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BENTON J. UNDERWOOD
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A Biographical Memoir by
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February 28, 1915-November 29, 1994

BY GEOFFREY KEPPEL

BENTON J. UNDERWOOD was one of the pre-eminent leaders in the post-World War II development of research on the acquisition and retention of verbal materials, frequently referred to at the time as the study of verbal learning and memory. Underwood is recognized for his extensive contributions to the experimental and theoretical analysis of this field and for a career as an innovator and a pacesetter in a rapidly growing and changing domain of research. Between 1941 and 1982, he amassed nearly 200 publications, including 10 books and 5 research monographs. Approximately 85 percent of his articles and monographs consisted of reports of experiments. His most ambitious research effort was his study of massed and distributed practice, which spanned over 17 years and included 26 empirical reports and theoretical articles.

Underwood was born on February 28, 1915, in Center Point, Iowa. He received his primary and secondary education in Albion, a small town serving the farming community in central Iowa, where his father owned and operated the local lumberyard. His mother was particularly supportive of her children's education, providing each with the opportunity to take special music lessons and expressing great ad-

miration for a new idea, a well-written theme, or a good set of grades. She was particularly proud when Underwood published a short piece in the local paper on the history of Albion.

Upon graduating from high school in 1932, Underwood hoped to become a high-school athletic coach—a position viewed locally, in Underwood’s words, “as being little short of aristocratic.” With the help of a scholarship, personal loans, and room-and-board jobs, Underwood attended Cornell College in Mount Vernon, Iowa, and graduated in 1936 with majors in education and psychology. After graduation, he found a temporary teaching job in the high school in Clarion, Iowa, and then, a year later, realized his long-term dream by serving for two years as a junior college athletic coach and a part-time academic teacher in Tipton, Iowa. He decided to further his education when he realized that “it was of much greater interest and challenge to teach an academic subject to reluctant minds than to try to teach a pivot shot to would-be athletes lacking in basic coordination.” With his new bride, Louise Olson Underwood, the couple headed west, where he planned to enroll in the summer session of 1939 at the University of Oregon. Underwood was experiencing difficulty in choosing between graduate work in education or in psychology, which was resolved when he took a psychology course offered by John Dashiell, who was a visiting professor from the University of North Carolina. After a few weeks in this course, Underwood made the decision to dedicate himself to a career in psychology.

Late that summer, Underwood accepted a position as a research assistant to Arthur W. Melton, chairman of the Psychology Department at the University of Missouri. Under Melton’s guidance, Underwood discovered the importance of applying experimental techniques to understand behavior

and the excitement of research in Melton's field, verbal learning and memory, the study of which would occupy his entire professional life. After receiving a master's degree in the summer of 1940, Underwood moved to the State University of Iowa, where he became a research assistant to John A. McGeoch, who was then the head of the Psychology Department and a major figure in the field of verbal learning and memory. With the approval of a benevolent draft board, Underwood was permitted to complete his Ph.D. before being assigned to military duty. After McGeoch died in 1941, Kenneth W. Spence guided Underwood in his dissertation research, which was completed in late 1942.

By all accounts, Iowa was a stimulating environment for graduate students to grow and develop. There were theoretical battles being waged on a number of important fronts: hammering out positions in a philosophy of science appropriate to psychology, debating and arguing critical theoretical points in animal learning, and developing research based on Melton's recent proposal of the unlearning of associations. In Underwood's words, "Iowa was a very exciting place . . . and I consider myself to be most fortunate to have been able to participate in it. The interplay between theory and experiment which took place at that time was a very heady experience, one which too few graduate students have." This experience, particularly Spence's creative approach to solving problems in an analytical and experimentally rigorous manner, created a lasting impression on Underwood.

Underwood received a commission in the Naval Reserve in January 1943 and was assigned to the Naval Aviation Psychology Branch of the Bureau of Medicine and Surgery. After the war, he accepted a position in January 1946 as assistant professor at Northwestern University and advanced to associate professor in 1948 and to professor in 1952. In 1976 Northwestern University appointed him Stanley

G. Harris Professor of Social Science in recognition of his scholarly contributions to the discipline of psychology and of his service to the university, which included a term as chair of the Psychology Department. He retired from Northwestern in 1983. Except for a visiting year at Berkeley (1958-59), where he collaborated with Leo Postman on a number of research projects, Underwood remained in residence at Northwestern. He respected the faculty of the Northwestern department and enjoyed the general atmosphere of the university. He particularly valued the critical research orientation of his departmental colleagues.

