

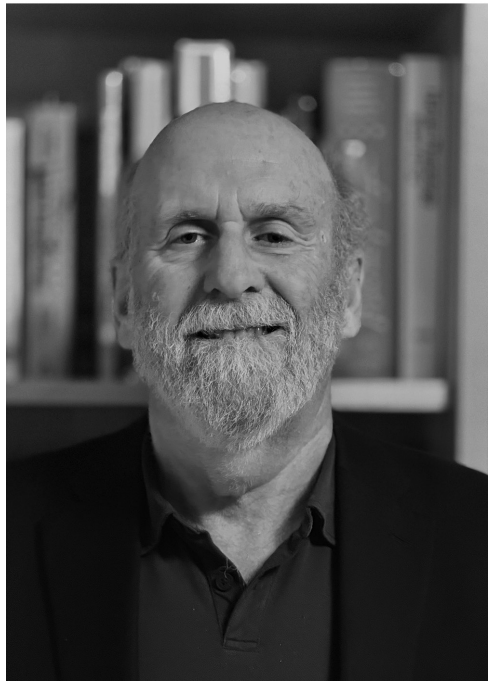
The History of Neuroscience in Autobiography
Volume 14

Edited by Thomas D. Albright
and Larry R. Squire
Published by Society for Neuroscience
ISBN: 978-0-916110-13-0

Daniel L. Schacter

pp. 334–379

https://www.doi.org/10.1523/hon.014008



Daniel L. Schacter

Born:

Brooklyn, New York
June 17, 1952

Education:

University of North Carolina, Chapel Hill, BA (1974)
University of Toronto, PhD (1981)

Appointments:

Research Associate and Assistant Professor, Department of Psychology, University of Toronto (1981–1987)
Associate Professor to Professor, Department of Psychology and Cognitive Science Program, University of Arizona (1987–1991)
Professor, Department of Psychology, Harvard University (1991–1995)
Chair, Department of Psychology, Harvard University (1995–2005)
William R. Kenan, Jr. Professor, Department of Psychology, Harvard University (2002–present)

Honors and Awards (Selected):

Arthur Benton Award, International Neuropsychological Society (1989)
Award for Distinguished Early Career Contributions to Psychology, American Psychological Association (1990)
Troland Research Award, National Academy of Sciences (1991)
Elected, Society of Experimental Psychologists (1994)
Elected, American Academy of Arts and Sciences (1996)
Harvard-Radcliffe Phi Beta Kappa Teaching Prize (1997)
Searching for Memory, William James Book Award, American Psychological Association (1997)
John Simon Guggenheim Memorial Fellowship (1998)
Elected Fellow, Association for Psychological Science (1999)
The Seven Sins of Memory, William James Book Award, American Psychological Association (2002)
Award for Scientific Reviewing, National Academy of Sciences (2005)
Howard Crosby Warren Medal, Society of Experimental Psychologists (2009)
Award for Distinguished Scientific Contributions to Psychology, American Psychological Association (2012)
Elected, National Academy of Sciences (2013)
William James Fellow Award, Association for Psychological Science (2017)
Fred Kavli Distinguished Career Contributions Award, Cognitive Neuroscience Society (2019)

Daniel L. Schacter's early research focused on characterizing the nature of implicit versus explicit memory and exploring the cognitive and neural underpinnings of phenomena such as perceptual priming, initially through behavioral studies of brain-damaged amnesic patients and healthy individuals, and later through functional neuroimaging experiments. Schacter then focused on developing the conceptual and empirical basis for a cognitive neuroscience approach to constructive memory phenomena, such as memory distortions and errors, by combining insights from neuropsychological and neuroimaging studies. This work provided a foundation for more recent research exploring the cognitive neuroscience of imagination, future thinking, and creativity, emphasizing the contributions of episodic memory retrieval to these processes. Combining the latter two lines of research led Schacter to develop an adaptive perspective on memory errors, characterizing them as consequences of functionally useful aspects of memory. In addition to this empirical research, Schacter has written several books, including Forgotten Ideas, Neglected Pioneers: Richard Semon and the Story of Memory *(1982/2001),* Searching for Memory *(1996), and* The Seven Sins of Memory *(2001/2021). He also has coauthored an introductory text,* Psychology*, currently in its seventh edition.*

