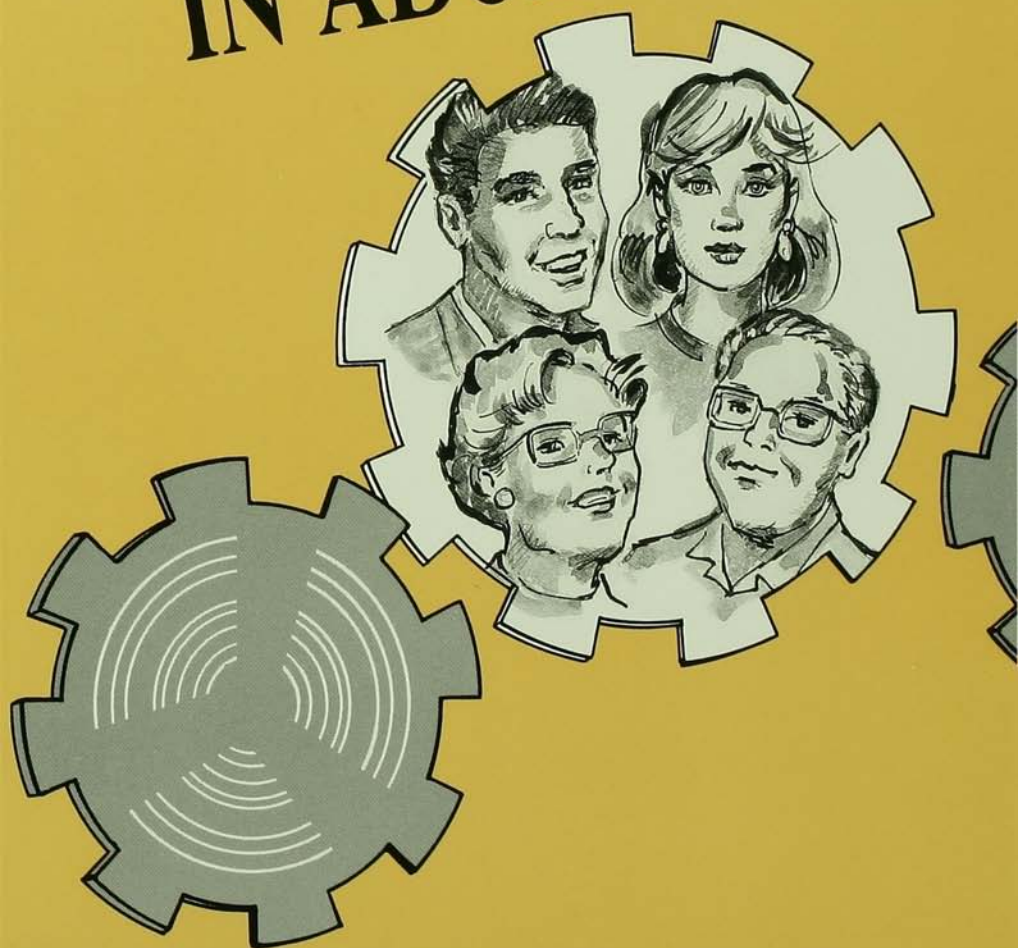


# MECHANISMS OF AGE-COGNITION RELATIONS IN ADULTHOOD



TIMOTHY A. SALTHOUSE

# **Mechanisms of Age-Cognition Relations in Adulthood**

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Timothy A. Salthouse  
*Georgia Institute of Technology*



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# Preface

This monograph is the written version of a series of talks delivered as the 1991 MacEachern Lectures at the University of Alberta. The informal style of the lectures, and the inclusion of a relatively large number of figures, has been preserved in order to keep the monograph faithful to the concept of an individual describing his own research. I viewed the lecture series as an opportunity to integrate the results of my research over the last 5 years into a single, reasonably coherent, framework. The monograph thus is very much a personal account of one individual's perspective and research, although the studies reported are naturally a product of many collaborations, and of inspirations from numerous colleagues.

I would like to acknowledge financial support from the National Institute on Aging through Grants AG06826 and AG06858 that made the research described in this monograph possible. I also want to thank Professors Neil Charness and Robert Kail for their thoughtful critiques of a draft of this monograph, the faculty and students at the University of Alberta for their stimulating questions and comments regarding the lectures, and the graduate students in the Cognitive Aging Program at the Georgia Institute of Technology for providing feedback on several of the ideas discussed in this monograph as they were in the process of being developed.

*Timothy A. Salthouse*

# John M. MacEachran Memorial Lecture Series

The Department of Psychology at the University of Alberta inaugurated the MacEachran Memorial Lecture Series in 1975 in honor of the late John M. MacEachran. Professor MacEachran was born in Ontario in 1877 and received a Ph.D. in Philosophy from Queen's University in 1905. In 1906 he left for Germany to begin more formal study in psychology, first spending just less than a year in Berlin with Stumpf, and then moving to Leipzig, where he completed a second Ph.D. in 1908 with Wundt as his supervisor. During this period he also spent time in Paris studying under Durkheim and Henri Bergson. With these impressive qualifications the University of Alberta was particularly fortunate in attracting him to its faculty in 1909.