Benton J. Underwood died on November 29, 1994, following a long degenerative illness. He is survived by his wife, Louise, a retired high-school English teacher; his two children, Judith Maples, a librarian, and Kathleen Olson, an author; and six grandchildren.

While the remainder of this biographical note will emphasize Underwood's academic and professional contributions, I would be remiss not to mention some of his personal qualities that endeared him to others. One of these characteristics was his fondness for playful arguments in which he would take a strong position and later admit that he did not necessarily believe the position he had been arguing. He also thoroughly enjoyed hearing about new research findings. Neal F. Johnson, a speaker at Underwood's memorial service, poignantly described Underwood's reaction to a new empirical finding or theoretical analysis:

When a clever experimental approach to an issue was outlined, he would show the quick flash of a radiating smile; then would come the look of intense concentration as you described the details of the methods and procedures that were used; but when you came in with that final bit of confirming data as the clincher, he would give an exclamation—slap his knee—and then his face would literally explode into his marvelous warm

smile. To me, I think that smile was more rewarding than an editor's letter of acceptance."¹

Another characteristic was his passionate enjoyment of musical comedies, particularly a professional production of *The Music Man*, in which his granddaughter Karen Olson Pierce performed a starring role. Still another was his broad interest in sports, undoubtedly stemming from his early experiences as a player and coach. At the annual departmental picnic, Underwood would always emerge as the "most valuable player" in the highly contested softball games held at these events. In addition to an interest in sports, he was also a devoted gardener and an avid reader of historical biographies.

Two remarkable publications provide summaries of Underwood's research contributions. The first is the chapter prepared by Leo Postman, his frequent collaborator on a number of important papers dealing with interference and forgetting, for the Festschrift held in 1971 to honor Underwood, who was completing his twenty-fifth year at Northwestern University. Postman's chapter, titled "The Experimental Analysis of Verbal Learning and Memory: Evolution and Innovation," concluded with the following statement:

I have tried to touch upon some of the major landmarks in the continuous evolution of our field during the last quarter century. It has been a period of methodological advances, productive self-criticism, and theoretical growth. Before concluding, let me make explicit what you have undoubtedly known all along. In developing this account I have drawn, with a few scattered exceptions, on the work of only one man. So great is the debt of gratitude that we owe to Benton J. Underwood."²

The other publication is a 1982 book prepared by Underwood for the Praeger Centennial Psychology Series in which he presented a representative sampling of his re-

search papers and divided his work into the following categories: (a) research on the role of proactive interference in forgetting; (b) studies of the role of implicit associative responses in learning, recognition, and recall; (c) the development and testing of the frequency theory of memory; (d) investigations on the higher mental processes involved in concept learning and thinking; (e) research on the effects of massed versus distributed practice; and (f) an analysis of the structure of memory. In the first chapter, Underwood provided the theoretical background that guided the 15 papers that are reprinted in the volume. In the last chapter, he offered a fascinating glimpse at future directions he anticipated for this and related research. Here is Underwood at his speculative best.

Underwood's research exemplified the functionalist tradition in which global relationships between manipulated independent variables and response or dependent variables were analyzed into subcomponents through the use of new methodology and revised theoretical orientations. His work on interference and forgetting provides a good example. In a careful review of the literature, Underwood (1957) discovered that the forgetting reported in these studies was directly related to the number of lists of verbal material subjects had received before they learned and recalled a particular list. In fact, when he measured forgetting by testing subjects who learned and later recalled a single list of verbal materials, he found forgetting to be in the range of 20-25 percent, rather than the 75 percent usually reported in multi-list studies.