Daniel L. Schacter

Early Years: The New York Connection

I was born in Brooklyn, New York, on June 17, 1952. My parents, Philip and Harriet, were both the children of Eastern European immigrants—Paul and Florence Schacter were Phil's parents, and Ben and Hannah Flanzig were Harriet's. We did not stay in Brooklyn for very long, and my earliest memories begin after we moved to the nearby suburb of New Rochelle in 1953. Phil and Harriet bought a newly built ranch-style home on Daisy Farms Drive, around the corner from the fictional home of Rob and Laura Petrie (and actual home of Carl Reiner) on Bonnie Meadow Road in the classic sit-com *The Dick Van Dyke Show*. We lived just a short walk from the George M. Davis Elementary School, which had just opened in 1953, in time to accommodate the postwar boom of families who were eager to exchange city life for a place in the suburbs.

As a memory researcher, I am a bit skeptical of the veracity of our earliest memories, but I believe that mine dates to age four and involves playing in a sandbox at Colonial Nursery School in New Rochelle, which I attended before beginning kindergarten at Davis Elementary in the fall of 1957. I am much more confident, however, of the clear memory I have of sitting on a small hillside just outside of Davis while playing hooky with a friend one day during first grade. I do not recall why we played hooky, nor do I recall why we sat in a place so near the school during our misadventure that it virtually guaranteed that we would get caught, but I do recall my parents' anger and disappointment when the principal told them what happened. That was the last time I played hooky.

Another memory from the Davis Elementary years is one that is no doubt shared with many other grade-schoolers of that era: hiding-under-the-desk drills in case of a Russian nuclear attack. I recall half-jokingly saying goodbye to my fifth-grade classmates in October 1962 during the terrifying Cuban missile crisis. On a more positive note, during those years, I played baseball in the New Rochelle Little League, and went to major league games at Yankee Stadium and also at the Polo Grounds, the initial home of the expansion team, the New York Mets. I vividly recall what we used to call "the initial ballpark rush"—the exciting first sight of the impossibly green outfield grass at Yankee Stadium when emerging from an internal tunnel. I was an avid Yankee fan, and I also recall crying when, after running home from school to watch the end of game seven in the 1960 World Series against the Pittsburgh Pirates, Bill Mazeroski broke our hearts with a walk-off, series-ending home run.

Our family grew with the birth of my younger brother Ken (now a retired attorney) in 1955 and sister Jane (now a professor at Stanford Law School) in 1958. During the summer of 1963, we moved from New Rochelle to a newly built house in neighboring Scarsdale, a wealthy town whose public schools had amassed a towering reputation. My father Phil was an insurance broker, and my mother Harriet had been an elementary school teacher before having children, but she did not work during our time in New Rochelle or during our first few years in Scarsdale. When it became apparent after a few years in Scarsdale that a second income was needed to support our family, Harriet went back to school to obtain a master's degree from the Hunter College School of Education and then began a new job as a reading teacher in the nearby Yonkers school system.

With the move, in the fall of 1963 I began sixth grade at Scarsdale Junior High School (later renamed Scarsdale Middle School). There was nothing remarkable about that first middle-school fall semester until one fall day when the dean unexpectedly entered our classroom and whispered something into our teacher's ear. It was November 22, and like so many others, we were stunned by the awful news that President Kennedy had been shot. On Sunday, November 24, after returning home from my weekly Sunday School class at Westchester Reform Temple, I saw on television that Jack Ruby had shot and killed Lee Harvey Oswald. Those events were overwhelming to us at the time and were also a precursor to the violence and tumult that would characterize much of the remaining years of the 1960s.

