing this conclusion. First, the overall fit of the model, as judged by its (likelihood ratio) $\chi^2$ test, was good. So too was the LISREL adjusted goodness-of-fit index, which assesses goodness of fit in a manner less sensitive to sample size than the $\chi^2$ test.

So, as a whole, the model fit the entire data matrix well. The model also fit the sample covariances among the semantic RT tasks well. This was judged by examining the residual correlations among the items, removing from them the parts predicted by the model. These residual correlations were small, indicating that the covariances among the semantic RT tasks were well fit by the model. Finally, the estimated factor loadings for the SMA factor were large. After standardization, all the factor loadings for the SMA factor are very high, exceeding 0.9. The corresponding (standardized) unique variances were all less than 0.2. The analysis therefore indicated that the SMA factor is well defined, and we can conclude that these RT tasks all are indeed measures of the same latent variable.

The third measurement issue relates to the equivalence of the RT measures between the young and the old age groups. Do they measure the SMA factor equivalently in the two age groups? We addressed this issue by estimating the model in the two age groups, while testing whether the regression coefficients (factor loadings) of Figure 11-1 could be constrained equal over the two groups. Forcing the groups to have equal factor loadings on the SMA factor did not result in a statistically significant increase in $\chi^2$. We concluded that the SMA factor is equivalently defined in the young and in the old adults.

Is there evidence of individual differences in the rate of slowing, as measured by RT tasks? Longitudinal data are required to answer this question definitively, but the cross-sectional design can give us some indirect evidence. Individual differences in rates of age-related change imply (1) increasing latent variable variances, and (2) *increasing latent variable covariances on variables that share common causes of change* (Hertzog, 1985b). Hertzog et al. (1986) found the estimated factor variance for SMA to be higher in the old than in the young. Furthermore, the correlation among two-choice RT and SMA was higher in the old group (.50) than in the young group (.31). Conversely, the correlation of simple RT and SMA was lower in the old group (.35 versus .45). This pattern of results is consistent with the hypothesis that the nonverbal and semantic two-choice RT tasks share a common cause of change from young adulthood to old age. Other explanations are also consistent with the results, of course, and large-sample replication as well as analysis of longitudinal change data would be needed to provide more definitive evidence favoring the hypothesis of correlated individual differences in change.

## SEM MODELS FOR PSYCHOMETRIC INTELLIGENCE IN ADULTHOOD

One of the real success stories in the brief history of SEM applications in gerontological research involves research on whether the aging process produces qualitative shifts in factor structure of psychometric intelligence. Intelligence has been one of the most widely studied construct domains in gerontology, and considerable effort was expended addressing the issue of whether aging altered the factor structure of intellectual abilities. The question is extremely important, for it is in some senses a necessary first step to meaningful analysis of age changes in intelligence. Age changes in factor structure of intelligence would call into question the meaning of quantitative changes in levels of intelligence, as well as the meaning of individual differences in patterns of age-related change in intelligence (e.g., Baltes & Nesselroade, 1973). As discussed in some detail by Baltes and Nesselroade (1973; see also Schaie & Hertzog, 1985), a lack of factorial invariance across developmental levels could be produced by changes in the measurement properties of the psychometric tests (a lack of *measurement equivalence*) or a change in the fundamental properties of the constructs themselves (a lack of *construct equivalence*). With respect to psychometric intelligence, a lack of measurement equivalence might indicate a shift in the relative importance of performance-related processes (e.g., perceptual analysis of form, selective attention) necessary for adequate performance on the tests but clearly distinct from the construct(s) the tests were originally intended to measure. On the other hand, a lack of construct equivalence across age levels might indicate that there is a developmental shift in the organization of cognitive processes and their application to solving psychometric test items.

Prior to the use of SEM techniques for studying factorial invariance, the results from studies of factorial invariance presented a rather confusing picture (Reinert, 1970). The dominant hypothesis regarding adult age changes in intellectual factor structure has been one of *dedifferentiation,* in which intellectual ability factors become more highly interrelated with advancing age. Dedifferentiation (or reintegration) stands in opposition to the hypothesis of differentiation of intellectual factor structure in development from early childhood to adolescence. The differentiation hypothesis holds that abilities are first manifested as one or a very few abilities (such as general intelligence), but with increasing development, multiple intellectual abilities emerge. Dedifferentiation implies a tendency to return to a factor structure like that of early childhood—one or a very few ability factors. Extreme versions of dedifferentiation suggest actual factor collapse—reductions in the number of factors needed to account for ability factors. Milder forms of differentiation would include (1) shifts in the factor pattern weights, (2) increases in communalities, and, in particular, (3) substantial increases in the correlations among ability factors. Certainly, part of the confusion that existed regarding the phenomenon of dedifferentiation centered around variable criteria for dedifferentiation (Olsson & Bergman, 1977). Perhaps the weakest form of dedifferentiation would consist of invariant factor pattern weights accompanied by increased factor correlations. Such a result would suggest that the factors maintained invariant relationships to intelligence tests but that there were some shifts in the relationships among the abilities themselves.

Tests of dedifferentiation hypotheses have often been examined by means of comparative factor analysis of cross-sectionally defined age groups because longitudinal data appropriate to the issue have been relatively rare. Adequate tests of factorial invariance in multiple age groups requires use of simultaneous confirmatory factor analysis of covariance matrices from multiple age groups (Cunningham, 1978; Hertzog, 1985a; Schaie & Hertzog, 1985). The most crucial evidence for equivalence of factors is the test of equivalence in unstandardized factor-pattern weights across the multiple groups. The critical problems with the early literature were that (1) the primacy of the test of factor pattern weights was not clearly understood, and (2) exploratory factor analysis often led to inconsistent results as a function of the fundamental indeterminacy of exploratory factor analysis solutions (Cunningham, 1978; Reinert, 1970).

The literature using confirmatory factor analysis has converged on a common set of findings:

1. The number of factors present in different adult age groups seems remarkably consistent over the adult life span.
2. There are no major changes in which tests load on which ability factors—in Horn, McArdle, & Mason's (1984) term, *configural invariance.*
3. The unstandardized factor pattern weights appear to be numerically equivalent in different age groups (*metric invariance*—Horn et al., 1984).
4. But ability factors correlate more highly in old than in young or middle-aged populations.
5. Communalities appear to be higher in older groups.

The first evidence for this conclusion came from studies conducted by Cunningham (1980, 1981), and an impressive number of other studies have produced similar findings (e.g., Hertzog & Schaie, 1986a; Hultsch, Hertzog, & Dixon, 1984; Stricker & Rock, 1985). Cunningham's studies are based on comparisons of young subjects (15–32 years of age) with a sample of more than 300 adults, aged 53 to 91 years. In both studies this adult sample is divided into young-old (53–68) and old-old (69–91) age groups. Adults were administered a battery of tests from Guilford and the ETS Reference Kit measuring multiple abilities. Cunningham (1980) compared three primary abilities (Verbal Comprehension, Sensitivity to Problems, and Semantic Redefinition). Cunningham (1981) did age-comparative factor analysis on 14 ability tests defining five primary abilities (Verbal Comprehension, Number Facility, Perceptual Speed, Symbolic Cognition, and Flexibility of Closure). After complex and somewhat unorthodox analyses, Cunningham (1980, 1981) found equal numbers of factors and invariance in unstandardized factor loadings across the three age groups. However, he found convincing evidence that factor covariances are greater in the adult groups than in the young sample.

Similar data are reported by Stricker and Rock (1985), who applied SEM to analyze data from three age groups (20–29, 30–39, and 40–49) on the Graduate Record Examination. They drew random samples of 1,000 individuals from each age group and performed separate SEM models on each age group. They did not explicitly test factor invariance by constraining parameters equal (probably a decision based on the pragmatic problem of too many variables, and hence, too many parameters to estimate given three age groups). The degree of equivalence in the separately estimated factor loadings on the GRE Verbal, Quantitative, and Analytical factors is startling. The standardized loadings generally differed by less than .05 across the three age groups. Factor correlations increased across the age groups (without concomitant increases in standard deviations of the observed variables). Given the sample sizes, inferential statistics would not be needed to detect these differences as significant! Nevertheless, the differences are relatively substantial, given that all subjects sampled were less than 50 years of age. For example, the correlation between the GRE Verbal and GRE Quantitative factors increased from .53 in the 20- to 29-year-old group to .63 in the 40- to 49-year-old group. Data by the other studies cited above conform to this pattern: equivalence in factor loadings but age differences in factor covariances and communalities.

Any cross-sectional age group differences in factor structure are confounded with cohort differences (in analogy to the age/cohort problem in mean levels). Cunningham and Birren (1980) reported no time-lag differences in factor structure (factor loadings or factor covariance matrices) between student samples of widely different cohorts (but see below for some concerns regarding their SEM approach). Hayslip and Brookshire (1985) recently reported a time-lag comparison of two adjacent cohorts of older adults, in which they found invariant loadings on two factors they labeled fluid and crystallized intelligence. It seems at this juncture that there are neither age differences nor cohort differences in factor loadings. There appear to be age-related changes in factor covariances that are much greater than the (possibly nonexistent) cohort differences in factor covariances.

Baltes, Cornelius, Spiro, Nesselroade, and Willis (1980) reported one SEM study that may be viewed as favorable toward a stronger form of dedifferentiation in adult intelligence factor structure. They conducted a factor analysis of a battery of 17 ability tests selected to mark second-order factors of fluid and crystallized intelligence. They did not do age-comparative analysis; the sample consisted of 109 elderly adults (aged 60–89 years). Baltes et al. (1980) found substantial correlations among the ability tests in the elderly sample. A seven-factor model for the tests based on an a priori primary-ability-factor structure fit the data well but produced high factor correlations, especially among the Induction, Figural Relations, and Experiential Evaluation primaries. The high relationship of Experiential Evaluation to Induction was surprising because the former had been conceptualized as a marker for the second-order factor of Crystallized Intelligence, and the latter had been selected to measure Fluid Intelligence (e.g., Cattell, 1971; Horn, 1978). Horn and Cattell have consistently argued that fluid and crystallized abilities are positively (but modestly) correlated. Baltes et al. (1980) subsequently fit models with fewer factors and ultimately argued for a model that included a general factor (with largest loadings associated with the tests of reasoning ability) and three additional factors (Memory Span, Verbal Comprehension, and Perceptual Speed). They specifically argued that a Horn/Cattell fluid/crystallized model could not fit the data for their elderly sample (as it has for data in younger populations). Accordingly, they suggested that their results supported a dedifferentiation of factor structure; specifically, a collapse of the fluid and crystallized distinction into a general factor and a collapse of the primary abilities determined by fluid intelligence into a single factor highly related to general intelligence.

Results observed by Baltes et al. (1980) actually are ambiguous regarding the merits of the strong dedifferentiation hypothesis. Without age-comparative analysis, it is difficult to know the degree to which the battery they administered would also produce high intercorrelations among abilities in different age samples. Their comparisons to younger age groups are based on interpretations of research reports by Horn and Cattell (e.g., Horn, 1978), but these solutions were based on exploratory factor analysis allowing small loadings of all variables on all factors. This approach tends to estimate lower factor correlations than SEMs with fixed zero loadings. Gustaffson (1984) recently reported data showing substantial correlations among primary abilities in young adults—correlations much higher than one would expect given exploratory factor analysis results on fluid and crystallized intelligence. Moreover, Gustaffson (1984) argued that his general intelligence factor is isomorphic with fluid intelligence (a position consonant with Baltes et al., 1980). For now, it seems safest to conclude that the results of Baltes et al. support *at least* the mild dedifferentiation hypothesis, that is, increasing factor correlations.

Cornelius, Willis, Nesselroade, and Baltes (1983) reported an interesting analysis of additional data from the same sample, tested 2 years after the data analyzed by Baltes et al. (1980) were collected. In this data collection, additional measures of attention were administered. SEM was used to perform an extension analysis. Four factors (Reasoning, Crystallized Knowledge, Memory Span, and Perceptual Speed) were specified as oblique ability factors; the attention tests were then extended into this factor space by allowing free factor loadings for all of them on the four factors. A Continuous Paired Associates Recall measure loaded strongly on the Reasoning factor; the others loaded predominantly on Perceptual Speed. No attempt was made to extend the variables into the general factor model reported by Baltes et al.; nor was an attempt made to identify separate Attention factor(s) and estimate their correlation(s) with Perceptual Speed independent of the extension analysis. Their results support the hypothesis that these attentional measures are more highly related to Perceptual Speed than to other ability factors. Cornelius et al. (1983) concluded, on the basis of their own results and other studies, that there is little support for the hypothesis that attentional deficits mediate age changes in fluid abilities such as Reasoning.

## LONGITUDINAL SEM MODELS OF AGE CHANGES IN INTELLIGENCE

One of the most important classes of application for SEM is in modeling change in longitudinal data. Prior to the advent of SEM techniques for longitudinal factor analysis, conducting latent variable analysis in longitudinal data was a heroic task (see Bentler, 1973). SEM approaches enable modeling of latent variables in longitudinal data sets without great difficulty, providing that there are sufficient measures of the latent variable available. SEM models for longitudinal data also deal in a straightforward fashion with specification problems unique to longitudinal data (e.g., autocorrelated residuals in the measurement model). Details on longitudinal SEM models and their technical properties may be found in multiple references (e.g., Dwyer, 1983; Hertzog, 1985a, in press; Horn & McArdle, 1980; Joreskog, 1979; Joreskog & Sorbom, 1977, 1980; McArdle, 1986; Rogosa, 1979, 1980; Schaie & Hertzog, 1985). The discussion here will focus on illustrating a few advantages of the method in the context of reviewing published work in gerontology.

An adequate description of longitudinal SEM models requires first that we describe and discuss the properties of the longitudinal measurement model. Assume that we have longitudinal data across a particular age range collected in multiple birth cohorts. At each measurement point, one or more latent variables has been measured with multiple observed variables. The longitudinal measurement model requires that a model for each occasion be specified and that the model specify the relationships between latent and observed variables across longitudinal occasions. Figure 11-2 shows a simple longitudinal factor model, as developed by Hertzog and Schaie (1986a) for Schaie's longitudinal data on intelligence. At each occasion, a single latent variable (general intelligence, or *g*) is measured by five observed variables [subtests of the Thurstone Primary Mental Abilities (PMA) test]. The *g* latent variable relates to itself over time as a function of the covariances between *g* across occasions. Thus, age changes are reflected in (1) changes in *g* factor variances with increasing age and (2) *g* factor covariances over time (e.g., *g* at Age 1 with *g* at Age 2). We shall consider the interpretation of these parameters below. The model of Figure 11-2 does *not* provide a means by which residuals for the five subtests (the $\delta$ in Figure 11-2) relate, independent of *g*. As such, the model is badly misspecified, for there will usually be reliable components of observed variables that are not part of the common factors (latent variables). If these components are not specified and estimated, then the estimates of factor loadings and factor covariances for *g* will be biased. Fortunately, SEM permits modeling covariances among the residuals. In the Hertzog and Schaie (1986a) analysis, the differences in fit between models with and without the residuals was enormous; and plausible parameter estimates could be obtained only with the correlated residuals. The type of model graphed

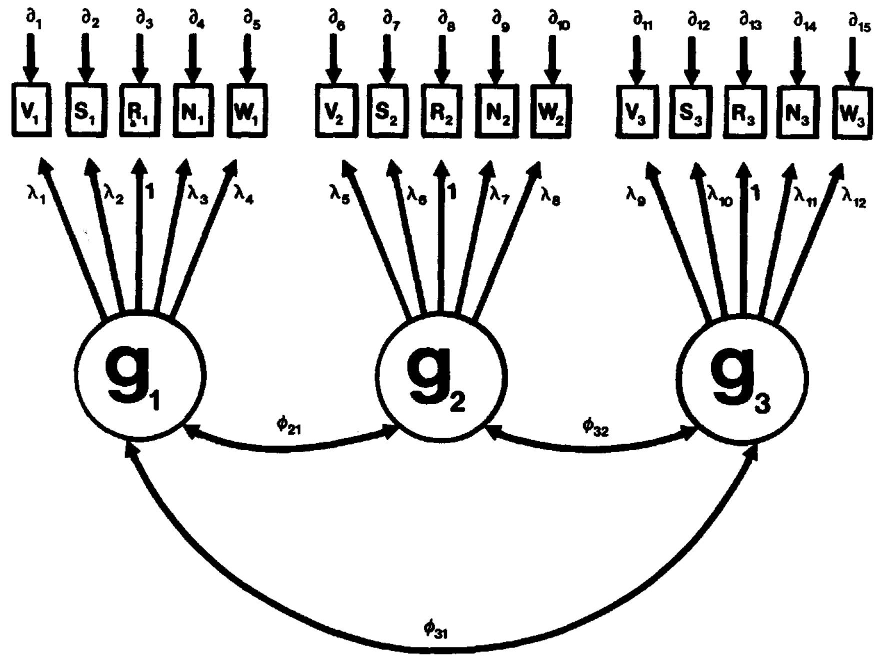


**Figure 11-2.** Longitudinal factor model for data from Schaie's Seattle Longitudinal Study. A general intelligence factor *(g)* determines covariances among five intelligence tests at each of three longitudinal occasions. Autocorrelated residuals among the five subtests across occasions are modeled but not shown. (From C. Hertzog & K. W. Schaie, Stability and Change in Adult Intelligence: I. Analysis of Longitudinal Covariance Structures. *Psychology and Aging, 1(2)*, 159–171. Copyright © 1986 by the American Psychological Association. Reprinted by permission of the publisher and author.)

in Figure 11-2 can be easily generalized to more than one latent variable at each occasion (see examples in Dwyer, 1983, and Horn & McArdle, 1980).

The longitudinal SEM measurement model provides a different basis for evaluating the dedifferentiation hypothesis than did the simultaneous factor analysis in multiple (cross-sectional) age groups. In the longitudinal analysis, dedifferentiation would be reflected in (1) differences in the number of factors at each occasion, (2) changes in the within-occasion factor covariances across occasions (e.g., Verbal Comprehension correlates more highly with Induction at age 50 than at age 30), (3) shifts in the factor loadings across occasions, and/or (4) increases in communalities across occasions. Longitudinal investigations of the dedifferentiation hypothesis using SEM are consistent with multiple group comparisons; there is little evidence for change in the number of dimensions or in the factor loadings across occasions, ruling out the stronger forms of the dedifferentiation hypothesis.

Cunningham and Birren (1980) used longitudinal data collected by Owens (see Cunningham & Owens, 1983) to test the dedifferentiation hypothesis. Eight subtests from the Army Alpha were measured on 96 males as college students and again at ages 50 and 60. The Army Alpha tests were used to define three ability factors. As mentioned above, Cunningham and Birren found no time-lag differences in factor structure between Owens's original young subjects and a recent group of university students. On the other hand, they found longitudinal differences in factor structure between young adulthood and age 50. Cunningham and Birren's results are inadequate for the purpose of localizing the changes to factor loadings, factor covariances, or both, owing to the nature of their analysis. They report convergence problems with their solution in many different parts of the analysis, which may be a function of the instability of their three-factor solution. Part of their problems may have been a function of the way the confirmatory analysis was treated. In a preliminary analysis of the pooled correlation matrix, Cunningham and Birren found an estimated factor correlation of .82 between two factors. Deeming this unacceptable, they fixed the correlation to .70 and re-estimated the model. This practice was adopted in subsequent comparisons of equivalence over longitudinal occasions, which were even more unusual in that the longitudinal occasions were modeled as if they were independent data from different age groups. They also reported fixing to zero factor correlations estimated to be negative. This was done to maintain some correspondence to expectations that ability-factor correlations ought to be positive. This pattern of outcomes and fixes suggests that Cunningham and Birren (1980) imposed questionable restrictions on the common factor space in order to salvage plausible parameter estimates for a misspecified model.

In fairness, these problems were probably brought about by the fact that the eight Army Alpha subtests apparently did not adequately define primary ability factors conforming to simple structure. Nevertheless, the procedures employed appear to cast doubt on the validity of the hypothesis tests for equivalence of factor pattern weights and factor covariance matrices. Moreover, a direct likelihood ratio $\chi^2$ test of equivalence was actually not computed. They evaluated the hypothesis of equivalence in factor loadings by assessing the overall fit of models with constrained equal factor loadings instead of computing the difference in $\chi^2$ between models imposing and relaxing the constraints. Taking these problems together, it is difficult to accept at face value Cunningham and Birren's (1980) suggestion that there are changes in factor loadings with advancing age. At best, one can argue that their results suggest that some kind of age-related shifts in factor structure occurred in the longitudinal data.

Evidence that factor loadings remain invariant in longitudinal data has been reported by Lachman (1983) and by Hertzog and Schaie (1986a). Lachman (1983) analyzed data from the Penn State ADEPT project, including intelligence data used in the studies by Baltes et al. (1980) and Cornelius et al. (1983). Lachman's research focus was on relationships of perceived intellectual competence (control) to intelligence in the elderly. As a result, she used two markers for each of four factors (Fluid Intelligence, Crystallized Intelligence, Perceptual Speed, and Memory Span). Like Cunningham and Birren (1980), Lachman did not directly test the hypothesis of invariance in factor loadings; however, her model constraining factor loadings to be equal fit the data well. Hertzog and Schaie (1986a) did test directly the hypothesis of longitudinal invariance in *g* factor loadings, defined in the model depicted in Figure 11-2. They found the hypothesis of invariance to fit well over 14 years of longitudinal age change for young, middle-aged, and old groups.