In subsequent research, Underwood examined characteristics of the learning materials that might be shown to influence this reduced amount of forgetting. Typically, he would manipulate independent variables that exert profound effects on acquisition, such as the meaningfulness and simi-

larity of the learning materials, and then determine whether these variables also affected the rate of forgetting. Such studies immediately presented a serious methodological problem, however, because subjects who learn at different rates are usually not matched in the degree to which they have learned the different sets of material. Underwood spent over a decade working on this problem, the result of which was to show that most independent variables that influence acquisition have little or no effect on forgetting. In fact, Underwood was led to the conclusion that there may be no individual differences in forgetting, once individuals are equated for differences in learning.

In addition to the 1982 retrospective book, the flavor of Underwood's approach to research is also reflected in his research books and monographs. In these more generous formats, he was able to describe the development of ideas and to detail the careful analyses of individual research protocols that were a hallmark of his empirical work. One cannot help but be impressed with the multitude of inter-related studies relentlessly chipping away at various puzzles revealed by earlier experiments, while still moving closer to a satisfactory resolution of some sort. Underwood's theoretical ideas were never too far removed from the data, reflecting a healthy respect for a fruitful interplay between fact and explanation. The first of his three research books, *Meaningfulness and Verbal Learning*, was coauthored with Rudolph W. Schulz and published in 1961. As some students have described, the book reads like a detective novel, with its false leads, red herrings, and careful "plot" development. His other two books were published within five years of his retirement, *Temporal Codes for Memories: Issues and Problems* (1977) and *Attributes of Memory* (1982), both representing new ways of conceptualizing memory storage and retrieval. A colleague of mine at Berkeley, Arthur P.

Shimamura, viewed his treatise on temporal codes as “a testament to Underwood’s scientific acumen” and a topic that is “important for our understanding of autobiographical memory, episodic retrieval, and source recollection.”³

Another facet of Underwood’s career was that of research methodologist, both in his research field of verbal learning and memory and in the more general arena of psychological research. Underwood was a master at designing simple, clean, and analytical studies. His development of methods permitting the study of forgetting as a function of independent variables that influence learning, which I described earlier, represents a major methodological contribution to the field.

Underwood produced two textbooks that dealt exclusively with issues of research design. One of these was his 1957 book intended for graduate students, *Psychological Research*, which conveyed the art and logic of experimental design in a clear and exquisite manner. Without question, this book helped to set the standards of research design in psychology in general—not just within the confines of experimental psychology. The other book, *Experimentation in Psychology*,⁴ published with John J. Shaughnessy in 1975, was addressed to the undergraduate student majoring in psychology, providing detailed discussions of the issues that confront a researcher in the design of common experimental designs employed in psychology and in the interpretation of the results of these experiments.

Underwood also wrote two other textbooks with the undergraduate in mind. One of these is his influential and successful *Experimental Psychology* (1949, 1966), which helped to define the field in the early years after the Second World War and continued to have an important influence on undergraduate courses in experimental psychology through the 1970s. The other textbook,⁵ which was coau-

thored with several faculty colleagues at Northwestern, offered a pragmatic and clear introduction to statistical procedures of relevance to undergraduate majors in psychology.

A third aspect of Underwood's career was his impact as a teacher and a research mentor. His major undergraduate teaching assignment at Northwestern was a required two-quarter laboratory course in experimental psychology. A faculty colleague recalls that "when [Underwood] taught his section of experimental psychology, a rigorous lab course with multiple papers always held at eight in the morning, so many students were eager to take it that he interviewed each of them in order to keep the section from getting too large." ⁶ Underwood found ways to engage and to motivate even the most recalcitrant student. From his students he excelled at eliciting energetic discussions on matters of experimental design and interpretation of results. I observed him on numerous occasions in this undergraduate course generating a productive class discussion with different examples of research problems and designs—bogus experiments in which critical design flaws were cleverly embedded. He was brilliant at encouraging students to stretch their newly acquired knowledge to the next step in the design process, by drawing out an incorrect answer to the point that the student and the class would recognize the mistake and then helping a student with a promising answer to gloriously reach the desired goal.