My academic path through middle school was largely unremarkable, but I did pick up a new hobby that I would pursue enthusiastically for much of my adult life: golf. My father Phil was an avid golfer (with a handicap that hovered around 18), and he and his friends used to sleep in their cars overnight to grab an early morning weekend tee time at Saxon Woods Golf Club, a Westchester County public course located near both our New Rochelle and Scarsdale homes. I played my first round at Saxon Woods with Phil and friends in June 1964 and occasionally joined their group that summer when they had an opening. In 1965, my parents joined a private golf club, Pines Ridge in Ossining, New York, in part so that I could have easier access to a golf course and more opportunity for professional instruction. My game improved, my parents joined another private club in spring 1967 (High Ridge, which straddled the border of Stamford, Connecticut, and Pound Ridge, New York), and as a freshman at Scarsdale High School in the spring of 1967, I made the varsity golf team, albeit occupying sixth spot on a six-man team. I gradually rose through the ranks to captain of the team, and in my junior and senior years, our team won the New York state sectional tournament. But my biggest accomplishment in golf happened in the summer of 1969, just before my senior year in high

school, when I won the High Ridge club championship by shooting four rounds in the 70s to edge out the five-time defending club champion.

Another notable development in high school was my musical transition from a fairly traditional rock fan (Grateful Dead, Traffic, and Jethro Tull were my favorite bands) to a rock fan who was also a jazz lover. The proximity of Scarsdale to the jazz clubs of Manhattan made it easy for my friends and I to check out live the greats of the era, including Miles Davis, Tony Williams, John McLaughlin, McCoy Tyner, Pharoah Sanders, and many others. We developed a particular affinity for Slugs', a now-defunct jazz club in the East Village, where we could sit just a few feet away from our musical heroes. One jazz musician we could not see live, however, was the great saxophonist John Coltrane, who had passed away at a young age in 1967, a couple of years before we started making near-weekly pilgrimages to Slugs' and our other favorite spots. Coltrane was a towering figure whose music and life story fascinated me from the moment I learned about him.

My improving golf performance during 1968 and 1969 influenced my thinking about where to go to college: I focused on southern schools that combined strong academics with a good golf program. After visiting several such schools, I decided to apply early decision to the University of North Carolina at Chapel Hill, and fortunately was accepted. That turned out to be a positive development for multiple reasons, one of which had to do with my choice of a thesis topic for my final semester of high school English in the spring of 1970. I decided to pursue my burgeoning interest in John Coltrane and proposed writing a thesis on the nature and impact of his music. My English teacher balked: He had never heard of Coltrane and did not think that writing about Coltrane constituted an acceptable topic for a serious thesis. I persisted to no avail (emboldened by having been accepted early to The University of North Carolina), and his continuing objections led to a meeting involving the English teacher, the principal of Scarsdale High School, my parents, and me. During this meeting, the extent of the teacher's misconceptions about Coltrane became apparent, and with the blessing of the principal, the English teacher finally relented and allowed me to write the thesis. I learned a lot while writing it and, happily, received an honors grade for my efforts.

One other academic experience at Scarsdale High School is worth mentioning because it had a strong influence on my subsequent study and career choices. Scarsdale offered a course in human health that I took in my junior year, and it included a substantial section on psychology. I read classic psychologists such as Freud, Jung, Skinner, and others with great interest, and wrote a term paper on the nature and basis of fear. Based on that experience, when I headed to Chapel Hill I did so with determination to choose psychology, with a focus on clinical issues, as my major.

