

**On Human Memory:
Evolution, Progress, and Reflections
on the 30th Anniversary of
the Atkinson-Shiffrin Model**

**Edited by
Chizuko Izawa**

With a Foreword by Richard C. Atkinson



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1999

LAWRENCE ERLBAUM ASSOCIATES, PUBLISHERS

Mahwah, New Jersey

London

Foreword

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An anniversary like this provides an occasion to reflect on science and on our lives. My own career has had three major phases: about two decades as a professor, mostly at Stanford University; 5 years at the National Science Foundation, having been appointed deputy director by President Ford and then director by President Carter; and the last two decades at the University of California, first as chancellor at UC San Diego, and now as president of the UC System. Each of these phases had its own challenges and rewards, but I recall with special fondness the exhilarating time I spent exploring the complexities of human memory and cognition in the company of some of the brightest young minds in the field.

The Atkinson and Shiffrin model discussed in this book achieved significance and fame far beyond anything we could have imagined at the time it was developed. In hindsight, I am sure that serendipity and timing played major roles. Even my collaboration with Rich Shiffrin arose somewhat by accident. Much of my career at Stanford was spent at the Institute for Mathematical Studies in the Social Sciences, housed in Ventura Hall. The institute was directed by Pat Suppes, a distinguished logician and philosopher, and served as the home for economists, psychologists, statisticians, computer scientists, and political scientists interested in mathematical models in the social sciences. Bill Estes and I, along with Pat Suppes, represented psychology in the institute's array of activities. The institute was a hotbed for the then-evolving field of mathematical psychology, and was populated by postdoctoral visitors and graduate students, too many to name in this foreword, a remarkable number of whom are leaders in the field today. In the early 1960s I began working on mathematical models of memory and used a computer-controlled system to conduct experiments that involved the continuous presentation and testing of items over extended periods of time. This experimental procedure proved to be very adaptable and generated large amounts of data on individual subjects; it was ideal for testing various assumptions embedded in the models. In the fall of 1964 a new graduate student, Richard Shiffrin, arrived at Stanford, having completed a double major at Yale University in psychology and mathematics. He came to work with Gordon Bower, who was housed in the psychology building elsewhere on campus. Shiffrin began developing models of memory applied to list paradigms, particularly free recall experiments. After Shiffrin's first year, Gordon Bower left for a sabbatical year in the United Kingdom, and asked if I would take over as Shiffrin's research advisor, since our more or less independently developed models seemed quite compatible. Thus began an intense and productive collaboration.

Within a few months Shiffrin and I became the hub of a group of students, postdoctoral visitors, and research associates carrying out a wide variety of memory studies suggested by an evolving theory of memory; many of these studies achieved independent publication. Then an invitation to contribute a chapter to *Psychology of Learning and Motivation* provided an opportunity to pull the various empirical and theoretical strands together into a larger framework. In the process, Shiffrin and I realized that the short-term buffer process that we were using in our various models was merely a stand-in for a more complicated set of processes representing short-term memory, leading us to broaden the conception of short-term memory to "control processes," a term standing in for "active memory" or "working memory." This conception in turn allowed us to put together a theoretical framework with relatively autonomous sensory processing, controlled processing in short-term memory, and a permanent long-term memory upon which control processes could operate to produce retrieval. The field was obviously ready to embrace this approach, and the publication of the chapter seemed to act like the nucleus that causes a solution in delicate equilibrium to precipitate.

That this model remains today a widely accepted description of human memory (and a subject for critical attack by continuing generations of theorists) is, I believe, more than a matter of a publication arriving on the scene at a propitious moment. The longevity of the model is most likely due to the parts of the chapter that are unknown to casual readers who learn of the model through secondary sources: namely, the quantitative fit of the model to a wide array of experimental paradigms and conditions. It was this rooting of the model in reality that forced it into a form that remains largely valid today. I believe this is the case for most of the lasting contributions to science, and provides perhaps the best argument for the collection of extensive parametric data and the testing of quantitative models.

It is indeed gratifying to witness this volume celebrating the 30th anniversary of the publication of our chapter. It is satisfying to see the many scientific outgrowths of that model and its use in one form or another in so many diverse fields. It is doubly satisfying to see the way in which Rich Shiffrin's own research has continued the evolution of those concepts, as in the SAM model (Raaijmakers & Shiffrin, 1980) and the REM model (Shiffrin & Steyvers, 1997). It is triply satisfying to see these theoretical efforts continuing into a third generation and beyond of PhDs. Chapters 5, 7, and 10 of the present volume, by Jeroen Raaijmakers, Scott Gronlund, Steve Clark, and their students and associates, provide excellent examples, as does an outstanding contribution by my student, Tom Wickens (Chapter 11). Another member of the circle of PhDs at Stanford in the 1960s, Mike Humphreys, also provides a valuable contribution to this volume (Chapter 7). A theoretical contribution of lasting value requires testing in the fire of intense critical evaluation, as noted by Chizuko Izawa in Chapter 1; over the years such testing has been provided by my friend and colleague, Ben Murdock (Chapter 3). Alice Healy and Tom Cunningham

contribute Chapter 8, building upon the ideas of Estes' perturbation model (1972).

I cannot fail to acknowledge my close friend and colleague, Bill Estes, one of the great figures in our field and a recent recipient of the National Medal of Science. He is better placed than anyone to evaluate the last 30 years of progress in memory, and provides an incisive, critical, and telling retrospective in Chapter 4.

It is appropriate to end this foreword with special thanks to Chizuko Izawa, an outstanding scientist, whose idea led to this volume, and whose editing saw it to completion. I recall her as a shy graduate student who arrived at Stanford fresh from the University of Tokyo. She proceeded to surmount the obstacles of culture and language that faced her, and produced a wonderful PhD dissertation in 1965. She has utilized her own experiences involving language learning in her research on memory processes, and has produced significant advances in our understanding of the "efficiency of acquisition," as witnessed by her test trial potentiating model (1971), her retention interval model (1981), her identity model (1985) and her hypothesis concerning the Study-Test-rest (S-T-r) presentation program that is the subject of Chapter 9. Rich Shiffrin and I, as well as all the other contributors to this volume, owe her warm thanks and commendation for her efforts in our behalf.