The latter two studies cannot be considered definitive evidence for invariant relationships between intelligence tests and factors in longitudinal data. In the case of Lachman's (1983) study, the older subjects were retested after only a 2-year interval, which may not be sufficient time to observe qualitative shifts in factor loadings. Hertzog and Schaie's (1986a) analysis is more convincing, in that changes were not observed over 14-year intervals, but their analysis estimated *g* factor loadings, not primary-ability loadings, and there is still a possibility that changes would be observed at the primary-ability level in appropriate data sets. Moreover, neither of these studies can rule out the possibility that qualitative change in factor structure occurs differentially in groups likely to drop out of longitudinal samples. In principle this argument is difficult to address, but it is highly plausible. Individuals in phases of terminal decline (Riegel & Riegel, 1972) may be those most likely to show qualitative shifts in factor structure at the same time they experience losses in level of functioning. Nevertheless, a definitive test of the hypothesis of structural invariance in subpopulations who do remain in longitudinal studies has not yet been made. The evidence available supports the invariance hypothesis (and, therefore, *only* the weak version of the dedifferentiation hypothesis).

Schaie, Willis, Hertzog, and Schulenberg (in press) examined whether factor loadings would change as a function of training skills needed to perform on psychometric ability tests. Subjects were either (1) trained on inductive reasoning, (2) trained on spatial rotation ability, or (3) treated as a no-training control. One criticism of training studies has been that the very act of training the skills needed for test performance may change the measurement properties of the tests. Schaie et al. (in press) used a pretest–posttest design to test the invariance of factor structure for older adults before and after they were trained. Factor loadings were invariant in the no-training control group, but there were some subtle shifts in factor loadings in the training group. These changes were specific to the ability tested. For both groups, configural invariance still held after training—the tests loaded on the same factors. However, loadings of one test on each factor were different after training, rejecting the hypothesis of complete metric invariance. These changes did not appear sufficient to warrant a conclusion that the factor was no longer measured accurately after training. Nevertheless, the results suggest that care must be taken in analyzing levels of training gain; if possible, analysis at the level of the latent variables (factors) would be preferable to analysis of single indicators.

The capability of SEM to provide direct tests of invariance of factor loadings is only one of its merits. Another crucially important feature of these models is that they afford examination of the *stability of individual differences* as individuals age. Stability has multiple definitions (e.g., Baltes, Reese, & Nesselroade, 1977; Bengtson, Reedy, & Gordon, 1985; Kagan, 1980; Schaie & Hertzog, 1985). Stability of individual differences is distinct from stability in mean levels over time; it reflects the degree to which individual differences are consistent across time and is often operationally defined in terms of the correlation of a variable with itself in longitudinal data. The magnitude of such a correlation [or its regression equivalent, the *stability coefficient* (Kessler & Greenberg, 1981)] is inversely related to the magnitude of what Baltes and his colleagues have labeled "interindividual differences in intraindividual change" (Baltes & Nesselroade, 1973; Baltes et al., 1977). The more the heterogeneity in patterns of change across individuals, the lower the stability coefficient. The greater the tendency for individual change patterns to run parallel to the average (mean) change pattern, the greater the stability coefficient. A high degree of stability is central to Costa and McCrae's (1980; Costa, 1986) argument of continuity in personality factors with aging [and more generally, to arguments of psychosocial continuity (see also Bengtson et al., 1985)]. As discussed in more detail by Schaie and Hertzog (1985), the Joreskog/Sorbom type longitudinal SEM approach allows one to explicitly study the stability in terms of the variances and covariances of the latent variables over time.

The available evidence strongly suggests that there is a high degree of stability in individual differences in intelligence during adulthood. For example, Schaie et al. (in press) found virtually perfect stability of individual differences in a 1-month retest of older individuals who were members of their no-training control group (see above). Stability over a 1-month period is hardly surprising. But Lachman (1983) reported perfect stability of fluid and crystallized intelligence over a 2-year period in elderly participants in the ADEPT studies. Evidence for longer-term stability has been found in the Seattle Longitudinal Study (SLS) by Hertzog and Schaie (1986a). They found stability of individual differences (high *g* factor covariances) and increases in the overall magnitude of individual differences (increased *g* factor variances) in middle-aged and old participants in the SLS. When standardized, the correlations among *g* at different times of measurement were generally at the .9 level or higher. The high factor covariances indicated that adults were preserving to a remarkable degree their relative orderings about the *g* factor mean over the 14-year interval in all age groups.

It is possible that the stability observed by Hertzog and Schaie (1986a) holds only for *g* but not for the primary abilities measured in the Thurstone PMA battery. Hertzog and Schaie could not test this hypothesis at the level of primary-ability factors, given that the PMA has but one measure of each primary ability. Stability in individual differences in the primary abilities was reflected in significant residual (specific) covariances for the PMA subtests across longitudinal occasions. Additional evidence for stability of individual differences at the primary-ability level was obtained with a model that added five *test-specific* factors to the occasion-specific factors for the groups (see Joreskog & Sorbom, 1977, for explication of similar models in single group designs). Figure 11-3 shows the hypothesized factor-pattern matrix for this model. The test-specific factors were forced to be orthogonal to *g*. The test-specific model allowed Hertzog and Schaie (1986b) to separate the variance in each measure due to test-specific covariance over time by removing it from the residual component. The proportion of variance due to test-specific covariance over time was substantial. For example, 45% of the variance in the PMA subtest Verbal Meaning was unique in the model with residual covariances, but only 12% of its variance was unique when the test-specific Verbal Meaning factor was added. Moreover, the residual variances in the model with test-specific factors were just noticeably larger than one would predict from the published reliabilities of the tests. For instance, the PMA manual reports an estimated reliability of .92 for Verbal Meaning. Thus, it appears that there is substantial stability in individual differences at the primary-ability level as well.

Stability of individual differences should not be confused with changes in the PMA means over time. There are age-related changes in mean performance levels in the SLS, but individual differences are relatively consistent around the means. This point was underscored when a simultaneous analysis of means and covariance structures was conducted by Hertzog and Schaie (1986b). Although there was high stability of individual differences in all three age groups, the means show differential patterns of change with increasing age. In the old, *g* exhibited large declines over the 14-year period (mean ages, 58 through 72 years). On the other hand, the data for the middle-aged group (mean ages, 42 through 56 years) could be modeled as stable in both level and covariance structure. Thus, the results seem to indicate a pattern of relative stability of performance levels during the decades of the 40s and 50s but a shift to a pattern of performance decline following age 60.

Thus, the available evidence strongly suggests that individual differences in intelligence remain highly stable in adulthood, at least for those individuals sufficiently advantaged to participate in longitudinal studies such as the SLS. Further investigation of the stability of individual differences in primary abilities is needed, as are studies of the conditions under which differential change (either positive or negative) is likely to be observed. One circumstance in which differential change might be expected is subsequent to ability training. Individuals might differ in the degree of training benefit, perhaps as a function of prior history of age-related change. Schaie et al. (in press) tested this hypothesis

VARIABLES

| | $g_1$ | $g_2$ | $g_3$ | V | S | R | N | W |
|---|---|---|---|---|---|---|---|---|
| $V_1$ | $\lambda_1$ | 0 | 0 | $\lambda_5$ | 0 | 0 | 0 | 0 |
| $S_1$ | $\lambda_2$ | 0 | 0 | 0 | $\lambda_7$ | 0 | 0 | 0 |
| $R_1$ | 1 | 0 | 0 | 0 | 0 | $\lambda_9$ | 0 | 0 |
| $N_1$ | $\lambda_3$ | 0 | 0 | 0 | 0 | 0 | $\lambda_{11}$ | 0 |
| $W_1$ | $\lambda_4$ | 0 | 0 | 0 | 0 | 0 | 0 | $\lambda_{13}$ |
| $V_2$ | 0 | $\lambda_1$ | 0 | 1 | 0 | 0 | 0 | 0 |
| $S_2$ | 0 | $\lambda_2$ | 0 | 0 | 1 | 0 | 0 | 0 |
| $R_2$ | 0 | 1 | 0 | 0 | 0 | 1 | 0 | 0 |
| $N_2$ | 0 | $\lambda_3$ | 0 | 0 | 0 | 0 | 1 | 0 |
| $W_2$ | 0 | $\lambda_4$ | 0 | 0 | 0 | 0 | 0 | 1 |
| $V_3$ | 0 | 0 | $\lambda_1$ | $\lambda_6$ | 0 | 0 | 0 | 0 |
| $S_3$ | 0 | 0 | $\lambda_2$ | 0 | $\lambda_8$ | 0 | 0 | 0 |
| $R_3$ | 0 | 0 | 1 | 0 | 0 | $\lambda_{10}$ | 0 | 0 |
| $N_3$ | 0 | 0 | $\lambda_3$ | 0 | 0 | 0 | $\lambda_{12}$ | 0 |
| $W_3$ | 0 | 0 | $\lambda_4$ | 0 | 0 | 0 | 0 | $\lambda_{14}$ |

**Figure 11-3.** Factor pattern matrix for the longitudinal factor model including both occasion-specific general intelligence *(g)* and five test-specific factors for the primary abilities. Rows correspond to observed variables, columns to factors. For example, row 1 shows that $V_1$, Verbal Meaning at the first occasion, loads on $g_1$ ($g$ at the first occasion) plus the Verbal Meaning factor (V). (From C. Hertzog & K. W. Schaie, Stability and Change in Adult Intelligence: I. Analysis of Longitudinal Covariance Structures. *Psychology and Aging, 1(2),* 159–171. Copyright © 1986 by the American Psychological Association. Reprinted by permission of the publisher and author.)

by comparing stability of individual differences in their Induction training group, Spatial training group, and no-training control group. Stability of individual differences was high for both training groups and not appreciably lower than in the control group. There was some suggestion of greater individual differences in gain for the Spatial training group. It appears that the type of training program used benefits most if not all individuals and that the variance in change is small relative to the total variance in ability. The advantage of testing the differential stability hypothesis using SEM is that it is estimated for latent variables, thus avoiding the nasty problem of regression to the mean in variables containing measurement error (see Nesselroade, Stigler, & Baltes, 1980).

## STRUCTURAL REGRESSION APPLICATIONS: SELECTED EXAMPLES

One of the major risks in SEM use is that individuals will assume that one is necessarily doing "causal" analysis. This assumption is often erroneous, for causal analysis is not merely (or even primarily) a function of using latent variable regression models (see Hertzog, in press; Mulaik, 1987). The stance taken here is that many, if not most, SEM applications in our field are descriptive, not explanatory, research. In fact, one can argue that SEM is an optimal method for fully informative and valid descriptive work (e.g., Hertzog, in press). Nevertheless, the following discussion of empirical SEM work will be noticeably devoid of causal terminology.

There are to date relatively few cases of full applications of SEM in gerontological research, that is, use of both the measurement model and the structural model to specify and estimate a system of regression equations for latent variables. It is much more common to observe single-indicator path analytic studies. An excellent example of this type of work is the study by Caspi and Elder (1986) on antecedents of life satisfaction for older women differing in social class levels. They used data from the Berkeley Guidance Study to predict life satisfaction in old age (mean age, 70 years) from psychological and social variables measured 40 years earlier. The covariance matrices differed by social class (middle class versus working class). Interviewer rating of emotional health at age 30 (operational definition not fully specified) predicted subsequent life satisfaction for middle-class women but not for working-class women. Conversely, degree of social involvement (operationalized as the number of groups with which an individual has active involvement) predicted life satisfaction for working-class women but not for middle class women. Caspi and Elder's study illustrates some of the benefits of path analytic approaches. The structural regression coefficients are attenuated by measurement error, but this is unavoidable in archival analysis, where multiple indicators are not available for the constructs of interest.

The effects of measurement error can be profound. This point is illustrated in a study by Lair, Hertzog, and Schulenberg (1985), who used LISREL to examine the stability of individual differences in personality. The data were from the Duke Adaptation Study, in which more than 300 adults were measured with Cattell's 16PF (Form C) scale over a 6-year period (four waves of measurement separated by two years). Siegler (1983) summarizes results from the Duke Adaptation Study and reports test–retest correlations in the .5 range for the different subscales of the 16PF. Costa (1986), in reviewing the literature on stability of personality, argued that these data show almost perfect stability of individual differences because of the likely degree of attenuation due to measurement error. His argument was based in part on the fact that Form C of the 16PF is less reliable than the more commonly used combined Forms A and B. Although it is likely that the attenuation is substantial, what is needed is a point estimate of the disattenuated stability of individual differences. A common practice is to correct for attenuation by using published estimates of reliability or, alternatively, to invoke assumptions such as those used by Heise (1969) to arrive at an estimate of stability in longitudinal data. Neither approach is fully satisfactory; in particular, use of corrections for attenuation can *overestimate* stability if the reliability estimates are inaccurate for the subpopulation under study. It is preferable to estimate the disattenuated stability directly using SEM techniques.

Lair et al. (1985) did so for the two second-order factors of neuroticism and extraversion. Three indicators of each factor were selected (Outgoing, Happy-Go-Lucky, and Venturesome for Extraversion; Stable, Controlled, and Tense for Neuroticism). An SEM analysis was used to estimate stabilities using a *first-order autoregressive model* (e.g., Joreskog & Sorbom, 1977). Autoregressive models can be used to study predictors of individual differences in change at the level of the latent variables. The autoregressive coefficients reflect the degree of stability in individual differences. Additional variables that also predict a latent variable, controlling for autoregression, are in essence predicting individual differences in change between the two time points (Kessler & Greenberg, 1981; but see Rogosa & Willett, 1985). In the Lair et al. analysis, no additional latent variables other than Neuroticism and Extraversion were measured, so the focus was merely on a descriptive analysis of individual differences in stability. Interest, then, centered on the magnitude of the autoregressive coefficients and residual variances. Figure 11-4 shows the model results for one-half of the sample. Although the original model estimated metric (unstandardized) regression coefficients, standardized coefficients are shown in Figure 11-4. As can be seen, the disattenuated stability coefficients (the regression of N2 on N1, etc.) are uniformly high, and in some cases close to 1. The differences between the zero-order (simple) regression coefficients and the LISREL estimates of stability are profound. Figure 11-4 shows why this is so; the factor loadings for both measures are small, and measurement error has been absorbed into the residual variances. The model did estimate correlated residuals (not shown in Figure 11-4), so it is the case that there is reliable but specific variance in the residual terms. Nevertheless, it is clear that the results support Costa's (1986) contention that these data indicate substantial stability of individual differences in the personality factors of neuroticism and extraversion.

The Lair et al. (1985) analysis is in some senses the minimum structural regression model that might be contemplated. No predictors or outcomes of the two personality variables were included in the analysis, which focused exclusively on the stability of individual differences. The only conclusion that can be drawn about predictors of change in such models occurs only in the situation when individual differences are *perfectly stable* over time (i.e, there are no individual differences in change, at the level of the latent variable, to be predicted). With stabilities in the range reported by Lair et al. (1985), there is

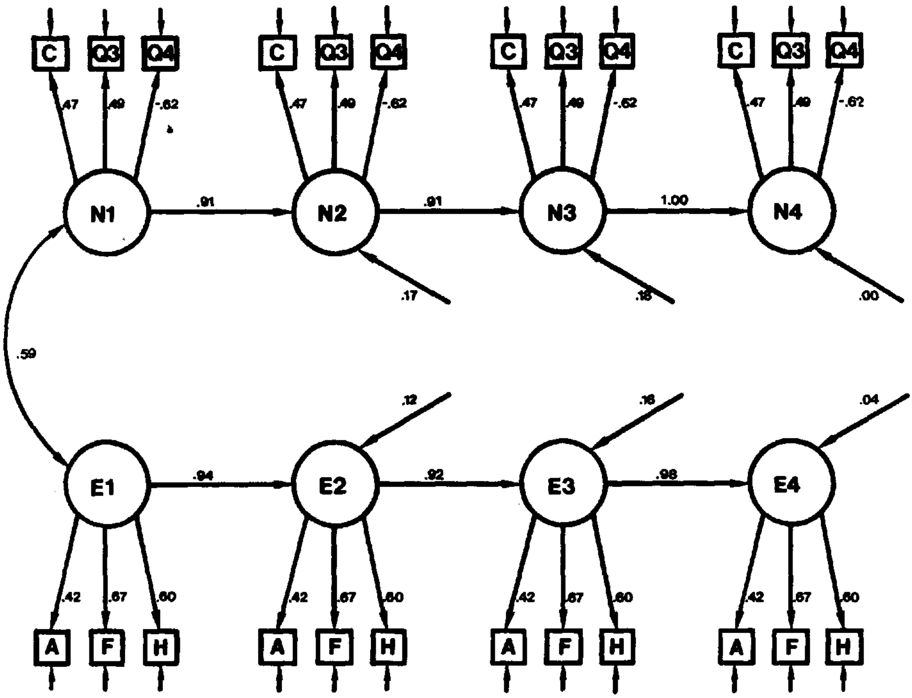


**Figure 11-4.** Model estimated by Lair et al. for two personality factors, Neuroticism (N) and Extraversion (E), measured at four longitudinal occasions. All regression coefficients have been rescaled to a standardized metric. Stability of individual differences in N and E is quite high over time, with all standardized stability coefficients exceeding .9.

relatively little variance residual to autoregression that could be accounted for by other variables, but nevertheless, the major problem is finding the appropriate variables.

The analysis by Lachman (1983), discussed above in terms of the longitudinal factor model, also included a structural regression analysis. Recall that Lachman (1983) found that the stability of individual differences in fluid and crystallized intelligence was essentially perfect (factor correlations of 1.0) for older persons measured 2 years apart. This result indicates that no analysis of predictors of change in these abilities would be particularly useful (although predictors of initial level of ability could be analyzed). However, Lachman (1983) did find less than perfect stability (a factor correlation of .70) for the memory span factor. Given that the LISREL estimate of stability is disattenuated for measurement error, one can conclude that about half of the variance in memory span is independent of autoregression and, hence, is change-related variance available for prediction by other variables.

Lachman (1983) investigated the degree to which perceptions of personal control and control specific to the domain of intelligence predicted change in memory span over the 2-year period. To do so, she assessed the degree to which latent variables from these two domains (e.g., intellectual self-efficacy, defined as beliefs in one's own competence in situations requiring intelligent behavior), measured at the start of the study (Occasion 1), predicted memory span at Occasion 2. Lachman freely estimated the correlations of these variables with memory span at Occasion 1, thus requiring that any prediction of memory span at Occasion 2 be independent of the Occasion 1 relationships. Lachman found that a model specifying only autoregression of memory span on itself fit reasonably well and that the fit could not be improved by adding lagged regression coefficients of general and intelligence-specific control beliefs. Figure 11-5 reproduces the essential results. A model focused on measuring predictors of change in Intellectual Self-Efficacy showed (1) the stability of that factor to be relatively low, and (2) changes in Intellectual Self-Efficacy to be predicted by general internal locus of control at Occasion 1. High internals are more likely to maintain or increase their perceived intellectual self-efficacy over time.

Liang (1986) recently reported a model for the determinants of self-rated physical health in adults, using data from the 1968 National Senior Citizens survey to predict self-ratings of physical health from four other latent variables (chronic illness, sick days, self-maintenance, and instrumental activities). The recursive SEM model specified multiple relations among these endogenous variables as well. All possible recursive paths were estimated (so the model is just-identified in structural equations) in the order of variables just listed. That is, Liang postulated that chronic illness would influence sick days, chronic illness and sick days would influence self-maintenance, and so on. Self-rated health was defined as a latent variable determining ratings such as "how good is your health" and "how good is your health compared to others your age." Chronic illness was measured by self-nomination of three problems characterized as "lasting or continuing." Liang used the approach of having eight domains of chronic illness (e.g., circulatory, respiratory) treated as exogenous variables that determined the latent variable of chronic illness. By fixing the residual variance of chronic illness to zero, Liang implicitly defined the chronic illness variable to be a linear composite of the eight health conditions, with weights determined (identified) by the relationship of chronic illness to the other latent variables.

Liang's (1986) results suggest a substantial relationship between self-report chronic disease conditions and self-rated health. The direct effect of chronic illness on rated health averaged –.36 across four subsamples. Liang computed effects decomposition for one of the samples, in which the relationship of a "cause" on an "effect" variable is partitioned into a direct effect (the actual regression weight of effect on cause) and indirect effects (the relationship mediated through other causes). The total effect (direct + indirect) of chronic illness on self-rated health was –.53. In addition, Liang found that instrumental activities (e.g., driving, taking a trip, gardening) had a substantial impact on

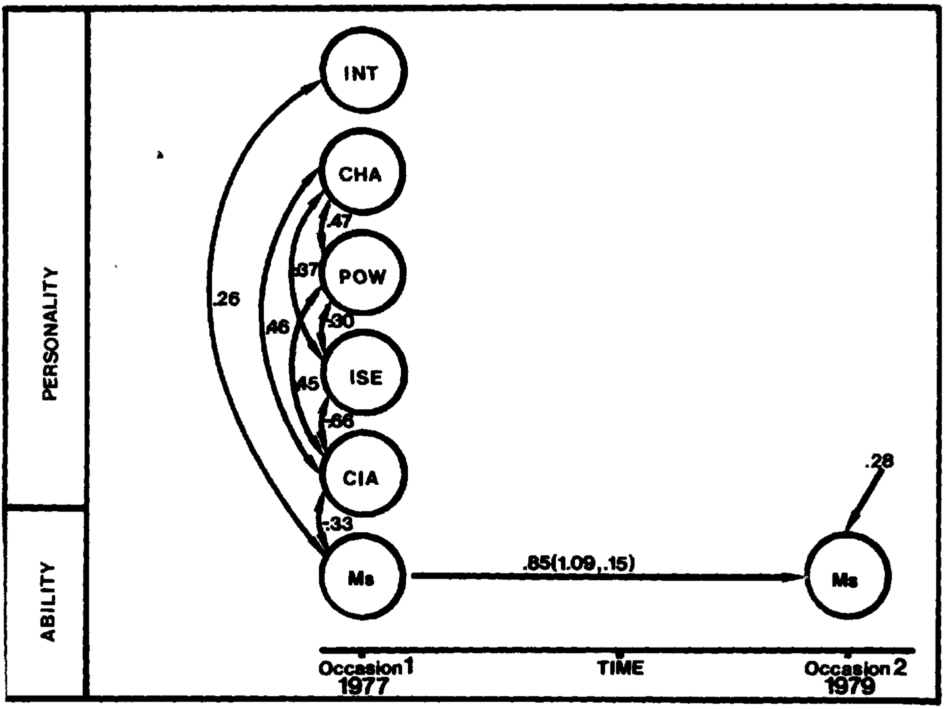


**Figure 11-5.** Lachman's model of change in memory span in elderly adults (INT, Internal Control; CHA, Chance Control; POW, Powerful Others Control; ISE, Intellectual Self-Efficacy; CIA, Concerns about Intellectual Aging; Ms, Memory Span). None of the personality factors significantly predicted change in memory span, with the only significant relationship being the autoregression (stability coefficient) of memory span on itself. Adapted with permission from Lachman (1983).

self-rated health independent of chronic illness. The model and results are intriguing and open several possibilities with respect to the relationship of subjective health perceptions to other variables, some of which are discussed by Liang.