Heading South: University of North Carolina and Duke

My golf game slipped a bit in 1970 compared with 1969, and by the time I arrived in Chapel Hill for the fall of 1970 semester, golf was no longer a high priority. Other political and social issues seemed far more important, particularly protesting the Vietnam War, which I did as part of campus demonstrations and also by attending the massive April 1971 protest in Washington, D.C. As planned, I took introductory psychology courses along with other required science and math courses. I maintained a clinical focus, which was solidified during my junior and senior years by the opportunity to write a historically based thesis, under the supervision of Professor Bernadette Grey-Little (who later served as chancellor of the University of Kansas), which explored the relationships among Sigmund Freud, Carl Jung, and Alfred Adler, and how their personal interactions shaped their psychological theorizing and clinical work. I also took a practicum course focused on self-injurious behavior in autistic youth in which I interacted with these individuals at what is now known as the Murdoch Developmental Center in Butner, North Carolina. The late Professor Stephen Schroeder was carrying out research there on behavioral approaches to reducing self-injurious behavior. I was fortunate to be offered a position in the early part of my senior year as a research assistant on a grant focused on this approach, which would begin shortly after my graduation in May 1974.

I accepted the offer, but as my senior year progressed, my interests began to shift. I took an introductory statistics course offered by Professor Tom Wallsten. The teaching assistant for his course, doctoral student Gerry Solfvin, was involved in some intriguing research at Duke University exploring such exotic topics as the brain correlates of altered states of consciousness and parapsychological phenomena. Solfvin worked with Dr. Edward Kelly, a recent Harvard doctoral graduate in psycholinguistics and cognitive science who had set up a psychophysiology lab in the Department of Electrical Engineering at Duke. They were seeking interested undergraduates to assist with their work, which I did during my senior year. This experience boosted my interest in experimental psychology and neuroscience research. Critically, it was through Ed Kelly that I was informed that the late Dr. Herbert Crovitz, a cognitive psychologist who split his time between the Duke Department of Psychology and the nearby Veterans Administration (VA) Medical Center, was seeking a new research assistant: Might I be interested in applying for the position? Having already accepted an offer to work on the self-injurious behavior project, I felt guilty for even thinking about interviewing for another position. However, I also realized that the kind of research Crovitz was doing fit much better with my evolving interests in cognition and neuroscience than did the self-injurious behavior project. So, I applied for the position

and Crovitz interviewed me. We hit it off immediately, and he offered me the position by the end of the interview, which I accepted on the spot. That made for a difficult conversation with Stephen Schroeder, but it was clear to me what kind of research I felt more passionate about, and Schroeder accepted my decision magnanimously despite the temporary disruption to his plans that it caused.

After working in Ed Kelly's lab during the summer of 1974, I began my position as Herb Crovitz's research assistant in September. One of the intriguing new directions that Crovitz was just beginning to pursue involved testing patients at the VA Medical Center who were characterized by significant memory problems. I had little exposure to memory research during my undergraduate psychology courses, but with Crovitz's guidance, I began digging into the neuropsychological literature on the amnesic syndrome and related kinds of memory disorders subsequent to brain damage. I was excited to administer standardized memory tests to a memory-impaired patient shortly after beginning the position and was stunned by what I observed: The man seemed normal during casual conversation, and performed well on tests of perception and language, but exhibited virtually no recall of word lists that I presented to him just minutes earlier and failed to recognize me when I left the testing room and returned after a short break. Observing similarly striking phenomena in multiple amnesic patients, plus my stimulating discussions with Crovitz of what it all meant, ignited what turned out to be a lifelong interest in the nature and function of human memory.

This promising beginning to my new position was unexpectedly interrupted by a traumatic event: On October 15, 1974, I received a phone call from my mother communicating the devastating news that my father had taken his own life. I knew that my dad had been struggling financially and drinking too much in an attempt to cope with his problems, but only a month earlier I had a reassuring conversation with him on a visit home conveying my love and support. He was seeing a psychiatrist, and we all thought he would make it through the rough patch he was experiencing. Unfortunately, however, Phil was skilled at hiding just how dark his world had become. He was a kind person who put the welfare of others above his own, which made his suicide that much more difficult for our family to take. More than 50 years later, it is still hard to think about this overwhelming event and describe it in writing. The emotional consequences were severe for all of us and took many years to work through. However, knowing how much my father sacrificed on my behalf also added to my determination to make good use of the gifts he had given me.