Professor MacEachran's impact has been significant at the university, provincial, and national levels. At the University of Alberta he offered the first courses in psychology and subsequently served as Head of the Department of Philosophy and Psychology and Provost of the University until his retirement in 1945. It was largely owing to his activities and example that several areas of academic study were established on a firm and enduring basis. In addition to playing a major role in establishing the Faculties of Medicine, Education and Law in the Province, Professor MacEachran was also instrumental in the formative stages of the Mental Health Movement in Alberta. At a national level, he was one of the founders of the Canadian Psychological Association and also became its first Honorary President in 1939. John M. MacEachran was indeed one of the pioneers in the development of psychology in Canada.

Perhaps the most significant aspect of the MacEachran Memorial Lecture Series has been the continuing agreement that the Department of Psychology at the University of Alberta has with Lawrence Erlbaum Associates, Publishers, Inc., for the publication of each lecture series. The following is a list of the Invited Speakers and the titles of their published lectures:

- 1975 Frank A. Geldard (Princeton University)  
 “Sensory Saltation: Mestastability in the Perceptual World”
- 1976 Benton J. Underwood (Northwestern University)  
 “Temporal Codes for Memories: Issues and Problems”
- 1977 David Elkind (Rochester University)  
 “The Child’s Reality: Three Developmental Themes”
- 1978 Harold Kelley (University of California at Los Angeles)  
 “Personal Relationships: Their Structures and Processes”
- 1979 Robert Rescorla (Yale University)  
 “Pavlovian Second-Order Conditioning: Studies in Associative Learning”
- 1980 Mortimer Mishkin (NIMH–Bethesda)  
 “Cognitive Circuits” (*unpublished*)
- 1981 James Greeno (University of Pittsburgh)  
 “Current Cognitive Theory in Problem Solving” (*unpublished*)
- 1982 William Uttal (University of Michigan)  
 “Visual Form Detection in 3-Dimensional Space”
- 1983 Jean Mandler (University of California at San Diego)  
 “Stories, Scripts, and Scenes: Aspects of Schema Theory”
- 1984 George Collier and Carolyn Rovee-Collier (Rutgers University)  
 “Learning and Motivation: Function and Mechanism” (*unpublished*)
- 1985 Alice Eagly (Purdue University)  
 “Sex Differences in Social Behavior: A Social-Role Interpretation”
- 1986 Karl Pribram (Stanford University)  
 “Brain and Perception: Holonomy and Structure in Figural Processing”
- 1987 Abram Amsel (University of Texas at Austin)  
 “Behaviorism, Neobehaviorism, and Cognitivism in Learning Theory:  
 Historical and Contemporary Perspectives”
- 1989 Robert S. Siegler and Eric Jenkins (Carnegie Mellon University)  
 “How Children Discover New Strategies”
- 1991 Timothy A. Salthouse (Georgia Institute of Technology)  
 “Mechanisms of Age–Cognition Relations in Adulthood”

*Eugene C. Lechelt, Coordinator*  
*MacEachran Memorial Lecture Series*

**Sponsored by The Department of Psychology, The University of Alberta with the support of The Alberta Heritage Foundation for Medical Research in memory of John M. MacEachran, pioneer in Canadian psychology.**

Chapter 1  
The Phenomenon and the  
Methods to Be Used in Its  
Investigation

I begin by describing two important restrictions on the material covered in this monograph. The first is that I refer only to my own research. This does not mean that I am unaware of, or unappreciative of, the important contributions of others. I firmly believe that progress in science is accomplished because of the combined efforts of a great many people, and thus a personal perspective inevitably provides a distorted portrayal of the total knowledge in a field, and of how that knowledge was achieved. Nevertheless, it is sometimes interesting to examine an individual researcher's approach to a problem, and it is certainly easier for that individual to describe his or her own research than also to attempt to review and integrate the research of others. Moreover, this type of egocentric perspective may be defensible when, as in the present case, almost all of the research to be discussed has been described in journal articles where the relevant research of other investigators has been cited.

The second restriction on the scope of the discussion is that it is limited to what is known as fluid or process aspects of cognition. That is, the focus is on the efficiency or effectiveness of processing at the time of evaluation, and not on the accumulated products of prior processing or inventories of one's knowledge. The emphasis is therefore on what Horn and Cattell (1967) refer to as *fluid intelligence*, rather than what they term *crystallized intelligence*, and on measures like those in the WAIS-R (Wechsler, 1981) Performance scale instead of those in the WAIS-R Verbal scale. The reason for this restriction is very pragmatic—these are the measures that have been found to have the largest relations with age, and consequently are the most in need of explanation.