## SEM MODELS FOR MEASUREMENT PROPERTIES OF SCALES

Schaie and Hertzog (1985) discuss in great detail the literature on SEM procedures for estimating reliability and equivalence of measurement properties across multiple populations. One recent application nicely illustrates two important concepts: (1) the distinction between *scale reliability* and *stability of individual differences* and (2) the use of alternate forms to reveal information about the measurement properties of scales. Hertzog and Nesselroade (1987) reanalyzed data originally collected by Nesselroade, Mitteness, and Thompson (1984). It consisted of self-ratings of elderly individuals of two mood state factors: Anxiety and Fatigue. The design involved a short-term retest, so individuals were given the mood state questionnaires twice, with approximately 1 month intervening between administrations. The three measures of State Anxiety included Spielberger's State Anxiety scale and Forms A and B of Curran and Cattell's Eight State Questionnaire. The three measures of Fatigue were subsets of items from the Eight State Fatigue scale. Nesselroade et al. (1984) demonstrated that the Anxiety and Fatigue factors could be identified using confirmatory factor analysis, and that the stability of individual differences in Anxiety was substantial, but not perfect, over the 1-month period.

Hertzog and Nesselroade (1987) reanalyzed the Nesselroade et al. (1984) data, focusing on estimating the measurement properties of the Forms A and B of the Eight State Questionnaire. The model, shown in Figure 11-6, closely resembles the longitudinal factor models described earlier. It specified that the three scales of state anxiety loaded on an Anxiety factor and that there was a residual covariance for the Spielberger scale across the two measurement occasions. In a series of models, Hertzog and Nesselroade (1987) tested whether the Cattell Forms A and B could be considered parallel forms. They also tested whether the measurement properties of Forms A and B were equivalent across the two measurement occasions. The hypothesis of parallelism was tested by constraining factor loadings and residual variances (error variances of measurement) to be equal for Forms A and B. The test of equivalence over time was made by constraining these parameters equal across the first and second administrations of the questionnaires. The results showed clearly that Forms A and B were parallel and that the measurement properties of Forms A and B were identical over the two occasions of measurement. The estimated reliability for Forms A and B was 89. Clearly, the Eight State Anxiety scales have excellent measurement properties in older populations.

The high reliabilities for the scales contrast with the moderate (but lower) stabilities of individual differences in the latent variable, Anxiety. As discussed above, the stability of individual differences is reflected in the covariance between the latent Anxiety factors over the two measurement points. Using the parameter estimates from the Hertzog and Nesselroade (1987) analysis, an estimate of .72 is obtained for the *disattenuated* correlation of Anxiety with itself over a 1-month period. This correlation was certainly greater than 0 but less than 1.0, indicating individual differences in mood state change over the 1-month interval. There is a marked contrast between the short-term stability of Anxiety and the long-term stability of intelligence and personality found in the studies already reviewed. Individuals who are anxious at Time 1 are likely to be anxious

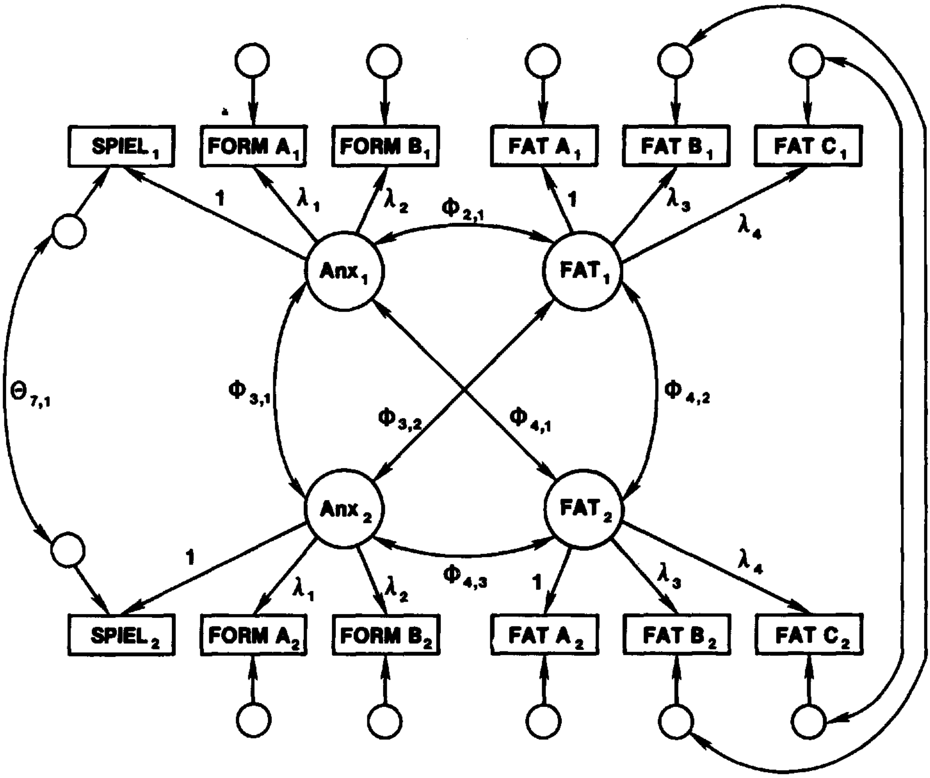


**Figure 11-6.** SEM for two mood state factors, Anxiety (ANX) and Fatigue (FAT), measured at two longitudinal occasions. For Anxiety, three measures were available: Spielberger's State Anxiety Scale (SPIEL) and two alternate forms of the 8-State Anxiety scale (FORM A, FORM B). A series of models tested the measurement properties of these alternate forms and their relationship to SPIEL at the two occasions (see text). Reprinted with permission from Hertzog and Nesselroade (1987).

at Time 2, but only about 50% of the variance in self-reported anxiety at Time 2 can be predicted from anxiety levels at Time 1. The most important feature of the analysis, however, is that this stability of individual differences has been estimated in a way that disentangles it from reliability. Using SEM, one can reject the hypothesis that the less-than-perfect stability is a function of attenuation due to measurement error. Conversely, the analysis shows that the lability in mood states does not imply that the mood state measures are unreliable. Given that one would expect mood states to fluctuate, the lability of Anxiety and the excellent measurement properties of Forms A and B argue indirectly for the construct validity of the scales and suggest that they measure something different from the personality trait of Anxiety, which has been shown to exhibit a high degree of stability of individual differences.

## CONCLUDING COMMENTS

This paper has reviewed a number of recent research studies using SEM approaches to address important research questions in gerontology. In a sense, the SEM technology is in its adolescent phase. The last several years have witnessed major growth in techniques and modeling applications, although our understanding of the potential and pitfalls of SEM has not yet reached full maturity. On the other hand, use of these approaches in gerontological research seems more accurately characterized as being in its infancy. In a few isolated areas, mostly related to psychometric theory and practice, SEM measurement models have been used to improve our understanding of constructs and measures relevant to aging and have led to some substantive advances in the literature. At this point, however, the major contributions of this class of technique—particularly applications of structural regression models for describing and explaining change—have yet to be realized. It is hoped that this chapter has succeeded in outlining some of the current (albeit modest) successes and whetted our collective appetites for more in the future. A measure of progress would be if future *Annual Reviews* did *not* contain chapters on SEM applications per se because use of the technique was sufficiently widespread and well understood that the results of SEM studies were treated as best covered in substantively oriented reviews of age-related phenomena.

## REFERENCES

Baltes, P. B., Cornelius, S. W., Spiro, A. Nesselroade, J. R., & Willis, S. L. (1980). Integration versus differentiation of fluid/crystallized intelligence in old age. *Developmental Psychology, 16,* 625–635.

Baltes, P. B., & Nesselroade, J. R. (1973). The developmental analysis of individual differences on multiple measures. In J. R. Nesselroade & H. W. Reese (Eds.), *Life-span developmental psychology: Methodological issues* (pp. 219–252). New York: Academic Press.

Baltes, P. B., Reese, H. W., & Nesselroade, J. R. (1977). *Life-span developmental psychology: Introduction to research methods.* Monterey, CA: Brooks-Cole.

Bengtson, V. L., Reedy, M. N., & Gordon, C. (1985). Aging and self-conceptions: Personality processes and social contexts. In J. E. Birren & K. W. Schaie (Eds.), *Handbook of the psychology of aging* (2nd ed.) (pp. 544–593). New York: Van Nostrand Reinhold.

Bentler, P. M. (1973). Assessment of developmental factor change at the individual and group level. In J. R. Nesselroade & H. W. Reese (Eds.), *Life-span developmental psychology: Methodological issues* (pp. 145–174). New York: Academic Press.

Birren, J. E. (1965). Age changes in the speed of behavior: Its central nature and physiological correlates. In A. T. Welford & J. E. Birren (Eds.), *Handbook of aging, behavior, and the nervous system* (pp. 191–216). Springfield, IL: Charles C Thomas.

Blalock, H. M., Jr. (1982). *Conceptualization and measurement in the social sciences.* Beverly Hills, CA: Sage.

Blalock, H. M., Jr. (Ed.). (1985a). *Causal models in panel and experimental designs.* Chicago: Aldine.

Blalock, H. M., Jr. (Ed.). (1985b). *Causal models in the social sciences* (2nd Ed.). Chicago: Aldine.

Botwinick, J. (1977). Intellectual abilities. In J. E. Birren & K. W. Schaie (Eds.), *Handbook of the psychology of aging* (pp. 580–605). New York: Van Nostrand Reinhold.

Campbell, R. T., & Mutran, E. (1982). Analyzing panel data in studies of aging: Applications of the LISREL model. *Research in Aging, 4,* 3–41.

Caspi, A., & Elder, G. H. (1986). Life satisfaction in old age: Linking social psychology and history. *Psychology and Aging, 1,* 18–26.

Cattell, R. B. (1971). *Abilities: Their structure, growth, and action.* Boston: Houghton-Mifflin.

Cook, T. D., & Campbell, D. T. (1979). *Quasi-experimentation: Design and analysis issues for field settings.* Chicago: Rand McNally.

Cornelius, S. W., Willis, S. L., Nesselroade, J. R., & Baltes, P. B. (1983). Convergence between attention variables and factors of psychometric intelligence in older adults. *Intelligence, 7,* 253–269.

Costa, P. T., Jr. (1986, August). *Psychosocial continuity in adulthood: Personality, abilities, social support, and well-being.* Paper presented at the 94th annual convention of the American Psychological Association, Washington, DC.

Costa, P. T., Jr., & McCrae, R. R. (1980). Still stable after all these years: Personality as a key to some issues in adulthood and old age. In P. B. Baltes & O. G. Brim, Jr. (Eds.), *Life-span development and behavior,* Vol. 3 (pp. 65–102). New York: Academic Press.

Cunningham, W. R. (1978). Principles for identifying structural differences: Some methodological issues related to comparative factor analysis. *Journal of Gerontology, 33,* 82–86.

Cunningham, W. R. (1980). Age comparative factor analysis of ability variables in adulthood and old age. *Intelligence, 4,* 133–149.

Cunningham, W. R. (1981). Ability factor structure difference in adulthood and old age. *Multivariate Behavioral Research, 16,* 3–22.

Cunningham, W. R., & Birren, J. E. (1980). Age changes in the factor structure of intellectual abilities in adulthood and old age. *Educational Psychological Measurement, 40,* 271–290.

Cunningham, W. R., & Owens, W. A., Jr. (1983). The Iowa State Study of the adult development of intellectual abilities. In K. W. Schaie (Ed.), *Longitudinal studies of adult psychological development* (pp. 20–39). New York: Guilford.

Dwyer, J. H. (1983). *Statistical models for the social and behavioral sciences.* New York: Oxford University Press.

Gustafsson, J.-E. (1984). A unifying model for the structure of intellectual abilities. *Intelligence, 8,* 179–203.

Hayslip, B., Jr., & Brookshire, R. G. (1985). Relationships among abilities in elderly adults. A time lag analysis. *Journal of Gerontology, 40,* 748–750.

Heise, D. R. (1969). Separating reliability and stability in test-retest correlation. *American Sociological Review, 34,* 93–101.

Hertzog, C. (1985a). Applications of confirmatory factor analysis to the study of intelligence. In D. K. Delterman (Ed.), *Current topics in human intelligence* (pp. 59–97). Norwood, NJ: Ablex.

Hertzog, C. (1985b). An individual differences perspective: Implications for cognitive research in gerontology. *Research on Aging, 7,* 7–45.

Hertzog, C. (in press). On the utility of structural regression models for developmental research. In P. B. Baltes, D. Featherman, & R. M. Learner (Eds.), *Life-span development and behavior,* Vol. 10. Hillsdale, NJ: Erlbaum.

Hertzog, C., & Nesselroade, J. R. (1987). Beyond autoregressive models: Some implications of the trait-state distinction for the structural modeling of developmental change. *Child Development, 53,* 93–109.

Hertzog, C., Raskind, C. L., & Cannon, C. J. (1986). Age-related slowing in semantic information processing speed: An individual differences analysis. *Journal of Gerontology, 41,* 500–502.

Hertzog, C., & Schaie, K. W. (1986a). Stability and change in adult intelligence: 1. Analysis of longitudinal covariance structures. *Psychology and Aging, 1,* 159–171.

Hertzog, C., & Schaie, K. W. (1968b). *Stability and change in adult intelligence: 2. Simultaneous analysis of longitudinal means and covariance structures.* Unpublished manuscript.

Horn, J. L. (1978). Human ability systems. In P. B. Baltes (Ed.), *Life-span development and behavior,* Vol. 1 (pp. 211–256). New York: Academic.

Horn, J. L., & McArdle, J. J. (1980). Perspectives on mathematical/statistical model building (MASMOB) in research on aging. In L. W. Poon (Ed.), *Aging in the 1980's: Psychological issues* (pp. 503–541). Washington, DC: American Psychological Association.

Horn, J. L., McArdle, J. J., & Mason, R. (1984). When is invariance not invariant: A practical scientist's look at the ethereal concept of factor invariance. *Southern Psychologist, 1,* 179–188.

Hultsch, D. F., Hertzog, C., & Dixon, R. A. (1984). Text processing in adulthood: The role of intellectual abilities. *Developmental Psychology, 20,* 1193–1209.

Joreskog, K. G. (1979). Statistical estimation of structural models in longitudinal developmental investigations. In J. R. Nesselroade & P. B. Baltes (Eds.), *Longitudinal research in the study of behavior and development* (pp. 303–351). New York: Academic.

Joreskog, K. G., & Sorbom, D. (1977). Statistical models and methods for analyses of longitudinal data. In D. S. Aigner & A. S. Goldberger (Eds.), *Latent variables in socio-economic models* (pp. 285–325). Amsterdam: North Holland.

Joreskog, K. G., & Sorbom, D. (1979). *Advances in factor analysis and structural equation models.* Cambridge, MA: Abt Associates.

Joreskog, K. G., & Sorbom, D. (1980). *Simultaneous analysis of longitudinal data from several cohorts.* Research Report 80-5. Uppsala, Sweden: University of Uppsala, Department of Statistics.

Joreskog, K. G., & Sorbom, D. (1984). *LISREL VI user's guide*. Mooresville, IN: Scientific Software.
Kagan, J. (1980). Perspectives on continuity. In O. G. Brim, Jr., & J. Kagan (Eds.), *Constancy and change in human development*. Cambridge, MA: Harvard University Press.
Kessler, R. C., & Greenberg, D. F. (1981). *Linear panel analysis*. New York: Academic Press.
Lachman, M. E. (1983). Perceptions of intellectual aging: Antecedent or consequence of intellectual functioning? *Developmental Psychology, 19*, 482–498.
Lair, T. J., Hertzog, C., & Schulenberg, J. E. (1985). *Stability of personality in adulthood: A structural equation model*. Paper presented at the 38th annual meetings of the Gerontological Society, New Orleans.
Liang, J. (1986). Self-reported physical health among aged adults. *Journal of Gerontology, 41*, 248–260.
McArdle, J. J. (1986). *Latent growth curves within developmental structural equation models*. Unpublished manuscript.
McArdle, J. J., & McDonald, R. P. (1984). Some algebraic properties of the reticular action model for moment structures. *British Journal of Mathematical and Statistical Psychology, 37*, 234–251.
McDonald, R. P. (1978). A simple comprehensive model for the analysis of covariance structures. *British Journal of Mathematical and Statistical Psychology, 31*, 59–72.
McDonald, R. P. (1981). The dimensionality of tests and items. *British Journal of Mathematical and Statistical Psychology, 34*, 100–117.
Messick, S. (1981). Constructs and their vicissitudes in educational and psychological measurement. *Psychological Bulletin, 89*, 575–588.
Mulaik, S. A. (1987). Toward a conception of causality applicable to experimentation and causal modelling. *Child Development, 58*, 18–32.
Nesselroade, J. R., & Baltes, P. B. (1979). *Longitudinal research in the study of behavior and development*. New York: Academic Press.
Nesselroade, J. R., & Baltes, P. B. (1984). From traditional factor analysis to structural-causal modeling in developmental research. In V. Sarris & A. Parducci (Eds.), *Experimental psychology in the future* (pp. 267–287). Hillsdale, NJ: Erlbaum.
Nesselroade, J. R., Mitteness, L. S., & Thompson, L. K. (1984). Short-term changes in anxiety, fatigue, and other psychological states in older adulthood. *Research on Aging, 6*, 3–23.
Nesselroade, J. R., Stigler, S. M., & Baltes, P. B. (1980). Regression toward the mean and the study of change. *Psychological Bulletin, 88*, 622–637.
Olsson, V., & Bergman, L. R. (1977). A longitudinal factor model for studying change in ability structure. *Multivariate Behavioral Research, 12*, 221–241.
Petros, T. V., Zehr, H. D., & Chabot, R. J. (1983). Adult age differences in accessing and retrieving information from long-term memory. *Journal of Gerontology, 38*, 589–592.
Reinert, G. (1970). Comparative factor analytic studies of intelligence throughout the human life span. In L. R. Goulet & P. B. Baltes (Eds.), *Life-span developmental psychology: Research and theory* (pp. 467–484). New York: Academic.
Riegel, K. F., & Riegel, R. M. (1972). Development, drop, and death. *Developmental Psychology, 6*, 306–319.

Rogosa, D. (1979). Causal models in longitudinal research: Rationale, formulation, and estimation. In J. R. Nesselroade & P. B. Baltes (Eds.), *Longitudinal research in the study of behavior and development.* (pp. 263–302). New York: Academic.

Rogosa, D. (1980). A critique of cross-lagged correlation. *Psychological Bulletin, 88,* 245–258.

Rogosa, D., & Willett, J. B. (1985). Understanding correlates of change by modeling individual differences in growth. *Psychometrika, 50,* 203–228.

Salthouse, T. A. (1985). *A theory of cognitive aging.* Amsterdam: North Holland.

Schaie, K. W., & Hertzog, C. (1982). Longitudinal methods. In B. B. Wolman (Ed.), *Handbook of Developmental Psychology* (pp. 91–115). Englewood Cliffs, NJ: Prentice-Hall.

Schaie, K. W., & Hertzog, C. (1985). Measurement in the psychology of adulthood and aging. In J. E. Birren & K. W. Schaie (Eds.), *Handbook of the psychology of aging* (2nd ed.). New York: Van Nostrand Reinhold.

Schaie, K. W., Willis, S. L., Hertzog, C., & Schulenberg, J. E. (In press). *Effects of cognitive training upon primary mental ability structure. Psychology and Aging, 2.*

Siegler, I. C. (1983). Psychological aspects of the Duke Longitudinal Studies. In K. W. Schaie (Ed.), *Longitudinal studies of adult psychological development* (pp. 136–190). New York: Guilford.

Stricker, L. J., & Rock, D. A. (1985). *The structure of the GRE General Test for Older Examinees: A confirmatory factor analysis.* Unpublished technical report. Educational Testing Service, Princeton, NJ.

*This page intentionally left blank*

CHAPTER 12

# Assessment of Depression and Dementia During the Late Years

LARRY W. THOMPSON
GERIATRIC RESEARCH, EDUCATION AND CLINICAL CENTER (GRECC)
VETERANS ADMINISTRATION MEDICAL CENTER
PALO ALTO, CALIFORNIA
STANFORD UNIVERSITY SCHOOL OF MEDICINE,
STANFORD, CALIFORNIA

VINCENT GONG
DEPARTMENT OF PSYCHIATRY
UNIVERSITY OF CALIFORNIA SCHOOL OF MEDICINE
SAN FRANCISCO, CALIFORNIA

EDMUND HASKINS
COMMUNITY HOSPITAL OF INDIANAPOLIS
INDIANAPOLIS, INDIANA

DOLORES GALLAGHER
GERIATRIC RESEARCH, EDUCATION AND CLINICAL CENTER (GRECC)
VETERANS ADMINISTRATION MEDICAL CENTER
PALO ALTO, CALIFORNIA
STANFORD UNIVERSITY SCHOOL OF MEDICINE,
STANFORD, CALIFORNIA

Probably the most frequent assessment question encountered by the psychologist working with the elderly involves the determination of whether observed or self-reported cognitive declines are due to progressive dementia or some type of psychiatric disturbance (most often depression) or are simply a reflection of changes presumed to occur with normal aging.