Underwood devoted a great deal of attention to his teaching. John J. Shaughnessy recalled an incident:

When I worked with Ben as his teaching assistant he worked at home on Wednesdays. When I saw him one Thursday I asked him what he had done the day before. He said he had worked on the upcoming test in his experimental psychology class. Knowing how much Ben could get done in a day I asked him what else he had worked on. Ben gave me that wonderful quizz-

cal look of his and said that he had spent the whole day making up the test. He commented that he typically spent an entire day to make up a test like that. I doubt that Ben's students knew or cared that they were taking a test that was made 'fresh' for them. I know that Ben cared about his students so much that he wanted to make a test that would best teach them.⁷

His graduate students remember him best not only as an unflagging critic of their research designs, data analyses, and theoretical interpretations but also as an infectiously enthusiastic connoisseur of research. In 1959 my wife, Sheila, and I reversed the migratory flow to California by moving from Berkeley to the Chicago area so that I could attend graduate school at Northwestern University and work with Underwood as his research assistant. While I was attracted to his approach to the study of verbal learning and memory, I was unprepared to be smitten by his talents as a teacher. His lectures were typewritten, reflecting close attention to fact, clarity, organization, and a great deal of time spent at preparation. He began his lectures by reading from his typescript, but quickly deviated from the printed page and breathed life into the myriad topics under study.

During his years at Northwestern, Underwood directed over 30 Ph.D. dissertations and an even greater number of master's theses. Perhaps his greatest contribution to teaching occurred when he was guiding graduate students through these major research projects. He was involved at all stages of the study, from debating the initial premise, to designing a thorough and compelling design, through the detailed analyses and final draft—he was an active and willing participant. His policy with master's students is particularly revealing. He viewed the thesis project as a training exercise, where the second-year student would learn how to conduct research. He often began the process by suggesting a research topic if the student needed help—a topic was drawn from his thick notebook of researchable ideas—and then

he coached and debated the implementation of the eventual study with fervor and good humor. Assistance and guidance in the fine-grain analysis of the response protocols were next, followed by an intense process of constructive criticism and endless drafts. But Underwood's responsibility did not end with the filing of the thesis with the graduate division. He offered to prepare the thesis for publication and to accept a "junior" authorship for his efforts. His students were grateful for his offer and for his intimate involvement in their development as researchers. As one student put it, "He stands above all others as the inspiration and benevolent guide to my academic, intellectual, and professional life. I shall always be grateful to him, and for him." And another student wrote, "His spirit is joyously intertwined with so many others—for the betterment of all."

Underwood's treatment of his research assistants is also revealing. He would appoint one individual as his assistant, a position that was held for four years, which coincided with the length of time typically required to complete a Ph.D. degree at Northwestern. As one of Underwood's research assistants, I was centrally involved in the crafting of experiments. Although the direction and thrust of the research was his, Underwood used me as a sounding board for his ideas and proposed research designs. I was responsible for translating a design into a set of experimental procedures that undergraduate assistants, who actually performed experiments, could follow. I supervised the data collection and the beginnings of the data summary. Summers at Northwestern were devoted to the heavy-duty analysis of the data we had collected during the school year. Since this was a joint effort, I could observe how Underwood would extract information from a response protocol; he was continually on the lookout for unique patterns of responses, which often suggested a new analysis or line of investiga-

tion. Finally, Underwood usually prepared the first draft of the research report, but expected his assistants to offer the same sort of critical comments he provided his students when they prepared drafts of their own research. This research apprenticeship provided me with a unique and valuable research experience that I would draw upon throughout my academic career.

Finally, there is Underwood's service to his profession, reflected in his leadership in professional organizations and his participation in the deliberation of government boards and panels. He was president of the Midwestern Psychological Association (1956-57), president of two divisions of the American Psychological Association, (Experimental Psychology, 1959-60, and General Psychology, 1969-70), and chair of the Psychology Section of the American Association for the Advancement of Science (1964). As for government boards and panels, he served on the Psychobiology Review Panel for the National Institute of Mental Health, the Department of Defense's Advisory Panel on Personnel and Training, the National Research Council's Committee on Naval Medical Education and panel for screening fellowship applications for the National Science Foundation, and the Illinois State Certification Board for Psychology. Underwood also contributed to scientific psychology through his service as an editor of the *American Journal of Psychology* and a member of the editorial boards of three other journals. With Leo Postman, Underwood participated in the founding of the *Journal of Verbal Learning and Verbal Behavior*, serving as a consulting editor for nearly two decades.