Herb Crovitz was very understanding of my situation, but I returned to his lab within a couple of weeks, and immersion in work helped to get me through the immediate aftermath of my father's death. Crovitz was an atypical supervisor in that he gave me an unusual amount of freedom

to pursue my own scholarly interests at those times when he was focused on writing tasks that did not require my involvement. I took advantage, and wrote a couple of review papers that followed up on phenomena and issues I had become acquainted with through working in Ed Kelly's lab: a *Psychological Bulletin* article on the hypnagogic state (Schacter, 1976) and a *Biological Psychology* paper on the relation between electroencephalogram (EEG) theta waves and psychological phenomena (Schacter, 1977). Crovitz and I collaborated on a *Cortex* review of memory disorders after closed head injury (Schacter and Crovitz, 1977), and that project helped to cement my emerging interest in human memory. By the time I had begun my second year in Crovitz's lab, I decided to pursue graduate studies focused on memory, and I submitted applications during the fall of 1975 to graduate programs with strength in memory research. Crovitz was instrumental in my decision to accept an offer from the Department of Psychology at the University of Toronto, which at the time was perhaps the most important center in the world for the cognitive study of human memory, with an impressive cast of leading researchers (i.e., Fergus Craik, Paul Kolers, Robert Lockhart, Colin MacLeod, Morris Moscovitch, Ben Murdock, Norman Slamecka, and Endel Tulving). I was fortunate that the late and great Endel Tulving, a memory researcher of whom Crovitz thought especially highly, accepted me as a student in his lab, where I initiated graduate studies in the fall of 1976.

On to Graduate School: Toronto and Oxford

The city of Toronto in 1976 had only recently emerged from its reputation during the 1950s and 1960s as a conservative, dull enclave of stuffy WASPs and was well on its way to becoming the vibrant, multicultural city that we know today. I enjoyed the city immediately upon arriving, notably the diversity of its ethnic restaurants, its clean and efficient subway system, and its cultural attractions, such as the Toronto Symphony and Art Gallery of Ontario. As a graduate student, however, most of my life was tied up with working to progress through the doctoral program and immersing myself in memory research. The richness of the Toronto environment for memory studies was as advertised and showcased most prominently in the weekly Ebbinghaus Empire brown bag meetings, during which students and faculty from the various Toronto-based memory labs came together to present talks on their latest findings, which were invariably subject to very tough but typically insightful critiques. I took invaluable courses offered by Ben Murdock on basic experimental and theoretical research in the cognitive psychology of memory and by Morris Moscovitch on neuropsychological approaches to memory and cognition. I was fortunate to form a great relationship from the start with Endel Tulving, a figure who some found intimidating (and not without reason), but whom I found to be both

approachable and an invaluable source of theoretical insight and stimulation (for an overview of Tulving's scientific contributions, see Roediger, Schacter, and Craik, 2025).

I initiated an experimental project during my first year of graduate school that, following from Tulving's work on the importance of retrieval cues in episodic memory, attempted to specify properties of retrieval cues that made some more effective than others. This project served as my first-year master's thesis. In early 1977, however, I became curious about a related topic that would soon become a dominant force in my academic life. A book chapter by Tulving titled "Ecphoric Processes in Recall and Recognition" (Tulving, 1976) piqued my interest regarding where the strange term "ecphoric" came from. As Tulving explained, the source was a little-known German biologist named Richard Semon who had written two books about memory in the early twentieth century in which he proposed new terminology to refer to key memory processes: "ecphory" for the process of retrieval; "engraphy" for the process of encoding; and "engram" for the memory trace (for English translations, see Semon, 1921, 1923). Tulving, like Semon, endorsed the idea of inventing new terms for scientific constructs because doing so allowed one to specify exactly what the terms meant and to avoid possibly misleading connotations attached to the everyday usage of these terms.