This work was supported in part by grants #R01-MH37196 and T01-MH17621 from the National Institute of Mental Health to Larry W. Thompson.

Although results from psychological tests are an integral part of this assessment process, there are few, if any, occasions when these will provide sufficient information to make a differential diagnosis independent of information from other disciplines. The clinician must therefore have a working knowledge of pertinent concepts and testing procedures in psychiatry, psychology, the neural sciences, clinical pharmacology, social work, dietetics, occupational therapy, and nursing and must be prepared to integrate findings from these and perhaps other subspecialties into a final summarization of probable causes and possible treatments.

## DEPRESSION

Depression is the most frequent emotional disorder reported in the elderly at present. Community surveys (e.g., Gaitz, 1977) have reported the presence of some depressive symptoms in the majority of elderly persons. Elders with sufficient symptoms to be diagnosed as clinically depressed are found less often. Point prevalence is reported between 2 and 7%, and lifetime rates are 18 to 20% (Blazer & Williams, 1980; Gurland, 1976; Vernon & Roberts, 1982).

The primary feature of most clinical depressions is dysphoria—a feeling of being sad, down-hearted, or blue. However, in order to meet criteria for a diagnosis of clinical depression, a number of other symptoms must be present for a specified period of time. Some of the other, more telling symptoms include loss of interest, fatigue or lack of energy, sleep and appetite problems, guilt, psychomotor agitation or retardation, inability to concentrate, and problems with making everyday decisions. The specific criteria for a diagnosis can be found in the Research Diagnostic Criteria (RDC) (Spitzer, Endicott, & Robins, 1978) or the American Psychiatric Association's Diagnostic and Statistical Manual of Mental Disorders (DSM-III) (APA, 1980).

A comprehensive evaluation of depression should include both a self-report measure and a behavioral rating. Although they are usually highly correlated, each can provide unique information helpful to the final diagnostic formulation. There are quite a number of scales and interview schedules designed to assess depressive symptoms (for reviews, see Brink, 1986; Gallagher, 1986; Kane & Kane, 1981; Raskin & Jarvik, 1979). We have selected several of the more frequently used scales that seem representative of available instruments to discuss here, but this list is by no means exhaustive, nor do we make any claim that these scales are necessarily preferred for all settings.

### Interview Techniques for the Assessment of Depression

*Schedule for Affective Disorders and Schizophrenia (SADS).* The SADS (Spitzer & Endicott, 1978) is used in most clinical research programs on depression, and it is currently regarded as the "gold standard" in this field. It is a structured interview with two parts containing more than 100 questions each. One part deals with historical information and the other with current status. This instrument is designed to explore in depth the multiple aspects of depression. It is intended for use by clinicians who have been trained to discern the degree to which symptoms are present or absent and to rate their severity on a multidimensional scale of duration and intensity. There are also questions dealing with psychotic processes, drug abuse, and alcoholism. Data collected with the SADS are used in conjunction with other information to make classifications of patients according to criteria listed in the RDC or DSM-III.

The SADS minimizes the variations typically seen in diagnostic interviewing by means of a standardized format. If interviewers are properly trained, reliability is extremely high (Endicott & Spitzer, 1978). The SADS provides a rich source of data about a patient's depression that is not tapped by other instruments so that it is possible to classify subtypes of depression with greater precision. The interview is tolerated well by older persons, despite its length. Disadvantages of the SADS include the lengthy training needed to administer and score the items, as well as the amount of clinical experience required in order to assure reliability. It also needs to be supplemented by other sources of information regarding medical condition, mental status, medication usage, and the like to minimize confusion concerning the underlying mechanisms responsible for a number of age-related symptoms.

*Diagnostic Interview Schedule (DIS).* The DIS was used in the multisite Epidemiological Catchment Area survey to determine the prevalence of psychiatric disorders in adults. Older adults were oversampled in this survey to assure an adequate sample of epidemiological data on the prevalence of psychiatric disorders across the life span (Regier et al., 1984). There are 254 questions in this interview, but many are contingency items. The interview is highly structured, and questions are worded so that respondents are encouraged to reply with brief answers.

The DIS takes only about an hour or a little more to administer. Interviewers need minimal formal training in psychology or psychiatry to administer and score the test items. It was designed specifically to provide information for Axis I diagnoses in DSM-III, and therefore it has a broader scope than the SADS. In cases of ambiguity the interview has specific probe items. A computerized scoring system has been developed that may decrease bias and increase accuracy of decision making about diagnoses (Robins, Helzer, Croughan, & Ratcliff, 1981).

The DIS is heavily loaded with items pertaining to drug abuse, alcoholism, acting-out disorders, and so on. Many of these items are inappropriate when questioning elderly individuals. In our opinion there are some clinical situations where the vast number of these kinds of questions, in combination with the manner in which they are presented, may serve to curtail the older person's inclinations to disclose other information that might reflect the presence of psychopathology.

*Comprehensive Assessment and Referral Evaluation (CARE).* The CARE is a multidimensional assessment device that inquires about the psychiatric, medical, nutritional, economic, and social status of the respondent. This assessment package has 22 "indicator scales" that highlight specific problem areas where individuals may need assistance to improve their quality of life. The development and current status of the CARE is reviewed in several papers (Gurland et al., 1977; Gurland & Wilder, 1984). A briefer version, called the SHORT-CARE, was designed specifically to assess depression and dementia, and an 11-item screening schedule assesses quickly whether additional evaluation for depression and dementia is necessary (Gurland, Golden, Teresi, & Challop, 1984).

The CARE has enjoyed meticulous conceptual and psychometric refinement over the years, and the payoff has been fruitful in terms of its comprehensiveness, reliability, and validity. It directs the clinician to focus on the multiple problems that elders may be experiencing, and it provides sensitive probes to ascertain the underlying basis of any psychiatric disorders, along with strategies for referral or other treatment approaches. To be effective this instrument should be used by highly trained professionals who have had considerable experience in working with the elderly.

*Hamilton Rating Scale for Depression (HRSD).* The HRSD was designed to assess the level of depression (Hamilton, 1967). Over the past two decades it has remained the most commonly used rating scale for level of depression in clinical research settings. The HRSD relies heavily on the skill of the interviewer to elicit the information required to make ratings on each item. A skilled interviewer can obtain sufficient information to make the ratings in about 30 min. The original version of the scale contained 21 items, 17 of which related to depression. Often the scale is administered by two interviewers, and the patient's score is the average of the ratings made by both.

This scale has numerous psychometric problems, and it is surprising that they have not been remedied long before now. Some items rate severity or frequency along one dimension; others include several dimensions, and the weighing may shift from a frequency to an intensity factor depending on what particular dimension seems predominant. Despite the problems with this measure, most laboratories report high reliability, and many researchers working with affective disorders clearly feel that this scale provides a common denominator for communicating information about the level of depression across samples. Perhaps more problematic for its use with elders is its heavy weighting on somatic items (Carroll, Fielding, & Blashki, 1973; Schwab, Bialow, Holzer, Brown, & Stevenson, 1967). Because of this, scores for elderly persons could be inflated because of legitimate health problems, not depression. To avoid such confounds the interviewer must be exquisitely sensitive to the older person's health status and consider this in making final ratings on somatic items included in the scale.

**Self-rating Scales of Depression**

Self-report scales are plagued with many of the same problems that occur when using interview techniques with the elderly. Many elders are reluctant to admit they are experiencing psychological distress (Raskin, 1979; Salzman & Shader, 1979) either because of a need to look healthy or because they are not well informed about the nature of psychopathology and how this might relate to their own experiences. The high prevalence of somatic complaints may also tend to inflate scores on a self-report scale, and this is particularly bothersome for those scales that rely heavily on the contribution of somatic factors to the severity of depression. There is also the problem of medication side effects, which may precipitate depression-like symptoms. Self-report scales currently available have no mechanism to account for these problems, and therefore it is essential to obtain information about a person's health status and medication usage to supplement test results.

*Zung Self-rating Depression Scale (SDS).* The Zung SDS (Zung, 1965) is one of the most popular self-report scales available. It contains 20 items reflecting common symptoms of depression. Respondents must make a judgment as to the duration of time a given symptom is present along a 4-point scale that ranges from "none of the time" to "all of the time." It has been used extensively in clinical research projects as an index of the level of depression, and there are about a dozen studies dealing specifically with age as a variable (cf. Zung & Zung, 1986). Although it has reasonable reliability when used with young subjects and with individuals in their sixties, there is some question regarding its reliability when used with samples over age 70 (McGarvey, Gallagher, Thompson, & Zelinski, 1982). There is also some question regarding its effectiveness to discriminate depressed from nondepressed in elderly samples. Using a cutoff score of 40, Zung and Green (1973) report that the SDS correctly identified 88% of a depressed sample but falsely identified slightly over 40% of the normal elderly as being depressed.

*Beck Depression Inventory (BDI).* Recent data suggest that the BDI (Beck, Ward, Mendelson, Mock, & Erbaugh, 1961) may be a reliable and valid screening instrument to use with elderly samples (Gallagher, Breckenridge, Steinmetz, & Thompson, 1983; Gallagher, Nies, & Thompson, 1982). It contains 21 items that are rated on a 4-point intensity (rather than frequency) dimension. Gallagher et al. (1983), using a sample of 102 elders seeking treatment for depression, found that 91% of those scoring 17 or greater on the BDI were independently diagnosed as being in an episode of major depression, using the SADS interview and RDC classification system. Also, 81% of those scoring 10 or less on the BDI did not meet criteria for any RDC-specified depressive disorder.

*Brief Symptom Inventory (BSI).* The BSI is an abbreviated version of the SCL-90 (Derogatis, 1977) containing 53 items that measure psychopathology along nine dimensions, including depression. Since the BSI contains a somatization subscale, its depression subscale (composed of 6 items) is free of somatic concerns. The entire scale takes about 20 min to complete. Norms are available on all nine subscales for older persons grouped by sex (Hale, Cochran, & Hedgepeth, 1984). General scoring information can be found in Derogatis and Spencer (1982).

*Geriatric Depression Scale (GDS).* The GDS was designed by Yesavage and colleagues (1983) to be a brief measure of depression in the elderly. None of its 30 items is somatic in focus; rather, items tap psychological distress (e.g., perceived helplessness, hopelessness, and lack of satisfaction with life). All items are answered in a yes/no format for ease of comprehension by even cognitively impaired elders. Comparisons of GDS cutoff scores with diagnoses achieved by independent raters indicate high concurrent and discriminative validity.

## DEMENTIA

Dementia is a general term referring to diseases of the brain that can result in the severe impairment of several intellectual functions. These may include impairment in memory, learning, attention, language functions, visuospatial skills, complex reasoning, and problem-solving skills (Albert, 1981). Haase (1977) suggests that symptoms of dementia can be caused by more than 60 different disorders, including depression, a primary neuronal dementia, vascular disorders, neurodegenerative disorders, infections, toxins, and metabolic disorders.

### Assessment of Dementia

In the initial phases of the assessment process, interest is focused on documenting whether or not a given patient is indeed experiencing greater cognitive impairment than would be expected for his or her age and socioeconomic level. Once it is established that the patient has impaired cognitive function, then the search for possible underlying mechanisms receives greater attention. This process entails the collection of information from a number of different areas, as listed below.

*Medical History.* Several salient features in the history should be emphasized:

1. The time and nature of the onset of symptoms can frequently indicate certain causes of mental changes. For example, a sudden and definable onset suggests a more precipitous cause of dementia, such as strokes,

metabolic disorders, infections, and the like, whereas a more gradual and insidious development is likely to reflect primary intracranial disease.

2. The rate and pattern of mental change over time can also assist in determining underlying causes. Some dementias, such as Creutzfeldt-Jakob disease, present with a rapid and steady course of decline (Joynt & Shoulson, 1979). Others, such as Alzheimer's disease, have a steady but comparatively slow course of deterioration over time (Katzman, 1986). And still others, such as multi-infarct dementia, may evidence a slow but stepwise course of deterioration (Hachinski, Lassen, & Marshall, 1974).
3. As will be seen later, a thorough evaluation of the patient's current psychiatric status and psychiatric history is essential for ruling out possible treatable psychiatric disorders.
4. A detailed assessment of the patient's present and past medical difficulties will aid in detecting potentially treatable medical conditions that contribute to the patient's change in cognitive functioning.
5. Inquiry into family medical history may reveal genetic predispositions toward specific types of disorders.

*Physical and Neurological Examination.* A physical and neurological exam often provides invaluable information for arriving at a final diagnosis. For example, assessment of vital signs, cardiovascular status, and pulmonary functions may reveal primary medical problems that secondarily impair the patient's cognitive status. Identification of gait, motor, sensory, and/or reflex abnormalities may prove to be central in revealing focal signs secondary to cerebrovascular disease, motor signs of Parkinson's disease, or the gait abnormalities of hydrocephalus. The absence of abnormal physical and neurologic findings, in the face of impaired cognitive functioning, may suggest the presence of a primary degenerative dementia.

*Mental Status Examination.* Mental status examinations range from brief procedures taking no more than 5 or 10 min to more comprehensive assessments requiring upward of an hour. A review of many of the available procedures has been provided by Kane and Kane (1981). Although there are differences in emphasis across measures, mental status exams generally include a quick evaluation of orientation to person, place, and time and a few items testing attention and immediate and remote memory. Some also have items focusing on abstract reasoning, judgment, visuospatial functions, language, and calculations. The procedures described below are not exhaustive but reflect past and current developments in this area.

*Mental Status Questionnaire (MSQ).* The MSQ (Kahn, Goldfarb, Pollack, & Peck, 1960) is a 10-item scale that measures orientation to place, time, and person; its last two items (on the names of current and immediate past presidents) also tap awareness of current events and memory for more distant events. It frequently is used in conjunction with the Face–Hand Test (Fink, Green, &

Bender, 1952), which taps the patient's ability to recognize simultaneous stimulation on cheek and palm. Zarit, Miller, and Kahn (1978) found that when the Face–Hand Test was jointly used with the MSQ, more cases of cognitive impairment were correctly identified.

*Mini-Mental Status Examination (MMSE).* This scale tests several domains of cognitive functioning, including orientation, registration, attention, calculation, recall, language, and copying skills (Folstein, Folstein, & McHugh, 1975). Validity and reliability data are included in the original article; it is impressive that the test/retest correlation coefficient (calculated after 28 days on clinically stable patients) was .98, indicating highly consistent total scores on this measure. According to more recent work (Anthony, LeResche, Niaz, von Korff, & Folstein, 1982), the MMSE has adequate sensitivity and specificity for use in research and clinical situations as a brief screening instrument to detect cognitive impairment.

*Alzheimer's Disease Assessment Scale (ADAS).* This scale was designed by Rosen, Mohs, and Davis (1984) to rate severity of cognitive and noncognitive behavioral dysfunctions characteristic of persons with progressive dementia. This scale has modest test/retest reliability and was found to discriminate between groups of patients with Alzheimer's disease and normal elderly subjects matched for sex and age. The cognitive subscale of the ADAS assesses language function (including spoken language ability, comprehension, and word-finding difficulties), ability to follow simple commands, naming of objects, memory functions (including orientation, word recognition, word recall, and remembering test instructions), and constructional and ideational dyspraxia. The noncognitive behaviors assessed include depression, concentration/distractibility, cooperativeness regarding testing, presence of any types of hallucinations, increased motor activity (including pacing and tremors), and changes in appetite. The scale appears to be sensitive to increasing dysfunction as the disorder progresses; normal elderly maintain the same level of functioning over time (with repeated administration of the ADAS).

*Global Deterioration Scale (GDS).* This measure was designed to assess the stages of decline in primary degenerative dementia (Reisberg, Ferris, DeLeon, & Crook, 1982). Seven clinically identifiable and ratable stages are defined, ranging from no cognitive decline to severe loss of verbal and psychomotor skills. Scale ratings are based on an interview with the patient (and family members if appropriate); additional information may be obtained from psychological or neuropsychological tests (such as the MSQ or Wechsler Memory Scale) to assist in pinpointing the most accurate stage. The authors state that the GDS has been used for more than 5 years in thousands of interviews with primary degenerative dementia patients; hence, they report it to be a reliable and valid instrument to assess cognitive decline in dementia patients.

*Mattis Dementia Rating Scale.* This scale contains a sufficient number of items sampling behavior consonant with preschool age development so that a "floor" effect is not common (Mattis, 1976). Assessed are attention, perseveration (both verbal and motor), drawing ability, verbal and nonverbal abstraction, and verbal and nonverbal short-term memory. Most subsections are hierarchically organized, so adequate performance on initial tasks enables the examiner to presume adequate performance on the following tasks within that section. Thus, examination of a normal elderly person may take 10 to 15 min, whereas examination of a demented patient more often requires 30 to 45 min. Normative data are available for the elderly (Montgomery, 1982). Information about concurrent validity and test/retest reliability are also available (Chase et al., 1984; Coblentz et al., 1973; Vitaliano, Breen, Albert, Russo, & Prinz, 1984). The Mattis Dementia Rating Scale has sparked considerable research, and given its sound psychometric properties and the presence of normative data for the elderly, it appears to be a valuable tool both for initial assessment of cognitive functioning and for evaluation of changes in function over time.

### Neuropsychological Testing

The majority of existing mental status exams provide only a gross estimate of the patient's cognitive deficits and therefore may lack adequate sensitivity and specificity. They also do little to illuminate the specific nature or constellation of cognitive deficits the patient experiences, which often can be helpful in generating hypotheses regarding the underlying cause of the patient's cognitive decline (Albert, 1981; Albert & Kaplan, 1980). Neuropsychological testing can also provide a comprehensive appraisal of a patient's baseline level of functioning for comparison with follow-up examinations. This may document whether a patient's symptoms are progressive, which can be extremely helpful in identifying the presence of a degenerative cortical disorder.

Although the specific neuropsychological procedures currently in use may vary across laboratories according to particular needs and preferences, there is virtual agreement that a minimum of six areas of cognitive functioning should be evaluated:

1. *Attention.* The evaluation of the patient's ability to attend to, focus, and accurately track information is a prerequisite to any other task. Both auditory and visual attention should be assessed.
2. *Language.* A thorough examination of language comprehension, repetition, reading, writing, and naming may reveal a language deficit that could generate hypotheses concerning the type or area of dysfunction.
3. *Memory.* Assessment of memory should include a thorough examination of the component processes of both visual and verbal memory, including immediate, recent, and remote, encoding retention, and retrieval. Although the specific nature of memory decline between normal and

impaired elderly is not well understood, recent studies (Moss, Albert, Butters, & Payne, 1986) indicate differential memory deficits between normal and impaired elderly and between diagnostically impaired groups.

4. *Visuospatial skills*. The patient's ability to organize perceptually and act accurately on the spatial demands of his environment should also be assessed. These should be separately assessed because each can be selectively impaired. Most traditionally, these functions have been evaluated by various design matching or figure construction tasks.
5. *Cognitive flexibility*. It is also recommended that the patient's ability to orient himself to a new problem, maintain the necessary strategy, and fluidly shift cognitive sets appropriate to the changing demands of a task be evaluated. Several tests that are presumed to measure these functions include the Stroop Color Naming Test (Golden, 1976), Categories Test (Reitan, 1955), and the Wisconsin Card Sorting Test (Heaton, 1981).
6. *Abstract reasoning*. An evaluation of the patient's ability to assess the overriding relationships or meaning of concepts or events should be completed. This is most frequently assessed by proverb interpretations and/or a concept-similarities test.

Evaluation of cognitive functioning can be more difficult in the elderly. Many tests do not have age-appropriate test norms based on a systematic distinction between elderly normal and impaired populations (Schaie & Schaie, 1977). Many are also insensitive to motivational and ecological validity considerations that are particularly important in this population (Miller, 1980). For example, decreased energy, speed of processing, and motor performance may provide serious confounds on timed tests (Kinsbourne & Berryhill, 1972); sensory and motor changes may encumber cognitive processing (Corso, 1977). Despite the problems, the demand for neuropsychological assessment of the elderly patient continues to grow in both research and clinical settings. Consequently, the development of a standard procedure for the assessment of the elderly patient continues to be a worthy venture. Some efforts have been made in this direction (cf. Albert, 1981; Albert & Kaplan, 1980; Golden, 1979; Kramer & Jarvik, 1979; Reitan & Wolfson, 1986), but continued development of instruments and procedures specifically for use with the elderly should be encouraged.

## Laboratory Examinations

The results of various laboratory tests may also prove helpful in the identification of specific medical disorders that contribute to the patient's decline in cognitive functioning. The following procedures have been proposed as standard: CT brain scan, chest X ray, comprehensive biochemical screening, thyroid functions test, $B_{12}$ levels, serologic tests for syphilis, and, when indicated, a cerebrospinal fluid exam (Alexander & Geschwind, 1985; Katzman, 1986; McKhann et al., 1984). In addition, when indicated and available, newer research/clinical procedures such as the positron emission tomographic technique or nuclear magnetic resonance imaging may prove to be useful in identifying diseases associated with compromised metabolic activity and demyelinating disorders in the brain.

## SYNDROMES OF DEMENTIA

This section will describe several disorders frequently associated with declining cognitive functioning in the elderly. An attempt will be made to illuminate the features that highlight these disease states within the context of a diagnostic examination.