Underwood received all the honors that his profession can bestow on an experimental psychologist. He was presented the prestigious Warren Medal given by the Society of Experimental Psychologists in 1964. He received an honorary doctor of science and an honorary membership in

Phi Beta Kappa from Cornell College in 1966. He was elected to the National Academy of Sciences in 1970 and subsequently served as the presiding officer of its psychology section between 1974 and 1977. He was awarded the Distinguished Scientific Contribution Award from the American Psychological Association in 1973, the Distinguished Teaching Award in Psychology from the American Psychological Foundation in 1987, and was named a distinguished graduate by the University of Iowa in 1989.

The citation accompanying the Distinguished Scientific Contribution Award, which he received at the peak of his career, reads as follows:

For his massive contributions to the experimental and theoretical analysis of verbal learning and memory. A master of experimental design, he has been a recognized leader in the development of a modern and sophisticated methodology in his field of research. For more than a quarter of a century his wide-ranging investigations have focused on the fundamental processes of acquisition and retention. The substantive areas in which his work has yielded new theoretical insights and basic empirical findings are too numerous to list. Among the highlights are his systematic explorations of the effects of distribution of practice, the principles of transfer, the mechanisms of interference in retention, and the role of discriminative processes in recognition. While firmly rooted in the traditions of his discipline, he has throughout his career been an innovator and a pacesetter in a rapidly growing and changing domain of research."⁸

Underwood's papers, monographs, and books continue to influence contemporary research on learning and memory. To illustrate, memory researcher Arthur P. Shimamura provided the following assessment of these lasting contributions, and included some recent applications of his work:

During the rise of cognitive psychology in the 70s and 80s, Underwood's empirical and theoretical contributions were influential in a variety of domains, including issues of semantic release from proactive interference, part-list cueing, the fan effect, encoding specificity, and the effect of misleading information in eyewitness testimony.

During the 90s, one could argue that Underwood's contributions have become, if anything, more influential. Interference effects in studies of learning and memory are again discussed as prominent issues in a variety of domains, including retrieval-induced forgetting, implicit versus explicit memory, and source recollection. Indeed, two volumes have been published that are specifically devoted to interference effects in memory. In terms of aging research, Lynn Hasher and Rose Zacks's inhibition theory is one of the most prominent views of age-related effects on memory and cognition. In cognitive neuroscience, inhibitory control (i.e., reducing interference) plays a significant role in our understanding of working memory and frontal lobe function. In computational models of memory, it is important to establish basic properties studied by Underwood, including effects of proactive interference and the distinction between massed and distributed practice."³

In short, Underwood's influence on research in the field of human learning and memory continues to be felt through the citation of his formal publications and through the research and teaching of those who were fortunate to be either his students or research colleagues and by their students as well. He will also be remembered for his goodness and kindness as a person.

THE BIOGRAPHICAL FACTS I have cited were drawn from a number of sources, including materials submitted by Underwood to the National Academy of Sciences, autobiographical notes published in the Praeger Centennial Psychology Series (1982) and in the announcement of the Distinguished Scientific Contribution Award presented by the American Psychological Association, and comments provided by his wife, Louise Olson Underwood.

NOTES

1. N. F. Johnson. My memories of Benton J. Underwood. Comments presented at the memorial service for Benton J. Underwood, December 16, 1994, held in the Alice S. Millar Chapel, Northwestern University, Evanston, Ill.
2. L. Postman. The experimental analysis of verbal learning and memory: Evolution and innovation. In *Human Memory: Festschrift*

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3. A. P. Shimamura. Personal communication, 1998.

4. B. J. Underwood and J. J. Shaughnessy. *Experimentation in Psychology*. New York: John Wiley and Sons, 1975.

5. B. J. Underwood et al. *Elementary Statistics*. New York: Appleton-Century-Crofts, 1954.

6. W. F. Hill. Testimonial to Ben Underwood at his memorial service. Comments presented at the memorial service for Benton J. Underwood, December 16, 1994, held in the Alice S. Millar Chapel, Northwestern University, Evanston, Ill.

7. J. J. Shaughnessy. Ben, the teacher. Comments presented at the memorial service for Benton J. Underwood, December 16, 1994, held in the Alice S. Millar Chapel, Northwestern University, Evanston, Ill.

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