I was able to check out the English translations of Semon's books from the University of Toronto library. As I plunged into reading them, it did not take long for me to realize that in addition to inventing new terms for memory processes, Semon had advanced a novel and sophisticated theoretical framework for conceptualizing human memory, one that anticipated many ideas that had only recently emerged in the cognitive psychology of human memory during the 1960s and 1970s. I discussed these ideas with Tulving and my fellow graduate student Eric Eich, and we decided that the depth and originality of Semon's ideas, which were largely unknown and virtually never cited among contemporary cognitive psychologists, deserved exposure to the field. So together, we wrote an article that explained Semon's theorizing and linked it to contemporary memory research (Schacter, Eich, and Tulving, 1978).

As I unearthed more information about Semon, I came to realize that he not only had developed original ideas about memory but also had been a prominent evolutionary biologist at the University of Jena before having to leave the university on account of a scandalous affair with Maria Krehl, the wife of another professor there. Semon moved with Maria to Munich and began working as a private scholar, where he wrote his two books on memory. Sadly, he suffered greatly from the negative reception of these books. I was shocked to learn that, suffering from depression resulting from a combination of scientific neglect, the death of Maria from cancer in spring 1918, and the fate of Germany in World War I, Semon took

his own life in December 1918 at age 59. I also came to see that Semon's early, impactful research as a biologist, and the neglect of his work on memory, raised intriguing general issues about the history and psychology of science. As an avid reader of books on the history of science, I began to wonder: Could I write one about Richard Semon?

Given the time requirements of my graduate coursework and experimental studies, the prospect of taking on a book writing project was daunting, but I found it hard to resist the intrigue of Semon's personal life story, the prescience of his ideas about memory, and the broad implications of the scientific issues raised by the neglect of his work. Moreover, being only a couple of years removed from my father's suicide, Semon's decision to take his own life produced a strong emotional attraction to his story. The transition from a fanciful idea to a concrete project occurred when I joined Endel Tulving for part of his 1977–1978 sabbatical at the University of Oxford (I was a visiting graduate student at Oxford's Department of Experimental Psychology from January to September 1978). Larry Erlbaum, who had just a few years earlier started publishing books on memory and cognitive psychology under the imprint of Lawrence Erlbaum Associates, visited Oxford in early 1978 and was open to listening to my pitch for a book on Semon. Much to my surprise and delight, he was interested in the project and soon after offered me a contract to write the book. Being close to continental Europe was helpful, as I learned of the existence of Semon's correspondences with a variety of important scientific figures that were housed in archives located in Zurich and Munich that I was able to visit. (Although I did not know any German at the time, I took a three-week German immersion course during the summer of 1978 that equipped me to read the letters with a German-English dictionary at hand; and I received invaluable assistance from an Oxford friend, Agnes Kocsis, who was fluent in German.)

My time in Oxford was also enriched by the opportunity to participate in regular meetings with Tulving and the neuroscientist Lawrence Weiskrantz, who a few years earlier had published pathbreaking papers with the neuropsychologist Elizabeth Warrington demonstrating surprisingly robust retention in amnesic patients on tests that used fragmented words and pictures as retrieval cues. We had numerous stimulating discussions concerning the nature and implications of the Warrington and Weiskrantz work that influenced our subsequent experimental work.

Upon returning to Toronto in September 1978, I devised plans for moving forward with my graduate studies in a way that could accommodate writing the Semon book. For example, Semon's first book, *Die Mneme*, discussed not only human memory but also memory in a broader sense that included "biological memories" passed down across generations through the Lamarckian principle of the inheritance of acquired characteristics. I planned to include a chapter in my book examining these ideas

and the historical context in evolutionary biology for Semon's proposals. To acquaint myself with the relevant literature, I took a course on the history of evolutionary biology offered by the University of Toronto historian of biology Polly Winsor that provided me with relevant background and, at the same time, fulfilled a course requirement in the Department of Psychology's doctoral program (my term paper in this course provided the basis for chapter 7 in the book).