### Alzheimer's Disease

Recent statistics indicate that 50 to 60% of patients suffering from dementia have Alzheimer's disease (Smith & Kiloh, 1981). The Department of Health and Human Services Task Force on Alzheimer's Disease (McKhann et al., 1984) formally designated the following criteria as necessary for the diagnosis of probable Alzheimer's disease: (1) dementia established by clinical examination that is documented by a test of mental status and confirmed by neuropsychological tests, (2) deficits in two or more areas of cognitive functioning, (3) progressive worsening of memory and other cognitive functions, (4) no disturbance of consciousness, (5) onset between the ages of 40 and 90, and (6) absence of systemic disorders or other brain diseases that in and of themselves may account for the presenting decline in functioning.

A number of specific structural changes in the brain are known to occur in Alzheimer patients, including primary features of abnormal frequency of neuritic plaques and neurofibrillary tangles (Terry & Katzman, 1983), cerebral atrophy and cell loss (Terry & Katzman, 1983), and granulovacular degeneration (Blessed, Tomlinson, & Roth, 1968; Woodard, 1962). Despite these specific changes, there are no consistent findings on computerized tomography studies, electroencephalography, or other laboratory techniques that would allow for an unequivocal diagnosis in the clinical setting. Although abnormal findings may exist in the later stages of this disease process, these procedures do not function as a consistently reliable diagnostic measure during the earlier stages (Kemper, 1984; Naugle, Cullum, Bigler, & Massman, 1985; Neary et al., 1986). Recent research evaluating cortical metabolic activity by positron emission tomography has identified a temporoparietal pattern of reduced metabolism (Cutler et al., 1985; Friedland et al., 1983), which holds future promise in aiding the diagnostic process in the living patient.

There are several consistent features apparent in the patient's clinical presentation that can support a presumptive diagnosis. The history generally reveals an insidious and gradual onset of symptoms with a slow but steady deteriorating course. In the early stages, complaints involving increasing forgetfulness and cognitive inefficiency resulting in declining occupational or social performance are typical. Yet, to the casual observer, patients in the early stages of this illness appear relatively intact. They present with relatively well preserved social skills and little or no indication of any dramatic behavioral problems. Impairment of memory functioning is generally the most prominent feature of cognitive decline found in the early stages of this disease. Numerous studies have investigated the memory functioning of suspected Alzheimer patients, revealing a unique pattern of performance. These include relatively preserved immediate "scratch pad" memory (Joynt & Shoulson, 1979), impairment in both anterograde and retrograde memory (Wilson, Bacon, Fox, & Kazniak, 1983), acquisition and retrieval deficits (Weingartner et al., 1981), dramatic impairment in learning rate (Gibson, 1981), attrition of information over time (Moss et al., 1986), intrusion errors on recall (Fuld, Katzman, Davies, & Terry, 1981), and impaired recognition memory (Miller & Lewis, 1977).

Although memory loss is regarded as the most prominent feature of this disorder, there may be a varying combination of deficits in the Alzheimer patient. Cummings and Benson (1986) propose the following schema of deficits as potential symptoms in the early stages: (1) memory deficits, (2) language deficits, (3) visuospatial impairments, (4) impairment of concrete thinking, (5) compromised calculation skills, (6) cognitive inflexibility, and (7) personality or behavior changes. As the patient progresses to the middle and advanced stages of the disease, there is a rather global and dramatic compromise in intellectual functioning, with frequent manifestations of impaired motor functions. Given the variability in the presenting constellation of deficits across patients in the early stages, researchers are now investigating the possibility of distinct subgroups of this disorder. Several studies have found consistent differences in deficits on the basis of age of symptom onset (Loring & Largen, 1985; Seltzer & Sherwin, 1983). Such studies suggest that Alzheimer dementia may be heterogeneous in nature and may present with differing prognosis and course as a function of varying etiology.

### Multi-Infarct Dementia

Approximately 12 to 20% of patients evaluated for an impairment in cognitive functioning present with a multi-infarct dementia (National Institutes of Health, 1981). Generally, multi-infarct dementia refers to a condition of impaired cognitive functioning secondary to multiple occlusions of cerebral arteries (Roth, 1981). A variety of cerebrovascular conditions have been associated with this condition, including multiple large cerebral infarctions (Tomlinson, Blessed, & Roth, 1970), small lacunar infarctions (Fisher, Karnes, & Kubrik, 1961), and subcortical arteriosclerotic encephalopathy (Loizou, Kendal, & Marshall, 1981). Pathological examination of multi-infarct patients frequently reveals atherosclerotic disease of the vessels with small lacunar infarcts. Yet, regardless of the specific vascular pathology, the clinical features of multi-infarct dementia are relatively consistent across cases.

Clinical features considered characteristic of multi-infarct dementia include an acute, abrupt onset, with a stepwise or fluctuating course of deterioration and the presence of focal neurological signs (Hachinski, Lassen, & Marshall, 1974). In addition, Hachinski and his colleagues (1975) have identified several other features in patient history and presentation that have been highly correlated with multi-infarct dementias. These include nocturnal confusion, relative preservation of personality, depression, history of somatic complaints, emotional incontinence, history or presence of hypertension, history of strokes, and evidence of associated atherosclerosis. Rosen, Terry, Fuld, Katzman, and Peck (1980) have replicated these original findings and revised the criteria according to their marked correlation with histological results. Accordingly, clinical features designated as of primary importance include abrupt onset, stepwise deterioration, history of stroke, and focal neurological signs and symptoms. Other prodromal features include headaches, dizziness, tinnitus, and syncope (MacInnes, 1983).

The nature and extent of cognitive impairment in multi-infarct dementia is dependent on the location and size of infarction and the collateral circulation available to the lesioned area (Marsden, 1976). However, there is usually evidence of compromised functioning in the areas of short-term memory, concentration, abstract reasoning, speech functions, visuospatial functions, and apraxia (Caplan & Schoene, 1978; Horn, 1975). Thus, frequently it may be difficult to distinguish between multi-infarct dementia and Alzheimer's disease based solely on the constellation of cognitive deficits, without information about the history of the illness and laboratory findings.

## Alcohol Dementia

Hospital admission studies have reported that 7 to 9% of patients presenting with cognitive impairment evidence a dementia secondary to chronic alcohol abuse (Freemon, 1976; Horvath, 1975). Numerous neuropathologic studies have revealed structural and physiological abnormalities suggestive of cerebral atrophy (Courville, 1955; Brewer & Perrett, 1971; Fox, Ramsey, Huckman, & Proske, 1976; Iivanainen, 1975; Lishman, 1981). Regional cerebral blood flow studies also indicate neurophysiological abnormalities associated with alcohol abuse (Berglund & Ingvar, 1976).

Neuropsychological studies have also revealed performance deficits consistent with the disruption of central nervous system functioning. Some authors have reported results consistent with diffuse brain damage (Chmielewski & Golden, 1980; Fitzhugh, Fitzhugh, & Reitan, 1965; Lezak, 1976; Sandok, 1975). Other investigators have speculated that alcoholics may suffer greater damage to the right hemisphere (Bertera & Parsons, 1978; Chandler, Vega, & Parsons, 1973; Cutting, 1978; Fitzhugh et al., 1965; Goldstein, Neuringer, & Klappersack, 1970; Goodglass & Peck, 1972; Jenkins & Parsons, 1979; Jones, 1971; Miglioli, Buchtel, Campanini, & DeRisio, 1979; Parsons, Tartar, & Edelbert, 1972). Still others have proposed that alcoholics present with deficits consistent with frontal lobe dysfunction (Chelune & Parker, 1981; Chmielewski & Golden, 1980; Klisz & Parsons, 1977; Tartar, 1976).

Despite the variations in behavioral findings leading to controversy over the areas of the brain implicated in alcohol dementia, Ryan and Butters (1983), in an exhaustive review, reported that there were relatively consistent findings across studies suggesting impairment in new learning, abstract reasoning, and perceptual organization. Others have failed to identify a consistent pattern of impairment among chronic alcoholics and emphasize the critical examination of potentially confounding variables (i.e., age, history of alcohol consumption, education, sex, medical status, etc.) in the interpretation of findings (Kleinknecht & Goldstein, 1972; Parsons & Farr, 1981).

## Subcortical Dementia

Recently there has been increased interest in subcortical disorders that have an eventual course leading to severe cognitive impairment (Benson, 1983). Those most often referred to are Huntington's chorea, progressive supranuclear palsy, and Parkinson's disease. These disorders have several common features: (1) movement disorders are prominent; (2) dementia occurs in most cases, although not necessarily all; and (3) the primary neuropathological site in each is subcortical nuclear centers with little cortical involvement. The characteristics of the dementia associated with these disorders is somewhat different from those observed in cortical dementia. There is a marked change in verbal function, with poor articulation and decreased volume accompanied by a decline in verbal output. Motor, sensory, and mental processes show a general slowing. Difficulty in information processing is quite apparent but may be due to the slowness of system functioning rather than to an actual loss of ability. Therefore, if the rate of information presentation is slowed and time demands on responses are minimized, evidence of cognitive strengths can be more apparent. Memory problems are also present, but some investigators (Albert, Feldman, & Willis, 1974; McHugh & Folstein, 1975) feel that this is not due to an inability to learn; rather, they argue that this problem reflects a difficulty in initiating retrieval. Benson (1983) has noted that new learning is relatively preserved in subcortical dementing disorders until late in the course of the disease.

In the case of Huntington's chorea and progressive supranuclear palsy, the course of the dementia becomes a devastating feature of the disease. The picture is more controversial for Parkinson's disease. Although dementia does occur in Parkinson patients, available studies do not provide an unequivocal consensus as to the nature of deficits present nor how frequently they are manifested. A review of this literature reveals prevalence figures ranging from 20 to 80% (Loranger, Goodell, McDowell, Lele, & Sweet, 1972; Martin, Loewenson, & Resch, 1973; Pollock & Hoinabrook, 1966; Sweet, McDowell, & Feigenson, 1976). The constellation of cognitive deficits appears equally variable, including problems with recent memory, complex abstract reasoning, concentration, visuomotor ability, and cognitive rigidity (Caltagirone, Masullo, Benedetti, & Gainotti, 1985; Loranger et al., 1972; Reitan & Boll, 1971). Some investigators have raised the question of whether Parkinson patients with dementia may actually have superimposed Alzheimer cortical changes (Hakiem & Mathieson, 1979). A clear delineation of the nature and prevalence of dementia associated with Parkinson's disease awaits further critical investigations.

## COGNITIVE DECLINE WITH DEPRESSION

A number of studies have reported decreased memory function in elderly depressives (Fraser & Glass, 1980; Gibson, 1981; Hilbert, Niederehe, & Kahn, 1976; Raskin, Friedman, & DiMascio, 1982; Whitehead, 1973). Others have reported no substantial group differences across a variety of tasks ranging from simple recognition to delayed free recall (Camp & Niederehe, 1978; Derry & Kuiper, 1981; Friedman, 1964; Kahn, Zarit, Hilbert, & Niederehe, 1975; Kendrick & Post, 1967; Miller & Lewis, 1977; Niederehe & Camp, 1985). In general, it appears that the impact of depression on cognitive function is more likely to be evident in patients who are hospitalized, who are outpatients with a severe episode of depression as opposed to a mild to moderate level of depression, who are in poor physical health, or who are in the lower socioeconomic brackets. Patients who have symptoms of agitation and withdrawal are also likely to perform more poorly than those who are not. Weingartner (1986) has proposed that arousal and activation deficits prevent depressed patients from engaging in effortful processing in the initial stages of memory encoding. As a result, unstructured memory tasks or other cognitive tasks requiring active organization of materials during processing may be performed poorly by depressives.

### Pseudodementia

In 1961 Kiloh (1961) reported on 10 patients with functional disorders who presented with symptoms of cognitive impairment sufficiently severe to be labeled as dementia. By virtue of their lack of deterioration at follow-up, these cognitive impairments were viewed as secondary to a primary affective disorder, particularly depression. He labeled this condition pseudodementia. Others have reported similar findings in patients, although they might emphasize greater or less specificity in the functional determinants (Cavenar, Maltbie, & Austin, 1979; McAllister & Price, 1982; Nott & Fleminger, 1975; Post, 1975; Wells, 1979). Caine (1981) argued that a patient must meet four criteria for inclusion in a pseudodementia group: (1) intellectual impairment in a patient with a primary psychiatric disorder; (2) neuropsychological abnormalities resembling the presentation of a neuropathologically induced cognitive deficit, (3) reversible intellectual disorder, and (4) no apparent primary neuropathological process that led to the genesis of the disturbance.

Retrospective studies have emphasized that misdiagnoses of dementia can be high, with younger demented patients often diagnosed as having depression (Perlick & Atkins, 1986) and older depressed patients as having dementia (Nott & Fleminger, 1975; Ron, Toon, Garralda, & Lishman, 1979). In one of the few prospective studies done to date, Rabins, Merchant, & Nestadt (1984) examined the cognitive and affective status of patients over 60 with suspected dementia and then followed them for 2 years. The authors reported that the MMSE scores of the dementia patients without depression showed significant deterioration, whereas both the normal and depressed subjects remained unchanged. The authors interpret these findings as evidence that the presence of depression and dementia generally, but not invariably, predicts an absence of cognitive deterioration. This qualification is supported by the study of Ron et al. (1979), who found evidence of depression in two-thirds of his nondemented patients as compared to only one-third of the demented patients.

Case studies further emphasize the difficulty in differentiating cognitive impairment due to depression from cognitive impairment due to progressive dementing disease on the basis of clinical presentation alone (Caine, 1981; Cavenar, Maltbie, & Austin, 1979; McAllister & Price, 1982). This view stands in contrast with the work of Wells (1979), who presented 22 features that he claims can differentiate his pseudodementia patients from his demented patients. These include such features as abrupt onset, relatively short duration, history of psychiatric dysfunction, inconsistency between different tests of the same function, inconsistency over time on the same test, inconsistency between test results indicating impairment and actual competent behavioral functioning, outspoken and detailed complaints of dysfunction coupled with a strong distress over failures, and numerous avoidance responses (e.g., I don't know; I can't remember) during testing.

Several authors have noted the frequent coexistence of depression and neurological disorder (Caine, 1981; McAllister & Price, 1982; Reifler, Larson, & Hanley, 1982; Shraberg, 1978). Reifler (1982) has urged the abandonment of the term *pseudodementia* altogether in view of his contention that (1) the term "implies mutually exclusive pathologic processes, suggesting that the patient has either an organic illness or a functional one"; and (2) the term "is often mistakenly used as a diagnosis, whereas originally it was only intended to be a description" (p. 665). Although not discounting the possibility of true pseudodementia, he emphasizes the likelihood that depression can occur in the context of a neuropathological process. In a sample of 102 patients, Reifler and his associates (1982) determined that 23% of the patients with cognitive impairment were also found to be depressed. Depression was more likely in patients with only a mild degree of dementia. These results could be explained in several ways. First, it is possible that in their sample of patients, the milder cases of dementia may have been represented by a greater percentage of pseudodementia cases. On the other hand, an increase in dementia may have resulted in a corresponding decrease in self-awareness and thus a decrease in depressive symptoms. A third possibility is that depressive symptoms in the demented patient may frequently become obscured by severe cognitive deficits and often manifest as "simpler equivalents" of the typical symptoms seen in the non-demented patient (DeMuth & Rand, 1980). These include agitation and a variety of regressed, stereotyped, and inappropriate behaviors. It is possible that the use of even sophisticated classification schemas, such as the RDC, would miss these simpler equivalents of depression in the more severely demented patient.

Surprisingly few researchers have investigated the usefulness of specific neuropsychological tests in differentiating elderly demented from depressed patients with severe cognitive impairment. Miller and Lewis (1977) used a continuous recognition paradigm for geometric designs and found no differences between normals and depressives on the measure of memory sensitivity, whereas both groups were superior to patients with dementia. The depressed group differed significantly from both the demented and normals on the measure of response bias, suggesting that the depressives were more uncertain and cautious in responding than were the other two groups. LaRue and her associates (LaRue, D'Elia, Clark, Spar, & Jarvik, 1986) looked at three tests of memory—the Benton Visual Retention Test (Benton, 1974), Inglis Paired Associate Learning Test (Inglis, 1959), and the Fuld Object-Memory Evaluation (Fuld, 1981)—and found that the Fuld made the sharpest distinction among elderly depressed, demented, and control subjects. In a second prospective study of unselected psychiatric patients they were able to predict diagnostic status accurately in 21 of 25 patients using the Fuld cutoff scores determined in an earlier retrospective analysis. As expected, they were more accurate in confirming true dementia than in detecting dementia associated with other psychiatric disorders.

## Clinical Implications

There appears to be a significant percentage of patients with primary affective disorder who are misdiagnosed as demented. In general, the presence of depression in a patient's history or at the time of an evaluation would predict a lack of deterioration over time. The absence of signs of organic abnormalities in special diagnostic procedures also predicts a stable course. However, beyond this much remains unclear. Case studies suggest that pseudodementia (as defined by criteria listed earlier) may occur, but they provide little information pertaining to a systematic assessment, either medical or behavioral, that would lift all doubts. Research investigations concerning diagnostic accuracy of pseudodementia have also been typically flawed in ways that render them suggestive but not convincing. For example, the major criterion for rejecting a diagnosis of dementia has often been a lack of symptom progression. However, this falls short of demonstrating either an underlying psychiatric basis for the cognitive impairment or a potential reversibility of the symptoms. It remains unclear to what extent the pseudodementia cases described in the literature truly show a total reversibility of cognitive impairment and to what extent there may be residual problems that were merely missed because of inadequate assessment procedures. Further, the nature of the data base in many of the studies was such that it would be difficult to rule out other nonprogressive neuropathology, for example, head injury, mild infarction, metabolic disorders, or nutritional deficiencies.

There is fairly convincing evidence, however, that at least some kinds of cognitive abilities are impaired in elderly patients who are severely depressed, particularly if they show accompanying signs of withdrawal or if their clinical picture is complicated by physical health problems. In such instances the question often arises as to whether the cognitive impairments are a result of the combined effects of normal aging and depression or the combined effects of early dementia and depression. This is an extremely difficult differential diagnosis, but the literature does suggest several points that can be helpful.

One factor often overlooked in making diagnostic decisions of this type is the depressed patient's negative self-perception of his abilities and the role this may play in the assessment process. An increase in complaints about declining cognitive abilities occurs with great regularity in patients who are merely depressed, and invariably an objective evaluation will prove this problem to be grossly overexaggerated or sometimes even unfounded. If there is some substance to the complaint, it often can be linked with the patient's reluctance to risk failure on a given task, either because he or she feels that the negative outcome of failure is inevitable, or because he or she legitimately has difficulty maintaining the sustained effort required to accomplish the task. Therefore, it is important to assess such complaints with objective tests in order not to be misled by the testimonials of the patients or their families. Of course, many patients with mild dementia also complain about their loss of functioning, but often there are qualitative differences in the complaints that emerge in their testing. For example, dementia patients frequently will have less difficulty in initiating a trial of the task in question. If they perceive that they are having difficulty, they may say something like "I need to take this home and practice more, and then maybe I could help you with this." If their reaction to any given failure is negative, it is more likely to be catastrophic in nature, whereas the depressed patient may resignedly accept the failure experience as yet another confirmation of his cognitive difficulties and thereby firmly resolve never to try this again.

Careful appraisal of memory function can sometimes be extremely helpful when addressing this diagnostic question. Depressed elderly patients may do more poorly than normal elderly on tests of learning and memory performance, but often this is not the case. This can make decisions about diagnosis much easier. Furthermore, even if learning and memory scores are lower than the expected values for healthy elderly, differences in performance between depressed and demented patients can still be useful at times in deciding on a likely diagnosis. La Rue et al. (1986), for example, found memory performance to be helpful in correctly classifying sequential inpatients, all of whom were referred for testing because of complaints about cognitive functioning. In our experience, tests of memory using a free recall paradigm that assess rate of acquisition across trial presentations can also reveal helpful differences between depressed and dementia patients. For example, differences might not be apparent on the first trial, but as the stimulus material is presented repeatedly, depressives often show a more substantial rate of learning than patients with dementia due to organic problems. Typically, dementia patients will continue to show a strong primacy and/or recency effect across trials, whereas depressives will eventually show the added effect of clustering or other organizational strategies. A measure of recognition at the end of the list can also be diagnostic in some cases. On occasion a depressed patient will perform in a mediocre manner during the learning phase and then do exceptionally well on a test of recognition. Although dementia patients also remember more words in the recognition phase, they rarely will show exceptional performance even on this simpler section of the memory task. They also are more inclined to make false-positive errors during recognition than are the depressives. One other useful point pertaining to memory performance involves the percentage of material retained from immediate to delayed recall. Evidence suggests that memory impairment in depression is, at least in part, due to dysfunction in the earliest stages of the memory process, for example, registration and encoding, whereas memory retention per se is not likely to be greatly affected (Moss et al., 1986; Squire, 1986). Therefore, although the amount of material retained may be less for depressives than for normals, the percentage of material retained from immediate to delayed recall by depressives should be in the normal range (i.e., at least 80% or better and rarely below 70%).

Finally, the clinician needs to be alert to the possibility of delirium. Ordinarily one would not expect this to be a problem when attempting to make a differential diagnosis between dementia and depression. However, delirium is occasionally missed in elderly patients who are experiencing some acute medical crisis. In such situations, clouding of consciousness and fluctuations in confusional episodes are often mistaken for signs of dementia rather than an indication of some acute physiological reaction that may need immediate attention (Salzman &

Shader, 1979). Although elderly patients with delirium also frequently have dementia, this diagnosis should not be made until the delirious state has remitted.