The major issue to be addressed in this monograph is represented in Figure 1.1, and can be succinctly expressed in the form of the

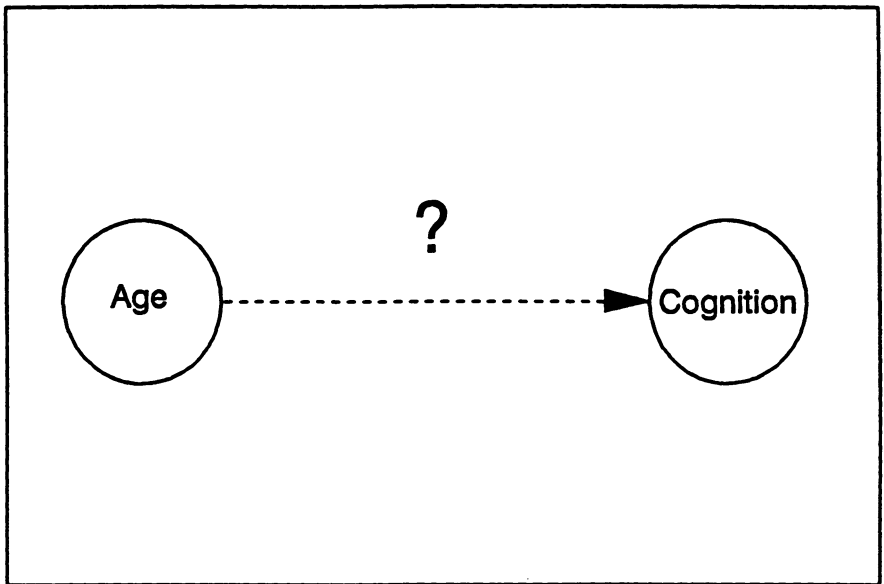


FIGURE 1.1 The fundamental issue addressed in this monograph: What is responsible for the relations between age and cognition?

following question: What is responsible for the relations between age and measures of cognitive functioning? More specifically, the purpose of this monograph is to describe the research I have conducted in which I have attempted to replace the question mark with detailed mechanisms.

### THE AGE-COGNITION PHENOMENON

An important initial step is to describe the phenomenon to be explained. The research participants in the projects I discuss were primarily middle class adults, with moderately high levels of education (typically averaging between 14 and 15 years of formal education), who generally reported themselves to be in good to excellent health. In most of the projects I have tried to obtain nearly the same number of males and females, and the age range of the participants usually has been between about 18 and 80 years of age. These characteristics mean that I am not dealing with the very old, or with individuals obviously suffering from debilitating diseases. Instead, I

am concerned with normal aging across a wide range of adulthood, and not extreme old age or pathological aging. Most research participants were recruited from newspaper advertisements, community organizations, and referrals from other participants. Some of the projects involved two extreme groups, in which case the young adults typically were students (almost always between 18 and 25 years of age), and the older adults were volunteers from the community (usually between 55 and 80 years of age).

A wide range of tests or tasks were used to assess cognitive functioning in these projects. (The terms *tests* and *tasks* are used interchangeably in this monograph.) Three typical tests are illustrated in Figure 1.2. An example of a test used to measure reasoning abilities is the Raven's Advanced Progressive Matrices. As can be seen in the top panel of Figure 1.2, items in this test consist of a matrix of geometric patterns in eight cells of a  $3 \times 3$  matrix. The requirement for the examinee is to select the best completion for the missing cell in the matrix from a set of eight alternative patterns.

The Paper Folding Test is an example of the type of test used to measure spatial abilities. The examinee in this test is to inspect a series of rectangles representing the folding of a piece of paper and the punching of a hole through the folded paper, and then to determine whether the displayed pattern of holes would result from that sequence of folds and punch location.

One test used to assess memory abilities is the Spatial Matrix Memory Test. The to-be-remembered material in this test consists of the locations of seven targets in a  $5 \times 5$  matrix, and recall is evaluated in terms of the number of targets reproduced in their correct positions in a blank matrix.

Comparison of results across such different kinds tests is complicated when the measures are not in the same scale, and only indirect contrasts may be possible when the tests have different units of measurement. Moreover, direct comparisons are not always meaningful even when all the variables are reported in the same units. As an example, two tests might both be measured in terms of the percentage of responses answered correctly, but the measures may not be equivalent because the tasks might vary in the difficulty of the discriminations, or in the accuracy rates attributable to chance (e.g., 12.5% for the Raven's Progressive Matrices Test, and 50% for the Paper Folding Test).

**Raven's Progressive Matrices**

**Paper Folding**

Yes    No

\_\_\_\_\_

**Spatial Memory**

FIGURE 1.2 Examples of items in three cognitive tests assessing reasoning ability, spatial ability, and memory ability.