In parallel with researching and writing the book, I moved forward with other lines of work. One involved the initiation of experimental research that would ultimately provide the basis for my doctoral thesis, focusing on what was, at the time, a little-investigated aspect of human memory known as "the feeling of knowing": the subjective feeling that a person could recognize in the future an item that they cannot recall at the moment. While it had been established that feeling-of-knowing judgments about unrecalled items from a recent study list predict a person's ability to recognize that item at above-chance levels, not much else was known about them. Influenced in part by Tulving's ideas about the interactive relationship between encoding and retrieval processes, over the next couple of years, I carried out experiments that showed that the relative frequency and accuracy of feeling-of-knowing judgments were affected by experimentally induced changes in encoding, storage, and retrieval conditions in ways that helped to characterize their nature and basis and that were consistent with Tulving's theorizing about encoding-retrieval interactions. The experiments formed the basis of my 1981 doctoral thesis, and they were published a couple of years later (Schacter, 1983b).

While pushing forward on the thesis experiments and book writing, I was also afforded the opportunity to pursue my interests in amnesic patients and follow up on issues that were central to my discussions with Weiskrantz and Tulving in Oxford. One such opportunity came about as a result of an invitation that Tulving received to attend a conference in the fall of 1979 organized by the amnesia researcher Laird Cermak to promote exchange between cognitive psychologists working on normal memory and neuropsychologists studying memory disorders. In addition to accepting Cermak's invitation, Tulving managed to convince Cermak to agree that I could attend the conference. The meeting was held in October 1979 at an idyllic location—the Lake Morey Inn in Fairley, Vermont—and boasted a roster of some of the most eminent researchers from both the neuropsychology and cognitive psychology of memory, including Marilyn Albert, Alan Baddeley, Nelson Butters, Robert Crowder, Larry Jacoby, Marcel Kinsbourne, Elizabeth Loftus, Morris Moscovitch, and Larry Squire. It was a thrill for a graduate student such as myself to be included among these luminaries, and both to witness and participate in highly stimulating and occasionally contentious discussions. Looking back many years later, several of us felt that this conference played an important role in generating the increased interactions between

cognitive and neuropsychological perspectives that characterized some areas of memory research during the 1980s. After the conference, Tulving and I wrote an introductory chapter for the volume that Laird Cermak edited based on the conference, in which we laid out the key issues and problems that we thought researchers needed to address in order to promote productive interactions (Schacter and Tulving, 1982).

Post-Oxford, the question of how to think about amnesic patients' surprisingly good performance on memory tests using fragmented words and pictures continued to intrigue both Endel Tulving and myself. In the summer of 1980, we came up with a design for a study with Toronto undergraduates in which we conceptualized memory effects on word fragment completion performance as a possible manifestation of the phenomenon of *priming*: a facilitation of test performance produced by a prior exposure to a test item. Recent studies from Larry Jacoby and others had shown that priming effects on tasks such as word identification could be dissociated from performance on a standard recognition test (e.g., Jacoby and Dallas, 1981). Might a similar dissociation be observed between fragment completion and recognition performance? To find out, we exposed participants to a long list of low-frequency words, and tested half of the items at a one-hour delay and the other half at a one-week delay using old–new recognition and word fragment completion tests. Whereas recognition performance declined as expected across the delay, priming effects on the word fragment completion test did not. In addition, the magnitude of the priming effect was identical for studied words that had been judged "old" and those judged "new" on a preceding recognition test, suggesting independence between the two processes (Tulving, Schacter, and Stark, 1982). Combining these results with evidence from Larry Jacoby concerning priming of perceptual identification performance, the earlier observations of Warrington and Weiskrantz regarding amnesic patients, and a more recent demonstration of preserved procedural learning in amnesic patients from Neal Cohen and Larry Squire, we concluded with a provocative suggestion: "Since the priming effects described in this article are clearly independent of episodic memory, and since there are problems with their interpretation in terms of modifications of semantic memory, we are tempted to think that they reflect the operation of some other, as yet little understood, memory system" (Tulving, Schacter, and Stark, 1982, 341). That suggestion would motivate much of my research during the 1980s and 1990s.