## CONCLUSIONS

The need to determine whether a patient's cognitive problems are due to a depressive disorder or stem from organic causes is so common in the clinical setting that it seemed reasonable to consider the assessment of both depression and dementia in the same chapter. Often the two are intertwined in ways that pose serious diagnostic challenges. Evidence suggests that at times depression can result in cognitive impairment sufficient to raise questions about an underlying pathophysiological process. Changes in cognitive or behavioral functioning can also precipitate depression. Many of the symptoms associated with both also occur more regularly in normal elderly. At present the clinician still has limited tools with which to address this assessment challenge in the older patient. The psychologist's unique contribution to the assessment process comes from the interpretation of standardized procedures for measuring cognitive and behavioral functioning. However, his or her contribution is maximized by integrating test results with information from other relevant domains. The psychologist can heighten his or her contribution in this multidisciplinary undertaking by becoming familiar with the concepts and measuring instruments used by other disciplines in making a diagnosis. For example, interpretations of test data can be more useful if the examiner is informed about the health history of the patient, current and past medications, current medical status as determined by physical exam, other relevant laboratory and diagnostic procedures, and a psychiatric and psychosocial history.

Affective status should always be considered when evaluating an elderly patient's cognitive status. There are a number of brief self-report screening instruments now available with some normative data for use with older patients. If the patient endorses depressive symptoms on one of these scales, a more extensive evaluation for depression and anxiety should be completed. In such instances, qualitative analysis of test behavior can also be extremely helpful in determining the contribution of psychological distress to decreased cognitive functioning. Complaints about loss of cognitive abilities frequently occur, and a comparison of self-perceptions with actual objective performance can sometimes prove diagnostic.

Assessment for the extent of cognitive impairment is usually initiated by administering a mental status screening device. There are a number of these available with a modicum of age norms, and others are currently under development. Brief mental status screening can be extremely helpful in providing preliminary objective information about a patient's cognitive function, with minimal time investment. In some instances this will be all of the information necessary to formulate an adequate diagnosis. In others the results of screening can provide guidelines for more extensive testing required to obtain an adequate appraisal of various cognitive processes. Mental status screening instruments are inclined to err on the side of being insensitive. Therefore, if a patient performs extremely poorly, the likelihood is high that he will have an organic dementia. On the other hand, false-negative errors are much more likely with these devices.

Whether the psychological testing is brief or extensive, the single test or battery of tests should be designed to provide information in six different areas. These include attention, language function, memory, visuospatial skills, cognitive flexibility, and abstract reasoning. The pattern of results seen across these areas can be extremely helpful in making inferences about underlying mechanisms responsible for observed deficits. There are a variety of testing procedures designed to make objective evaluations in each of these domains, and which is selected depends on the particular experience and needs of each individual clinician. Care should be taken to select tests that have some semblance of age-related norms for comparison purposes.

In the hands of an experienced clinician, data obtained with such instruments can make a valuable contribution to the assessment process. However, clinical testing with the elderly is yet in its infancy. Few clinicians have an interest in the assessment of elderly patients. Fewer still have had the experience required to be sensitive to the problems that arise from confounding variables. Improved test instruments are sorely needed. Few have appropriate norms. Most were designed for use with younger samples and secondarily have been pushed into service with elderly patients. Consequently, many important extracerebral factors have been overlooked. Virtually no attention has been paid to the ecological validity of tests, for example. Elderly patients are often penalized on tests because of sensory and motor constraints that are not taken into account in the design of the test. The impact of motivational and other attitudinal factors is often overlooked during administration of tests. This can be a particularly weighty problem if the tests seem to make little sense to the patient in terms of real-world issues.

The increased proportion of elderly individuals in the health care system today has highlighted the need for improved instruments in the assessment arena. Future developments should take greater advantage of the rich experimental literature on cognitive processes in the elderly.

## REFERENCES

Albert, M. S. (1981). Geriatric neuropsychology. *Journal of Consulting and Clinical Psychology, 49,* 835–850.

Albert, M. L., Feldman, R. G., & Willis, A. L. (1974). The subcortical dementia of progressive supranuclear palsy. *Journal of Neurology, Neurosurgery, and Psychiatry, 37,* 121–130.

Albert, M. S., & Kaplan, E. (1980). Organic implications of neuropsychological deficits in the elderly. In L. W. Poon, J. L. Fozard, L. S. Cermak, D. Arenberg, & L. W. Thompson (Eds.), *New directions in memory and aging: Proceedings of the George E. Talland Conference* (pp. 403–432). Hillsdale, NJ: Erlbaum.

Alexander, M. P., & Geschwind, N. (1984). Dementia in the elderly. In M. L. Albert (Ed.), *Clinical neurology of aging* (pp. 254–276). New York: Oxford University Press.

American Psychiatric Association. (1980). *Diagnostic and statistical manual of mental disorders* (3rd ed.). Washington, DC: Author.

Anthony, J. C., LeResche, L., Niaz, U., von Korff, M. R., & Folstein, M. F. (1982). Limits of the mini-mental state as a screening test for dementia and delirium among hospital patients. *Psychological Medicine, 12*, 397–408.

Beck, A. T., Ward, C. H., Mendelson, M., Mock, J. E., & Erbaugh, J. (1961). An inventory for measuring depression. *Archives of General Psychiatry, 4*, 561–571.

Benson, D. F. (1983). Subcortical dementia: A clinical approach. In R. Mayeux & W. G. Rosen (Eds.), *Advances in neurology: The dementias*, Vol. 38, pp. 185–194. New York: Raven Press.

Benton, A. L. (1974). *Revised Visual Retention Test* (4th ed.). New York: Psychological Corporation.

Berglund, M., & Ingvar, D. (1976). Cerebral blood flow and its regional distribution in alcoholism and Korsakoff's psychosis. *Journal of Studies on Alcohol, 37*, 586–597.

Bertera, J. H., & Parsons, O. A. (1978). Impaired visual search in alcoholics. *Alcoholism: Clinical and Experimental Research, 2*, 9–14.

Blazer, D., & Williams, C. D. (1980). Epidemiology of dysphoria and depression in an elderly population. *American Journal of Psychiatry, 137*, 439–444.

Blessed, G., Tomlinson, B. E., & Roth, M. (1968). The association between quantitative measures of dementia and of senile changes in the cerebral gray matter of elderly subjects. *British Journal of Psychiatry, 114*, 797–811.

Brink, T. L. (1986). *Clinical gerontology: A guide to assessment and intervention.* New York: Haworth.

Brewer, C., & Perrett, L. (1971). Brain damage due to alcohol consumption: An airencephalographic, psychometric and electroencephalographic study. *British Journal of Addiction, 66*, 170–182.

Caine, E. D. (1981). Pseudodementia: Current concepts and future directions. *Archives of General Psychiatry, 38*, 1359–1364.

Caltagirone, C., Masullo, C., Benedetti, N., & Gainotti, G. (1985). Dementia in Parkinson's disease: Possible specific involvement of the frontal lobes. *International Journal of Neurosciences, 26*, 15–26.

Camp, C., & Niederehe, G. (1978). Signal detection analysis of recognition memory in depressed elderly. *Gerontologist, 18*, 56. (Abstract)

Caplan, L. R., & Schoene, W. C. (1978). Clinical features of subcortical arteriosclerotic encephalopathy. *Neurology, 28*, 1206–1215.

Carroll, B. J., Fielding, J. M., & Blashki, T. G. (1973). Depression rating scales: A critical review. *Archives of General Psychiatry, 28*, 52–58.

Cavenar, J. O., Maltbie, A. A., & Austin, L. (1979). Depression simulating organic brain disease. *American Journal of Psychiatry, 136*, 521–523.

Chandler, B., Vega, A., & Parsons, O. (1973). Dichotic learning in alcoholics with and without a history of possible brain injury. *Journal of Studies on Alcohol, 34,* 1099–1109.

Chase, T. N., Foster, N. L., Fedio, P., Brooks, R., Mnasi, L., & DiChiro, G. (1984). Regional cortical dysfunction in Alzheimer's disease as determined by positron emission tomography. *Annals of Neurology* (Supplement, June), 170–174.

Chelune, G. J., & Parker, J. B. (1981). Neurological deficits associated with chronic alcohol abuse. *Clinical Psychology Review, 1,* 181–195.

Chmieliewski, C., & Golden, C. (1980). Alcoholism and brain damage: An investigation using the Luria-Nebraska neuropsychological battery. *International Journal of Neuroscience, 10,* 99–105.

Coblentz, J. M., Mattis, S., Zingesser, L., Sasoff, S., Wisniewski, H., & Katzman, R. (1973). Presenile dementia: Clinical aspects and evaluation of cerebrospinal fluid dynamics. *Archives of Neurology, 29,* 299–308.

Corso, J. F. (1977). Auditory perception and communication. In J. E. Birren & K. W. Schaie (Eds.), *Handbook of the psychology of aging* (pp. 535–553). New York: Van Nostrand Reinhold.

Courville, C. G. (1955). *Effects of alcohol on the nervous system of man.* Los Angeles: San Lucal Press.

Cummings, J. L., & Benson, D. F. (1986). Dementia of the Alzheimer type: An inventory of diagnostic clinical features. *Journal of the American Geriatrics Society, 34,* 12–19.

Cutler, N. R., Haxby, J. V., Duara, R., Grady, C. L., Kay, A. D., Kessler, R. M., Sundaram, M., & Rapoport, S. I. (1985). Clinical history, brain metabolism and neuropsychological function in Alzheimer's disease. *Annals of Neurology, 18,* 298–309.

Cutting, J. (1978). Specific psychological deficits in alcoholism. *British Journal of Psychiatry, 133,* 119–122.

DeMuth, G. W., & Rand, B. S. (1980). Atypical major depression in a patient with severe primary degenerative dementia. *American Journal of Psychiatry, 137,* 1609–1610.

Derogatis, L. R. (1977). *The SCL-90 manual I: Scoring, administration and procedures for the SCL-90.* Baltimore: Johns Hopkins University School of Medicine, Clinical Psychometrics Unit.

Derogatis, L. R., & Spencer, P. M. (1982). *Brief symptom inventory: Administration and procedures.* Baltimore: Johns Hopkins University School of Medicine, Clinical Psychometrics Unit.

Derry, P. A., & Kuiper, N. A. (1981). Schematic processing and self-reference in clinical depression. *Journal of Abnormal Psychology, 90,* 286–297.

Endicott, J., & Spitzer, R. L. (1978). A diagnostic interview for affective disorders and schizophrenia. *Archives of General Psychiatry, 35,* 837–844.

Fink, M., Green, M., & Bender, M. B. (1952). The fact-hand test as a diagnostic sign of organic mental syndrome. *Neurology, 2,* 46–59.

Fisher, C. H., Karnes, W. E., & Kubrik, C. S. (1961). Lateral medullary infarction—the pattern of vascular occlusion. *Journal of Neuropathology and Experimental Neurology, 20,* 323–379.

Fitzhugh, L., Fitzhugh, K., & Reitan, R. (1965). Adaptive abilities and intellectual functioning in hospitalized alcoholics: Further considerations. *Quarterly Journal of Studies on Alcohol, 26,* 402–411.

Folstein, M. R., Folstein, S., & McHugh, P. R. (1975). Mini-mental state: A practical method for grading the cognitive state of patients for the clinician. *Journal of Psychiatric Research, 12,* 189–198.

Fox, J. H., Ramsey, R. G., Huckman, M. S., & Proske, A. E. (1976). Cerebral ventricular enlargement: Chronic alcoholics examined by computerized tomography. *Journal of the American Medical Association, 236.* 365–368.

Fraser, R. M., & Glass, I. B. (1980). Unilateral and bilateral ECT in elderly patients. *Acta Psychiatrica Scandinavica, 62,* 13–21.

Freemon, F. P. (1976). Evaluation of patients with progressive intellectual deterioration. *Archives of General Neurology, 33,* 658–659.

Friedland, R. P., Budinger, T. F., Ganz, E., Yano, Y., Mathis, C. A., Koss, B., Ober, B. A., Huesman, R. H., & Derenzo, S. E. (1983). Regional cerebral metabolic alterations in dementia of the Alzheimer type: Positron emission tomography with [18F] fluorodeoxyglucose. *Journal of Computer Assisted Tomography, 1,* 590–598.

Friedman, A. S. (1964). Minimal effects of severe depression on cognitive functioning. *Journal of Abnormal and Social Psychology, 69,* 237–243.

Fuld, P. A. (1981). *The Fuld Object-Memory Evaluation.* Chicago: Stoelting Instrument Company.

Fuld, P. A., Katzman, R., Davies, P., & Terry, R. D. (1982). Intrusions as a sign of Alzheimer dementia: Chemical and pathological verification. *Annals of Neurology, 11,* 155–159.

Gaitz, C. M. (1977). Depression in the elderly. In W. Fann, I. Karacan, A. Pokorny, & R. Williams (Eds.), *Phenomenology and treatment of depression* (pp. 153–166). New York: Spectrum.

Gallagher, D. (1986). Assessment of depression in elders by interview methods and psychiatric rating scales. In L. Poon (Ed.), *Handbook of clinical memory assessment* (pp. 202–212). Washington, DC: American Psychological Association.

Gallagher, D., Breckenridge, J., Steinmetz, J., & Thompson, L. W. (1983). The Beck Depression Inventory and Research Diagnostic Criteria: Congruence in an older population. *Journal of Consulting and Clinical Psychology, 51,* 945–946.

Gallagher, D., Nies, G., & Thompson, L. W. (1982). Reliability of the Beck Depression Inventory with older adults. *Journal of Consulting and Clinical Psychology, 50,* 152–153.

Gibson, A. J. (1981). A further analysis of memory loss in dementia and depression in the elderly. *British Journal of Clinical Psychology, 20,* 179–185.

Golden, C. J. (1976). *Stroop Color and Word Test.* Chicago: Stoelting Co.

Golden, C. J. (1979). *Clinical interpretation of objective psychological tests.* New York: Grune & Stratton.

Goldstein, G., Neuringer, C., & Klappersack, B. (1970). Cognitive, perceptual, and motor aspects of field dependency in alcoholics. *Journal of Genetic Psychology, 117,* 253–266.

Goodglass, H., & Peck, E. (1972). Dichotic ear order effects in Korsakoff and normal subjects. *Neuropsychologia, 10,* 211–217.

Gurland, B. (1976). The comparative frequency of depression in various adult age groups. *Journal of Gerontology, 31,* 283–292.

Gurland, B., Golden, R., Teresi, J., & Challop, J. (1984). The SHORT-CARE: An efficient instrument for the assessment of depression, dementia and disability. *Journal of Gerontology, 39,* 166–169.

Gurland, B., Kuriansky, J., Sharpe, L., Simon, R., Stiller, P., & Birkett, P. (1977). The comprehensive assessment and referral evaluation (CARE): Rationale, development and reliability. *International Journal of Aging and Human Development, 8,* 9–42.

Gurland, B., & Wilder, D. E. (1984). The CARE interview revisited: Development of an efficient, systematic clinical assessment. *Journal of Gerontology, 39,* 129–147.

Haase, G. R. (1977). Diseases presenting as dementia. In C. E. Wells (Ed.), *Dementia* (2nd ed.) (pp. 27–67). Philadelphia: Davis.

Hachinski, V. C., Iliff, L. D., & Zilkha, E. (1975). Cerebral blood flow in dementia. *Archives of Neurology, 32,* 632–637.

Hachinski, V. C., Lassen, N. A., & Marshall, J. (1974). Multi-infarct dementia: A cause of mental deterioration in the elderly. *Lancet, 2,* 207–209.

Hakiem, A. M., & Mathieson, G. (1979). Dementia in Parkinson's disease: A neuropathologic study. *Neurology, 29,* 1209–1214.

Hale, W. D., Cochran, C. D., & Hedgepeth, B. E. (1984). Norms for the elderly on the brief symptom inventory. *Journal of Consulting and Clinical Psychology, 52,* 321–322.

Hamilton, M. (1967). Development of a rating scale for primary depressive illness. *British Journal of Social and Clinical Psychology, 6,* 278–296.

Heaton, R. K. (1981). *Wisconsin Card Sorting Test: Manual.* Odessa, FL: Psychological Assessment Resources.

Hilbert, N. M., Niederehe, G., & Kahn, R. L. (1976). Accuracy and speed of memory in depressed and organic aged. *Educational Gerontology, 1,* 131–146.

Horn, J. G. L. (1975). Aging and intelligence. In S. Gershon & I. Sherwin (Eds.), *Genesis and treatment of psychologic disorders in the elderly* (pp. 19–44). New York: Raven Press.

Horvath, T. B. (1975). Clinical spectrum and epidemiological features of alcoholic dementia. In J. G. Rankin (Ed.), *Alcohol, drugs and brain damage* (pp. 1–16). Toronto: Addiction Research Foundation.

Iivanainen, M. (1975). Pneumoencephalographic and clinical characteristics of diffuse cerebral atrophy. *Acta Neurologica Scandinavica, 51,* 310–327.

Inglis, J. (1959). A paired-associate learning test for use with elderly psychiatric patients. *Journal of Mental Science, 105,* 440–443.

Jenkins, R. L., & Parsons, O. A. (1979). Lateralized patterns of tactual performance in alcoholics. In M. D. Galanter (Ed.), *Currents in alcoholism,* Vol. 5. New York: Grune & Stratton.

Jones, B. (1971). Verbal and spatial intelligence in short and long term alcoholics. *Journal of Nervous and Mental Diseases, 153,* 292–298.

Joynt, R. J., & Shoulson, I. (1979). Dementia. In K. M. Heilman & E. Valenstein (Eds.), *Clinical neuropsychology* (pp. 475–502). New York: Oxford University Press.

Kahn, R. L., Goldfarb, A. I., Pollack, M., & Peck, A. (1960). Brief objective measures for the determination of mental status in the aged. *American Journal of Psychiatry, 117,* 326–328.

Kahn, R. L., Zarit, S. H., Hilbert, N. M., & Niederehe, G. (1975). Memory complaint and impairment in the aged: The effect of depression and altered brain function. *Archives of General Psychiatry, 32,* 1569–1573.

Kane, R. A., & Kane, R. L. (1981). *Assessing the elderly: A practical guide to measurement*. Lexington, MA: Lexington Books.

Katzman, R. (1986). Alzheimer's disease. *The New England Journal of Medicine, 314*, 964–973.

Kemper, T. (1984). Neuroanatomical and neuropathological changes in normal aging and dementia. In M. Albert (Ed.), *Clinical neurology of aging* (pp. 9–52). New York: Oxford University Press.

Kendrick, D. C., & Post, F. (1967). Differences in cognitive status between healthy, psychiatrically ill, and diffusely brain-damaged elderly subjects. *British Journal of Psychiatry, 113*, 75–81.

Kiloh, L. G. (1961). Pseudo-dementia. *Acta Psychiatrica Scandinavica, 37*, 336–351.

Kinsbourne, M., & Berryhill, J. L. (1972). The nature of the interaction between pacing and the age decrement in learning. *Journal of Gerontology, 27*, 471–477.

Kleinknecht, R. A., & Goldstein, S. G. (1972). Neuropsychological deficits associated with alcoholism: A review and discussion. *Quarterly Journal of Studies on Alcohol, 33*, 999–1019.

Klisz, D. K., & Parsons, O. A. (1977). Hypothesis testing in younger and older alcoholics. *Journal of Abnormal Psychology, 88*, 268–276.

Kramer, N. A., & Jarvik, L. F. (1979). Assessment of intellectual changes in the elderly. In A. Raskin & L. F. Jarvik (Eds.), *Psychiatric symptoms and cognitive loss in the elderly: Evaluation and assessment techniques* (pp. 221–271). Washington, DC: Hemisphere.

LaRue, A., D'Elia, L. F., Clark, E. O., Spar, J. E., & Jarvik, L. F. (1985). Clinical tests of memory in dementia, depression, and healthy aging. *Journal of Psychology and Aging, 1*, 69–77.

Lezak, M. (1976). *Neuropsychological assessment*. New York: Oxford University Press.

Lishman, W. A. (1981). Cerebral disorder in alcoholism. *Brain, 104*, 1–20.

Loizou, L. A., Kendal, B. E., & Marshall, J. (1981). Subcortical arteriosclerotic encephalopathy: A clinical radiological investigation. *Journal of Neurology, Neurosurgery, and Psychiatry, 44*, 294–304.

Loranger, A. W., Goodell, H., McDowell, F. H., Lele, J. E., & Sweet, R. D. (1972). Intellectual impairment in Parkinson's syndrome. *Brain, 95*, 405–412.

Loring, D. W., & Largen, J. W. (1985). Neuropsychological patterns of presenile and senile dementia of the Alzheimer's type. *Neuropsychologia, 23*, 351–357.

MacInnes, W. (1983). Aging and dementia. In C. J. Golden, J. A. Moses, J. A. Coffman, W. R. Miller, & F. D. Strider (Eds.), *Clinical neuropsychology: Interface with neurologic and psychiatry disorders* (pp. 81–101). New York: Grune & Stratton.

Marsden, C. D. (1976). Cerebral atrophy. *Lancet, 2*, 1079.

Martin, W. E., Loewenson, R. B., & Resch, J. A. (1973). Parkinson's disease: Clinical analysis of 100 patients. *Neurology, 23*, 783–790.

Mattis, S. (1976). Mental status examination for organic mental syndrome in the elderly patient. In L. Bellak & T. B. Karasu (Eds.), *Geriatric psychiatry*. New York: Grune & Stratton.

McAllister, T. W., & Price, T. R. (1982). Severe depressive pseudodementia with and without dementia. *American Journal of Psychiatry, 139*, 626–629.

McGarvey, B., Gallagher, D., Thompson, L. W., & Zelinski, E. (1982). Reliability and factor structure of the Zung self-rating depression scale in three age groups. *Essence, 5*, 141–151.

McHugh, P. R., & Folstein, M. F. (1975). Psychiatric syndromes of Huntington's chorea: A clinical and phenomenologic study. In D. F. Benson & D. Blumer (Eds.), *Psychiatric aspects of neurologic disease* (pp. 267–285). New York: Grune & Stratton.

McKhann, G., Drachman, D., Folstein, M., Katzman, R., Price, D., & Stadlan, E. M. (1984). Clinical diagnosis of Alzheimer's disease: Report of the NINCDS-ADRDA work group under the auspices of the Department of Health and Human Services Task Force on Alzheimer's Disease. *Neurology, 34,* 939–944.

Miglioli, M., Buchtel, H. A., Campanini, T., & DeRisio, C. (1979). Cerebral hemispheric lateralization of cognitive deficits due to alcoholism. *Journal of Nervous and Mental Diseases, 167,* 212–217.

Miller, E. (1980). Cognitive assessment of older adults. In J. E. Birren & R. B. Sloane (Eds.), *Handbook of mental health and aging* (pp. 520–536). Englewood Cliffs, NJ: Prentice-Hall.

Miller, E., & Lewis, P. (1977). Recognition memory in elderly patients with depression and dementia: A signal detection analysis. *Journal of Abnormal Psychology, 86,* 84–86.

Miller, W. R. (1975). Psychological deficit in depression. *Psychological Bulletin, 82,* 238–260.

Montgomery, K. M. (1982). *A normative study of neuropsychological test performance of a normal elderly sample.* Unpublished master's thesis, University of Victoria, British Columbia, Canada.

Moss, M. B., Albert, M. S., Butters, N., & Payne, M. (1986). Differential patterns of memory loss among patients with Alzheimer's disease, Huntington's disease and alcoholic Korsakoff's syndrome. *Archives of Neurology, 43,* 239–246.

National Institutes of Health. (1981). *The dementias: Hope through research* (NIH Publication No. 81–2252). Washington, DC: U.S. Government Printing Office.

Naugle, R. I., Cullum, C. H., Bigler, E. D., & Massman, R. J. (1985). Neuropsychological and computerized axial tomography volume characteristics of empirically derived dementia subgroups. *Journal of Nervous and Mental Disease, 173,* 596–604.

Neary, D., Snowden, J. S., Bowen, D. M., Sims, N. R., Mann, D. M., Benton, J. S., Northen, B., Yates, P. O., & Davison, A. N. (1986). Neuropsychological syndromes in presenile dementia due to cerebral atrophy. *Journal of Neurology, Neurosurgery, and Psychiatry, 49,* 163–174.

Niederehe, G., & Camp, C. J. (1985). Signal detection analysis of recognition memory in depressed elderly. *Experimental Aging Research, 11,* 207–213.

Nott, P. N., & Fleminger, J. J. (1975). Pre-senile dementia: The difficulties of early diagnosis. *Acta Psychiatrica Scandanavica, 41,* 210–217.

Parsons, O. A., & Farr, S. P. (1981). The neuropsychology of alcohol and drug use. In S. Fiskow & T. Boll (Eds.), *Handbook of clinical neuropsychology.* New York: Wiley.

Parsons, O. A., Tartar, R., & Edelbert, R. (1972). Altered motor control in chronic alcoholics. *Journal of Abnormal Psychology, 80,* 308–314.

Perlick, D., & Atkins, A. (1984). Variations in the reported age of a patient: A source of bias in the diagnosis of depression and dementia. *Journal of Consulting and Clinical Psychology, 52,* 812–820.

Pollock, M., & Hoinabrook, R. W. (1966). The prevalence, natural history and dementia of Parkinson's disease. *Brain, 89,* 429–448.

Post, F. (1975). Dementia, depression and pseudodementia. In D. F. Benson & D.

Blumer (Eds.), *Psychiatric aspects of neurologic disease* (pp. 99–120). New York: Grune & Stratton.

Rabins, P. V., Merchant, A., & Nestadt, G. (1984). Criteria for diagnosing reversible dementia caused by depression: Validity of a 2-year follow up. *British Journal of Psychiatry, 144,* 488–492.

Raskin, A. (1979). Signs and symptoms of psychopathology in the elderly. In A. Raskin & L. F. Jarvik (Eds.), *Psychiatric symptoms and cognitive loss in the elderly: Evaluation and assessment techniques* (pp. 3–18). Washington, DC: Hemisphere.

Raskin, A., Friedman, A. S., & DiMascio, A. (1982). Cognitive and performance deficits in depression. *Psychopharmacology Bulletin, 18,* 196–202.

Raskin, A., & Jarvik, L. F. (1979). *Psychiatric symptoms and cognitive loss in the elderly: Evaluation and assessment techniques.* Washington, DC: Hemisphere.

Regier, D. A., Myers, J. K., Kramer, M., Robins, L. N., Blazer, D. G., Hough, R. L., Eston, W. W., & Locke, B. Z. (1984). The NIMH epidemiologic catchment area program: Historical context, major objectives and study population characteristics. *Archives of General Psychiatry, 41,* 934–941.

Reifler, B. V. (1982). Arguments for abandoning the term pseudodementia. *Journal of the American Geriatrics Society, 30,* 665–668.

Reifler, B. V., Larson, E., & Hanley, R. (1982). Coexistence of cognitive impairment and depression in geriatric outpatients. *American Journal of Psychiatry, 139,* 623–626.

Reisberg, B., Ferris, S. H., DeLeon, M. J., & Crook, T. (1982). The global deterioration scale for assessment of primary degenerative dementia. *American Journal of Psychiatry, 139,* 1136–1139.

Reitan, R. M. (1955). An investigation of the validity of Halstead's measures of biological intelligence. *Archives of Neurology and Psychiatry, 73,* 28–35.

Reitan, R. M., & Boll, T. J. (1971). Intellectual and cognitive functions in Parkinson's disease. *Journal of Consulting and Clinical Psychology, 37,* 364–369.

Reitan, R. M., & Wolfson, D. (1986). The Halstead-Reitan neuropsychological test battery and aging. In Brink, T. L. (Ed.), *Clinical gerontology: A guide to assessment and intervention* (pp. 39–61). New York: The Haworth Press.

Robins, L. N., Helzer, J. E., Croughan, J., & Ratcliff, K. S. (1981). National Institute of Mental Health Diagnostic Interview Schedule: Its history, characteristics, and validity. *Archives of General Psychiatry, 38,* 381–389.

Ron, M. A., Toone, B. K., Gerralda, M. E., & Lishman, W. A. (1979). Diagnostic accuracy in presenile dementia. *British Journal of Psychology, 134,* 161–168.

Rosen, W. G., Mohs, R. C., & Davis, K. L. (1984). A new rating scale for Alzheimer's disease. *American Journal of Psychiatry, 141,* 1356–1364.

Rosen, W. G., Terry, R. D., Fuld, P. A., Katzman, R., & Peck, A. (1980). Pathological verification of ischemic score in differentiation of dementias. *Annals of Neurology, 7,* 486–488.

Roth, M. (1981). The diagnosis of dementia in late and middle life. In J. A. Mortimer & L. M. Schuman (Eds.). *The epidemiology of dementia* (pp. 24–61). New York: Oxford University Press.

Ryan, C., & Butters, N. (1983). Cognitive deficits in alcoholics. In B. Kissin & H. Begleiter (Eds.), *The pathogenesis of alcoholism,* Vol. 7 (pp. 485–538). New York: Plenum.

Salzman, C., & Shader, R. I. (1979). Clinical evaluation of depression in the elderly. In A. Raskin & L. F. Jarvik (Eds.), *Psychiatric symptoms and cognitive loss in the elderly: Evaluation and assessment techniques* (pp. 39–72). Washington, DC: Hemisphere.

Sandok, B. (1975). Organic brain syndromes. In A. Freedman & H. Kaplan (Eds.), *Comprehensive textbook of psychiatry,* Volume 1 (pp. 1060–1078). Baltimore: Williams & Wilkins.

Schaie, K. W., & Schaie, J. P. (1977). Clinical assessment and aging. In J. E. Birren & K. W. Schaie (Eds.), *Handbook of the psychology of aging* (pp. 692–723). New York: Van Nostrand Reinhold.

Schwab, J. J., Bialow, M., Holzer, C. E., Brown, J. M., & Stevenson, B. E. (1967). Sociocultural aspects of depression in medical inpatients. *Archives of General Psychiatry, 17,* 533–536.

Seltzer, B., & Sherwin, I. (1983). A comparison of clinical features in early- and late-onset primary degenerative dementia: One entity or two? *Archives of Neurology, 40,* 143–146.

Shraberg, D. (1978). The myth of pseudodementia and the aging brain. *American Journal of Psychiatry, 135,* 601–603.

Smith, J. S., & Kiloh, L. G. (1981). The investigation of dementia: Results of 200 consecutive admissions. *Lancet, 1,* 824–827.

Spitzer, R. L., & Endicott, J. (1978). *Schedule for Affective Disorders and Schizophrenia (SADS).* New York: New York State Psychiatric Institute, Biometrics Research Division.

Spitzer, R. L., Endicott, J., & Robins, E. (1978). Research Diagnostic Criteria: Rationale and reliability. *Archives of General Psychiatry, 35,* 773–782.

Squire, L. R. (1986). The neuropsychology of memory dysfunction and its assessment. In I. Grant & K. M. Adams (Eds.), *Neuropsychological assessment of neuropsychiatric disorders* (pp. 268–299). New York: Oxford University Press.

Sweet, R. D., McDowell, H., & Feigenson, J. S. (1976). Mental symptoms in Parkinson's disease during treatment with Levadopa. *Neurology, 26,* 305–310.

Tarter, R. E. (1976). Neuropsychological investigations of alcoholism. In C. Goldstein & C. Neuringer (Eds.), *Empirical studies of alcoholism* (pp. 231–256). Cambridge, MA: Ballinger/Lippincott.

Terry, R., & Katzman, R. (1983). Senile dementia of the Alzheimer type: Defining a disease. In R. Katzman & R. Terry (Eds.), *Neurology of aging* (pp. 51–84). Philadelphia: Davis.

Tomlinson, B. E., Blessed, G., & Roth, M. (1970). Observations on the brains of demented old people. *Journal of Neurological Science, 11,* 205–242.

Vernon, S. W., & Roberts, R. E. (1982). Use of the SADS-RDC in a tri-ethnic community survey. *Archives of General Psychiatry, 39,* 47–52.

Vitaliano, P. P., Breen, A. R., Albert, M. S., Russo, J., & Prinz, P. N. (1984). Memory, attention and functional status in community-residing Alzheimer type dementia patients and optimally healthy aged individuals. *Journal of Gerontology, 39,* 58–64.

Weingartner, H. (1986). Automatic and effort demanding cognitive processes in depression: A model for distinguishing types of impairments in information processing. In L. Poon (Ed.), *Handbook of clinical memory assessment* (pp. 218–225). Washington, DC: American Psychological Association.

Weingartner, H., Kaye, W., Smallberg, S. A., Ebert, M. H., Gillan, J. C., & Sitaram, N. (1981). Memory failures in progressive idiopathic dementia. *Journal of Abnormal Psychology, 90,* 187–199.

Wells, C. E. (1979). Pseudodementia. *American Journal of Psychiatry, 136,* 895–900.

Whitehead, A. (1973). Verbal learning and memory in elderly depressives. *British Journal of Social and Clinical Psychology, 13,* 201–208.

Wilson, R. S., Bacon, L. D., Fox, J. H., & Kazniak, A. W. (1983). Primary memory and secondary memory in dementia of the Alzheimer type. *The Journal of Clinical Neurology, 5,* 337–344.

Woodard, J. S. (1962). Clinicopathologic significance of granulovacuolar degeneration in Alzheimer's disease. *Journal of Neuropathology and Experimental Neurology, 21,* 85–91.

Yesavage, J., Brink, T., Rose, T., Lum, O., Huand, O., Adey, V., & Leirer, V. (1983). Development and validation of a geriatric depression screening scale: A preliminary report. *Journal of Psychiatric Research, 17,* 37–49.

Zarit, S. H., Miller, N., & Kahn, R. L. (1978). Brain function, intellectual impairment and education in the aged. *Journal of the American Geriatrics Society, 26,* 58–67.

Zung, W. (1965). A self-rating depression scale. *Archives of General Psychiatry, 12,* 63–70.

Zung, W., & Green, R. L. (1973). Detection of affective disorders in the aged. In C. Eisdorfer & W. E. Fann (Eds.), *Psychopharmacology and aging* (pp. 213–223). New York: Plenum.

Zung, W., & Zung, E. M. (1986). Use of the Zung Self-Rating Depression Scale. In Brink, T. L. (Eds.), *Clinical gerontology: A guide to assessment and intervention* (pp. 137–148). New York: The Haworth Press.

# Index

*This page intentionally left blank*

# Index


Abel, L. A., 39
Abelson, H., 73
Abramson, L. Y., 66
Accomodative identity style, 195–197, 205–209
  differences from assimilative style, 208–209
  hypersensitivity to age changes, 206
  hysterical diffuseness, 195–196
  impulsiveness, 196–197
  neurotic preoccupation with health, 207–208
  potential gain from "senior citizen" identity, 206–207
Adam, J., 128
Adams, C., 63
Adaptation to aging, identity styles and, 197–201
Adaptation-level theory, sensory-perceptual processes and, 33
Age Discrimination in Employment Acts, 243, 244, 253–255
Ageism, 217
  *see also* Perceptions of aging and elderly
Albert, M. L., 303
Albert, M. S., 300, 303, 308
Alcohol, memory and, 73–75
Alexander, M. P., 305
Alzheimer's disease, 301, 302, 305–306
Alzheimer's Disease Assessment Scale (ADAS), 302
Anders, T. R., 11
Anderson, C. A., 63
Anderson, J. R., 58
Anderson, N. H., 221
Andrews, F. M., 203
Anthony, J. C., 302
Anxiety, memory and, 67
Anxiety reduction, memory and, 77
Arenberg, D., 141
Arvey, R. D., 253
Assimilative identity style, 194–195, 201–205
  denial of aging, 202–203
  differences from accomodative style, 208–209
  effects on health, 204–205
  obsessive-compulsive rigidity, 194
  origin in childhood, 202
  paranoid thinking, 194–195
  projection as function of extreme assimilation, 203–204
Atkinson, R. C., 58
Attention enhancement, memory and, 77
Attitudes vs. beliefs, 219
Attneave, F., 31
Audition
  aging and, 40–46
  auditory indices of biological aging, 45
  memory and, 75–76
  noise exposure and age effects, 42–43
  presbycusis, 41–42
  social impact of hearing loss in elderly, 45–46
  speech intelligibility, 43–44
  structural changes in auditory system with age, 40–41
  tinnitus, 43
Austin, D. R., 60, 229–230
Autobiographical memory, 59
Avolio, B. J., 252, 253, 259
Avorn, J., 75

Backman, L., 181
Balanced identity style, 197, 209–212
  benefits of, 209–210
  costs of, 211–212
Balint, M., 206
Baltes, P. B., 62, 123, 140, 160, 170, 173, 174, 175, 180, 205, 271, 273, 273–274, 277, 279
Balzer, D., 67
Bandura, A., 60, 66, 248, 250
Banziger, G., 232
Bardwick, J. M., 246
Barrett, T. R., 149
Barrick, M. R., 250
Barrow, G. M., 217, 235
Barrows, C. H., 71
Bartoshuk, L. M., 47
Bartus, R. T., 72
Bashore, T. R., 6, 13, 14, 19
Baugher, D., 128
Baum, B. J., 46
Beattie, R. C., 44
Beck, A. T., 67, 299

Beck Depression Inventory (BDI), 299
Belbin, E., 78, 250, 251
Beliefs vs. attitudes, 219
Bell, B. D., 224
Bellucci, G., 162
Belmore, S. M., 108
Bennett, E. S., 127
Bennett, R., 219
Benson, D. F., 308
Benton Visual Retention Test, 311
Beres, C., 166, 168
Berg, C., 120, 175, 176
Berg, S., 124
Berglund, M., 307
Berry, J. M., 66, 68, 78
Birren, J. E., 1, 2, 10, 101, 125, 139, 244, 266
Blackburn, J., 171
Blazer, D., 296
Blessed, G., 305
Block, R., 75
Blum, M. L., 251
Blumenthal, J. A., 207
Bornstein, M. H., 40
Botwinick, J., 62, 98, 122, 125, 180
Braff, D. L., 39
Braithwaite, V. A., 221, 225, 230
Brewer, M. B., 232, 233–234, 236
Brief Symptom Inventory (BSI), 299–300
Britton, B. K., 111
Brown, W. S., 7, 17
Bruce, P. R., 63
Buccola, V., 211
Buell, S. J., 121
Bultena, G. L., 202
Burke, D. M., 93
Burr, M. L., 72
Butler, R. N., 60, 68, 217
Butler, R. W., 127

Cameron, P., 221, 222
Campbell, A., 203
Campbell, D., 161, 162
Campbell, J. D., 65
Caplan, L. R., 307
Career development, 245–248
Carp, F. M., 199, 207, 222
Carroll, B. J., 298
Caspi, A., 282
Categories Test, 304
Cattell, R. B., 273, 277
Cavanaugh, J. C., 60, 61, 63, 64, 66, 67, 68, 77, 78
Central Institute for the Deaf (C.I.D.) Auditory Test W-22, 43–44
Cerella, J., 2, 10, 13–14, 120, 125, 176
Cervellera, G., 41
Chaffin, R., 60
Chapman, L. J., 20
Charness, N., 144–145
Chase, W. G., 120, 137
Chi, M. T. H., 137
Clark, J., 182
Clayton, V., 126
Coan, R. W., 192
Coben, L. A., 17
Cognitive changes in normal aging, 2–16, 180–182
Cognitive training
  age-comparative studies of magnitude of training effects, 162–168
  and everyday competence, 176–180
  experimental conditions associated with training effects, 168–172
  irreversible decrement, 181
  major questions in research, 159–176
  models of intellectual aging, 180–182
  nature of training improvement, 172–176
  practical intelligence, 176–177, 179–180
  range of plasticity/variability in training improvement, 160–162
  reversible decline, 180–181
  stability, 182
  traditional and practical intelligence, 177–179
Cohen, D., 123
Cohen, G., 100, 101, 108, 109
Color vision, 40
Commons, M., 177
Comprehensive Assessment and Referral Evaluation (CARE), 298
Computed tomography (CT) scans, 16
Conceptual memory, 59
Conley, J. J., 193, 198
Connor, C. L., 226, 230
Contingent negative variation (CNV), 4, 5
Contrast-sensitivity function (CSF), 35–36
Coping strategies, personality and, 200
Cornelius, S. W., 124, 149, 274, 277

Corso, J. F., 29, 30, 31, 32, 33, 34, 35, 40, 41, 42, 43, 44, 45, 46, 47, 48, 49, 76, 304
Costa, P. T., 68, 192, 193, 207, 208, 279, 282, 283
Cotman, C. W., 98
Coyne, A. C., 66, 166, 168
Coyne, J. C., 212
Craik, F. I., 59, 61, 94
Creasy, H., 121
Creutzfeldt-Jacob disease, 301
Crockett, W. H., 220, 225, 235, 236
Cronbach, L., 162
Cross, K. P., 249, 252
Crystallized intelligence, experience and, 138–140
Cummings, J. L., 306
Cunningham, W. R., 122, 123, 124, 126, 272, 273, 277, 278
Cutler, N. R., 305
Czaja, S. J., 251

Danziger, W. L., 38
Davey, C. P., 70
Davies, D. R., 244
Deimling, G. R., 199
Dementia
  alcohol, 307–308
  Alzheimer's disease, 305–306
  assessment of, 300–303
  laboratory examinations, 304–305
  multi-infarct, 306–307
  neuropsychological testing, 303–304
  pseudo, 309–311
  subcortical, 308–309
  syndromes of, 305–309
Demming, J. A., 139
DeMuth, G. W., 311
Denial of aging, 202–203
Denney, N. W., 62, 159, 160, 162, 170
Depression
  assessment of, 296–300
  cognitive decline with, 309–314
  interview techniques, 296–298
  memory and, 67
  pseudodementia, 309–311
  self-rating scales, 299–300
Derogatis, L. R., 299
Detterman, D. K., 174
deVries, H. A., 69
Diagnostic Interview Schedule (DIS), 297
Disuse theory of aging, 148, 149
Dixon, R. A., 60, 61, 63, 66, 100, 103, 104, 109, 110, 127, 128, 177
Doering, M., 244, 245, 250, 253, 254
Donaldson, G., 172, 173, 174
Donchin, E., 2, 6, 7, 8, 10, 14, 15
Drachman, D. A., 121
Drugs, memory and, 75
DSM-III, 296, 297
Duffy, F. S., 7
Dustman, R. E., 3, 4, 70
Dwyer, J. H., 276

Edelman, C. D., 254
Eisdorfer, C., 68, 78
Ekstrom, R. B., 96, 117
Electroencephalogram, research on cognitive change in normal aging, 2–4, 16–17, 19
  P300, 6–10
  P300 and the maintenance of working memory, 15–16
  P300, RT, and the slowing of behavior, 13–15
  P300/RT relationships in memory function, 10–13
Elsayed, M., 70
Emery, O. B., 43
Endicott, J., 297
Eriksen, C. W., 11
Event-related brain potentials (ERPs), 2, 5, 6, 8, 10, 11, 15, 17, 18, 19, 21
Expectations, memory and, 65–66
Experience, openness to, identity styles and, 192–193
Experience in cognitive aging, role of, 135–153
  conceptualizations of, 147–152
  direct manipulation of experience, 140–142
  experience and crystallized intelligence, 138–140
  expertise research, overview of, 136–137
  Molar Equivalence–Molecular Decomposition Strategy, 144–147
  occupational experience studies, 142–144
Expertise research, overview of, 136–137
  *see also* Experience in cognitive aging
Eye movements, 38–39

Face-Hand Test, 301–302
Faris, J. B., 48
Farwell, L. A., 10, 15
Feldman, R., 76
Ferris, S., 127
Fink, M., 301–302
Fischer, D. H., 218
Fisher, C. H., 307
Fitzgerald, J. M., 220
Flavell, J. H., 62
Flynn, J. H., 227
Folkins, C. H., 207
Folstein, M. R., 302
Ford, J. M., 6, 7, 8, 9, 10, 11, 12, 13, 14
Foster, J. M., 199
Foulds, G. A., 122
Fowler, C. G., 41
Fozard, J. L., 36
Frederickson, N., 118
Freemon, F. P., 307
Friedland, R. P., 305
Fuld, P. A., 306
Fuld Object-Memory Evaluation, 311

Gagne, R. M., 251
Gaitz, C. M., 296
Gallagher, D., 299
Garber, J., 67
Gardner, E. F., 139
Garfein, A., 182
George, L. K., 67, 200
Gerbner, G., 60
Geriatric Depression Scale (GDS), 300
Gerken, G. M., 44
Giaquinto, S., 4
Gilchrest, B. A., 30
Gillund, G., 59
Gintner, G. G., 19
Ginzberg, E., 246
Global Deterioration Scale (GDS), 302
Glynn, S. M., 96, 97
Golden, C. J., 304
Goldney, R. D., 203
Goldstein, I. I., 250, 251
Goodin, D. S., 6, 7, 16, 17, 18
Goodstein, R. K., 67
Goodwin, D., 71, 72, 74
Gordon, S. K., 102
Gotlib, I. H., 67
Grant, E., 166, 168
Green, S. K., 217, 218, 222
Greene, V. L., 120
Grice, G. R., 11
Gruneberg, M. M., 62
Guilford, J. P., 118
Gurland, B., 296, 298
Gustafsson, J.-E., 274
Gustatory system, aging and, 46–47

Haase, G. R., 300
Hachinski, V. C., 301, 307
Hale, W. D., 300
Hall, D. T., 247, 248
Hall, J. W., 44–45
Hamilton Rating Scale for Depression (HRSD), 298
Han, S. S., 30
Harker, J. O., 102
Harkins, S. W., 47
Harris, J. E., 62, 77
Harris, L., 202, 219, 220, 222, 231
Hartley, G. H., 211
Hartley, J. T., 93, 95, 96, 97, 98, 99, 101
Havighurst, R. J., 244
Hayslip, B., Jr., 273
Haywood, K. M., 38–39
Hearing Handicap Inventory for the Elderly, 45
Hearing loss
  social impact of, in elderly, 45–46
  *see also* Audition
Heaton, R. K., 304
Hebb, D. O., 138
Heinzelman, F., 210
Hellerstein, H. K., 205
Helson, H., 32
Henig, R. M., 60
Hertzog, C., 60, 66, 123, 127, 208, 266, 270, 272, 275, 277, 278, 279–280, 287, 288
Hinchcliffe, R., 30
Hoff, E. H., 248
Hofland, B. F., 174, 175
Honjo, I., 45
Horn, J. L., 62, 118, 124, 138, 139, 273, 274, 276, 307
Hornblum, J. N., 169
Horvath, T. B., 307
House, J. S., 198
Howell, S. C., 48
Hoyer, W., 169, 171, 181
Hoyer, W. J., 30, 205

Hulicka, I. M., 251
Hultsch, D. F., 93, 96, 99, 102, 109, 110, 251, 272
Hunter, J. E., 253
Huntington's chorea, 308, 309
Hysterical neurotic style, 195
  *see also* Accomodative identity style

Identity accomodation, 190
  *see also* Accomodative identity style
Identity assimilation, 190
  *see also* Assimilative identity style
Identity styles, 189–191
  accomodative, 195–197, 205–209
  and adaptation to aging, 197–201
  assimilative, 194–195, 201–205
  balanced, 197, 209–212
  forms of, 193–197
  individual differences in identity processes, 191–192
  model of identity processes, 189–191
  and openness to experience, 192–193
Impulsive identity style, 196–197
  *see also* Accomodative identity style
Industrial gerontology, 243–259
  *see also* Work, elderly and
Information processing speed, individual differences in, 266–270
Information theory, sensory-perceptual processes and, 31–33
Inglis Paired Associate Learning Test, 311
Intellectual abilities, age and, 117–129
  level of performance studies, 123–127
  methodological issues, 128
  nature of aging, 120–121
  relationships with other variables, 127–128
  structural studies, 122–123
  theories and models of intelligence, 118–120
Intellectual aging, models of, 180–182
Intelligence, theories and models of, 118–120
Irreversible decrement, 181
Ismail, A. H., 210
Ivester, C., 221

James, William, 140
Jantz, L., 221
Jarvik, L. K., 30
Jobs, *see* Work, elderly and
Johnson, D. F., 251
Johnson, R., 15
Johnson, R. E., 103
Johnsson, L. G., 40
Jones, H. E., 122
Joreskog, K. G., 269
Joynt, R. J., 306

Kahn, R. L., 67, 68, 78, 301–302
Kalish, R. A., 60
Kane, R. A., 301
Katz, R., 3, 246
Katzman, R., 301, 305
Kausler, D. H., 10, 32, 122, 125
Keeney, A. H., 35
Kemper, T., 305
Kennelly, K. J., 67
Kerlinger, F., 162, 166
Kidwell, I. J., 221
Kiloh, L. G., 309
Kinsbourne, M., 304
Kintsch, W., 103
Kirby, N. H., 8
Klemack, D. L., 220, 222
Klerman, G. L., 67
Kliegl, R., 160, 180
Kline, D. W., 36, 39, 40
Kogan, N., 217, 218, 219, 222, 223, 228–229
Kohut, H., 202, 206
Kreitler, H., 191
Kucharski, L. T., 227
Kutas, M., 12, 14
Kuypers, J. A., 60

Labouvie, E. W., 122
Labouvie-Vief, G., 174, 177, 220
Lachman, J. L., 62, 63, 78
Lachman, M. E., 124, 277–278, 284–285, 286
Lachman, R., 11, 139
Laing, R. D., 204
Lair, T. J., 282, 283–284
LaRiviere, J. E., 143
LaRue, A., 128, 311, 313
Laufer, A. C., 257
Layton, B., 32
Lazarus, R. S., 67, 199, 200, 205
Learned helplessness, 66
Le Breck, D., 162, 166
Leng, N., 210

Lerman, S., 35
Levin, J., 217, 227
Liang, J., 285–286
Light, L. L., 108
Lillard, L. A., 249
Lines and figures, judgment of, 36–38
Linton, S. J., 47
Linville, P. W., 236
Linville, S. E., 45
LISREL, 282, 283, 284
Locke-Connor, C., 226
Locus of control, 66
Loftus, G. R., 58
Loizou, L. A., 307
Long, J., 74
Lorden, R., 37
Lorge, I., 122
Loring, D. W., 306
Lowenthal, M. F., 68
Lutsky, N. S., 217, 218, 220, 222, 224, 228

MacInnes, W., 307
Mackworth Clock, 36
Madden, D. J., 11
Malin, H., 73
Mandel, R. G., 101, 103, 106, 107, 109
Mandler, G., 59
Mandler, J. M., 106
Marcia, J. E., 192
Markus, H., 190
Marsden, C. D., 307
Marsh, G. R., 3, 4, 5, 6, 11
Masking-level difference (MLD) test, 41–42
Masuda, M., 198
Mattis, S., 303
Mattis Dementia Rating Scale, 302–303
McCarthy, G., 19
McClelland, D., 177
McCrae, R. R., 198
McFarland, R. A., 258
McGarvey, B., 299
McGhee, W., 251
McHugh, P. R., 308
McKhann, G., 305
McPherson, B. D., 205
McTavish, D., 219
Memory
  age-correlated factors that affect, 64–76
  and aging, 57–79
  alcohol and, 73–75
  anxiety and, 67
  anxiety reduction and, 77–78
  attention enhancement and, 77–78
  auditory deficits and, 75–76
  autobiographical, 59
  behavioral data about memory aging, 61–64
  capacity, 61
  conceptual, 59
  conceptualization of, 58–59
  contents, 59, 62–63
  depression and, 67
  drugs and, 75
  encoding processes, 59
  mental health and, 67–69
  nutritional status and, 70–73
  P300 and maintenance of working, 15–16
  P300/RT relationships in function of, 10–13
  physical fitness and, 69–70
  psychological expectations and, 65–66
  questionnaire data about memory aging, 60–61
  remediation of problems of, 76–79
  retrieval processes, 59
  sensory functioning and, 75–76
  stereotypes about memory aging, 60
  storage structures and, 58
  transfer processes, 58–59, 61–62
Memory aids, 77
  external, 77
  internal, 77
Memory complaint, 68
Memory training programs, 78–79
Mental health, memory and, 67–69
Mental status examination, 301
Mental Status Questionnaire (MSQ), 301–302
Mergler, N., 168, 171
Messick, S., 267
Metacognitive knowledge, 59
Meyer, B. J. F., 93, 94, 95, 96, 97, 98, 100, 103, 104–105, 106, 107, 108, 109, 110
Michaelewski, H. J., 5, 7, 8
Miller, E., 304, 306, 311
Milner, B., 16
Mini-Mental Status Examination (MMSE), 302
Mishara, B., 74

Molar Equivalence—Molecular Decomposition Strategy, 144–147
Monat, A., 200
Montgomery, K. M., 303
Moore, J. L., 30
Morgan, C. M., 202
Morris, P. E., 77
Moss, M. B., 304, 313
Mueller, J. E., 30
Mullen, C., 251
Mullis, R. J., 7, 8
Murphy, M. D., 63, 66
Murphy, S. B., 35, 47
Murrell, K. F. H., 143

National Institute on Aging, 30, 49, 255
National Institutes of Health, 306
Naugle, R. I., 305
Naus, P., 221
Navon, D., 31
Neary, D., 305
Neisser, U., 62
Neopolitan, J., 248
Nesselroade, J. R., 287
Neugarten, B., 198, 212
Newquist, D. D., 258
Ninimaa, V., 69
Noise exposure and age effects, 42–43
Norris, M. L., 46
Nott, P. N., 310
Novak, R. E., 41
Nuclear magnetic resonance imaging (NMR, MRI), 17
Nuessel, F. H., 217
Nutritional status, memory and, 70–73

Obsessive-compulsive neurotic style, 194
  *see also* Assimilative identity style
Occupational experience studies, 142–144
O'Connell, A. N., 225
O'Hara, M. W., 68
Olsson, V., 271
Openness to experience, identity styles and, 192–193
Osipow, S. H., 246
O'Sullivan, C. S., 237
O'Toole, J., 249
Overton, W. F., 170
Owens, W. A., 122
Owsley, C., 36

P300, 6–10
  and maintenance of working memory, 15–16
  RT, and the slowing of behavior, 13–15
  /RT relationships in memory function, 10–13
  specificity of changes, 15–16
Pain, aging and, 47
Palmore, E. B., 60, 217, 218, 219, 222
Paranoid identity style, 194–195
  *see also* Accomodative identity style
Parker, E., 73
Parkinson's disease, 308, 309
Passuth, P. M., 60
Patchett, M. B., 246
Paulman, R. G., 67
Paykel, E. S., 67
Penner, M. J., 43
Perceived locus of control, 66
Perceptions of aging and elderly, 217–238
  effect of age on perceptions, 228–232
  elderly in general, 218–223
  multiple categories for elderly, 232–235
  specific individuals, 223–228
Perlick, D., 310
Perlmutter, M., 20, 59, 60, 61, 62, 63
Perri, S., 210
Perry, R. E., 226
Personality development, 189–212
  *see also* Identity styles
Personality traits attributed to elderly, 220–221
Petros, T., 94, 101, 106, 110, 266
Petty, R. E., 221
Pfefferbaum, A., 7, 8, 10, 11, 14, 17, 18
Physical fitness, memory and, 69–70
Physical health
  accomodative identity style and, 207–208
  assimilative identity style and, 204–205
  life style effects and, 208
  and psychological well-being, 199–200
Piaget, J., 37, 59, 190
Picek, J. S., 236
Pickett, J. M., 48
Picton, T. W., 7, 8
Plotkin, D. A., 69

Plouffe, L., 20
Podlesny, J. A., 5, 7, 8
Polich, J., 6, 7, 17
Poon, L. W., 61, 76, 79, 149, 160, 170, 172
Popkin, S. T., 68, 78
Powell, D. A., 210
Powell, R. R., 69–70
Practical intelligence, 176–177, 177–179
  cognitive training and, 179–180
  and traditional intelligence, 177–179
Presbycusis, 41–42
Prohaska, T. R., 127
Projection, assimilative identity style and, 203–204
Pseudodementia, 309–311
Psychiatric disease in the elderly, 16–19
  general health and the inevitability of CNS decline, 19
  specificity of P300 changes, 17–18
  *see also* Dementia; Depression
Psychological expectations, memory and, 65–66
Psychophysiological research, geriatric, 1–21
  contingent negative variation (CNV), 4, 5
  electroencephalogram, 2–4, 16–17, 19
  general health and the inevitability of CNS decline, 19
  normal aging, cognitive changes in, 2–16
  P300, 6–10
  P300 and the maintenance of working memory, 15–16
  P300, RT, and the slowing of behavior, 13–15
  P300/RT relationships in memory function, 10–13
  psychiatric and neurological disease, 16–19
  specificity of P300 changes, 17–18
Puckett, J. M., 226

Quilter, R. E., 36

Rabbitt, P., 8, 9, 59
Rabins, P. V., 310
Raskin, A., 204, 299
Reaction time (RT), 2, 4, 8–9, 10, 16, 19, 266–268, 270
Reading comprehension
  aging and, 93–112
  differential recall of main ideas and details, 106–110
  education and vocabulary levels, 94–98
  identification of important ideas, 106
  instruction and types of dependent variables, 102
  methods used to examine prose recall, 103–104
  presentation modes and rate, 100–101
  reader variables, 94–99
  task variables, 99–102
  text variables, 102–110
  use of text's top-level organization, 104–105
Reese, H. W., 62
Regier, D. A., 297
Reifler, B. V., 311
Reinert, G., 173, 271, 272
Reisberg, B., 302
Reitan, R. M., 304
Reno, R., 224, 232
Reversible decline, 180–181
Rhodes, S. R., 255, 256, 257, 258
Rice, G. E., 96, 97, 98, 105
Riegel, K. F., 278
Ritter, W., 14
Roberts, P., 60
Robertson, I., 253
Robins, L. N., 297
Robinson, D. W., 42
Robinson, P. K., 244
Rochlin, G., 191
Rockstein, M., 75
Rodin, J., 60, 66, 68
Rohrbaugh, J. W., 5
Ron, M. A., 310
Rosch, E., 232–233
Rosen, B., 226, 244, 250, 254
Rosen, W. G., 302, 307
Rosenbaum, J. E., 248
Rosenberg, G., 169
Rosenkranz, H., 225
Rosenthal, M. J., 75
Roth, S., 200, 201, 203
Royer, F. L., 126
Rubin, K. H., 220
Rumelhart, D. E., 32, 236
Ruth, J., 126
Ryan, C., 308

Ryan, E. B., 45, 224

Salthouse, T. A., 2, 10, 11, 13, 14, 125, 137, 138, 144, 182, 251, 253, 258, 266
Salvendy, G., 253
Salzman, C., 299
Samorajski, T., 70
Sanders, J. C., 170, 171
Sarason, I. G., 67
Schaie, K. W., 62, 94, 122, 124, 125, 126, 128, 161, 163–164, 166, 172, 173, 174, 177, 178, 179, 258, 271, 272, 278, 279, 281, 286, 304
Schedule for Affective Disorders and Schizophrenia (SADS), 296–297
Scheidt, R. J., 47–48
Scheier, M. F., 229, 237
Schein, E. H., 248
Schlenker, E. D., 71
Schmidt, D. F., 220, 234, 236, 237
Schmidt, F. A., 251
Schmitt, J. F., 44
Schonfield, D., 60
Schrank, H. T., 245
Schroth, M. L., 124
Schuckit, M., 74
Schuknecht, H. F., 41
Schultz, N. R., 169, 175
Schwab, D. P., 226
Schwab, J. J., 298
Schwartz, M. M., 191
Scogin, F. R., 62, 66, 68, 168, 171, 207
Sekuler, R., 36, 37, 40, 49
Self-efficacy expectations, 66
Seltzer, B., 306
Semantic Memory Access (SMA) speed, 267–270
Sensory functioning, memory and, 75–76
Sensory-perceptual deficits, methods of adjustment for, 47–49
Sensory-perceptual processes and aging, 29–49
  adaptation-level theory, 33–34
  audition, 40–46
  behavioral consequences of deficits, 47–48
  information theory, 31–33
  methods of adjustment for deficits, 47–49
  models and theories, 30–34
  signal-detection theory, 33
  vision, 35–40
Shapira, N., 46
Shapiro, D., 193, 194–195, 196, 197, 206
Shaver, K. G., 231, 232, 237
Shenfield, M. E., 210
Shepherd, R. J., 19, 211
Sherman, N., 225
Shiffrin, R. M., 59
Shipley, W. C., 97
Shock, N. W., 120
Showers, C., 200
Shupe, D. R., 66
Siegel, I. C., 10
Siegler, I. C.
Siemen, J. R., 250
Signal-detection theory, sensory-perceptual processes and, 33
Signoret, J. L., 72
Simon, E. W., 102
Simons, R. L., 211
Slaets, J. P. L., 18
Slowing of behavior, P300, RT and, 13–15
Smith, A., 181
Smith, D. B. D., 7
Smith, J. S., 305
Smith, K. U., 143
Smith, S. W., 94, 99, 103
Snyder, E., 7
Sohmer, H., 41
Sonstroem, R. J., 210
Spatial vision, 35–36
Speech intelligibility, 43–44
Sperbeck, D. S., 193
Spielberger's State Anxiety Scale, 287, 288
Spilich, G. J., 102, 109
Spitzer, R. L., 296
Spoor, A., 42
Squire, L. R., 313
Squires, K. C., 6, 8–9, 17
Stability, 182
Stability coefficient, 279
Stability of individual differences, 279–280
Stafford, J. L., 258
Starr, Arnold, 6
Stereotypes
  about aging and elderly, 217–238
  about memory aging, 60

*see also* Perceptions of aging and elderly
Sternberg, R. J., 118–120, 174, 177
Sternberg, S., 10–11, 12
Sterns, H. L., 159, 246, 249, 250, 258
Stewart, M. A., 45
Stewman, S., 255
Stier, D. L., 225
Stine, E. L., 100–101
Storandt, M., 127, 128
Storrie, M. C., 6
Strack, S., 67
Strayer, D. L., 10, 11, 12–13, 14
Stricker, L. J., 123, 272
Stroop Color Naming Test, 304
Structural equation models (SEM), 265–289
  individual differences in information processing speed, 266–270
  longitudinal, of age changes in intelligence, 275–281
  for measurement properties of scales, 286–289
  for psychometric intelligence, 270–274
  structural regression applications, 282–286
Structural regression model, 265
Suls, J., 60
Super, D. E., 245, 248
Supranuclear palsy, progressive, 308, 309
Surber, J. R., 99, 101, 102, 110
Syndulko, K., 7
Szanto, C., 43

Taub, H. A., 100, 162, 166
Taylor, S. E., 200
Tecce, J. J., 5, 7, 9
Terry, R., 305
Tessler, R., 200, 207, 208
Thomas, E., 221
Thompson, D. N., 95, 101
Thompson, L. W., 4
Thurstone, L. L., 178
Thurstone PMA battery, 279–280
Tibbitts, C. W., 60, 230
Tinnitus, 43
Tomlinson, B. E., 307
Tomoda, K., 40
Traditional intelligence, 177–179
Treat, N. J., 78, 251
Tringo, J. L., 229
Tripathi, R. C., 35
Tuckman, J., 219
Tulving, E., 59
Turvey, M., 39
Tyler, R. S., 43

U.S. House Select Committee on Aging, 255

Valasek, D. L., 250
Van Deusen, J., 38
Vernon, S. W., 296
Verrillo, R. T., 46
Vibrotactile system, aging and, 46
Viega, J. F., 248
Vigilance, 36
Vincent, J. P., 105
Vision
  aging and, 35–40
  color, 40
  eye movements, 38–39
  judgment of lines and figures, 36–38
  spatial, 35–36
  structural changes in, 35
  vigilance, 36
  visual indices of biological aging, 40
  visual masking, 39
Visual indices of biological aging, 40
Visual masking, 39
Vondracek, F. W., 245

Walaskay, M., 203
Waldman, D. A., 256, 257
Walsh, D. A., 39
Walsh, R. P., 225, 232
Weale, R. A., 30
Weg, R. B., 46
Weiberger, M., 199
Weiffenbach, J. M., 46
Weinberg, R. S., 65
Weinberger, A., 221, 227–228
Weinberger, L. E., 224, 229
Weingartner, H., 306, 309
Weinstein, B. E., 45, 46
Weiss, A., 75
Welford, A. T., 32, 70, 244, 251
West, R. L., 66, 68
Wexley, K. N., 251
Whitbourne, S. K., 189–190, 191, 192, 193, 203, 205
White, N., 60, 61, 123
Williams, S. A., 60, 61

Willis, S. L., 140, 152, 164, 171, 172, 173, 174, 175, 176, 177, 178, 182
Wills, T. A., 210
Wilson, B., 181
Wilson, R. S., 306
Wingard, J. A., 222
Winnicott, D. W., 204, 206
Winograd, E., 78
Wisconsin Card Sorting Test, 304
Wiswell, R. A., 69
Witt, S. J., 127
Woodard, J. S., 305
Work, elderly and
  absenteeism, 258
  Age Discrimination in Employment Acts, 243, 244, 253–255
  career development, 245–248
  definitions, 243
  job attitudes, 257
  job interviews, 252–253
  job performance, 255–258
  job-relevant training, 249–252
  selection, 252–253
  selection testing, 253
  training and development, 249–252

Yesavage, J. A., 68, 69, 76, 78, 169, 170, 171, 172, 300

Zarit, S. H., 64, 66, 67, 68, 73, 76, 79, 181, 302
Zelinski, E. M., 60, 101, 103, 109, 110
Zung, W., 299
Zung Self-rating Depression Scale, 299