Around the same time in 1980 that the fragment completion experiments were conducted, I encountered an unexpected opportunity to extend my interests in amnesia and memory systems when I received a call from neuropsychologist Paul Wang at nearby Mount Sinai Hospital. He had just seen an intriguing patient, a young man with a rare kind of memory disorder known as functional retrograde amnesia: an inability to remember

his personal identity or virtually any information about his personal past, despite an absence of detectable brain damage. The causes of these amnesias vary, but they are sometimes precipitated by an emotionally traumatic event, which appeared to be the trigger in this case (the patient's grandfather, who had raised him after he was abandoned by his parents, had just died and the patient became amnesic after attending his grandfather's funeral). Dr. Wang asked whether I would be interested in testing the patient, which I was. Knowing that memory problems in these kinds of patients sometimes clear up quickly, I assembled a battery of tests focused on episodic memory and semantic memory, and tested the patient (whom we called "Lumberjack") the next day, when he remained amnesic, and three weeks later, after the amnesia had cleared. Results from testing during the amnesic episode showed a profound impairment of episodic memory coupled with preservation of semantic memory. By contrast, Lumberjack performed normally on both kinds of tests in the post-amnesic session. These and various other observations allowed us to publish the first quantitative assessment of memory performance in a patient with functional retrograde amnesia (Schacter et al., 1982), paving the way for later observations on a larger sample from Mark Kritchevsky and Larry Squire.

Next Steps: The Unit for Memory Disorders

By the end of 1980, I confronted a question familiar to anyone nearing the completion of a doctoral program: What's next? Fortunately, an unusual opportunity presented itself: The Connaught Fund at the University of Toronto had just made available a new large grant program for innovative research projects. I discussed with Endel Tulving and Morris Moscovitch the possibility of writing a grant proposal for the establishment of a Unit for Memory Disorders within the University of Toronto that would employ cutting-edge techniques from the cognitive psychology of memory to study the performance of patients with memory disorders resulting from brain damage. We had made enough connections with clinicians in Toronto to make a strong case that we would have access to the required patient populations, and we had no shortage of ideas for proposed experiments. The grant was funded, and after defending my doctoral thesis in May 1981, I assumed the position of director of the Unit for Memory Disorders, housed in a historic University of Toronto building at One Spadina Crescent, located inside a traffic circle in the middle of busy Spadina Avenue, just a short walk from the Department of Psychology.

In parallel to getting started at the Unit for Memory Disorders, I worked hard to complete the Semon book, which I handed over to the publisher in late 1981. It finally saw the light of day in mid-1982 and was reissued in 2001 by a new publisher, Psychology Press, with a much nicer front cover

than the original and an engaging foreword by Endel Tulving (Schacter, 1982, 2001a). Throughout the next six years, I was fortunate to carry out numerous studies with colleagues in the Unit for Memory Disorders and also the Department of Psychology at the University of Toronto; here I will touch on just a few highlights. One of the lesser-known (but for me, most enjoyable) projects from that time was a case study of a man with a clinical diagnosis of early Alzheimer's disease who presented as severely amnesic, but knew enough about his life to tell me that golf was one of his hobbies. Given my history with golf, and that golf taps a variety of different aspects of memory—episodic memory for individual shots and one's score on each hole, semantic memory for golf jargon and rules, and procedural memory for swing mechanics—I was eager to find out how a severely amnesic golfer would fare during a round. We played two rounds separated by a couple of weeks, and the results were clear-cut (reported in detail in Schacter, 1983a). On the one hand, the patient generally hit the ball well and though it was impossible to know whether his execution of golf skills had deteriorated as a function of Alzheimer's disease, his performance was well within the range of typical golfers, consistent with his golf handicap from the past decade (i.e., a rough estimate of his ability based on posted scores), and reflected an ability to execute complex procedural skills. Similarly, he used golf jargon appropriately (e.g., birdie, par, divot) and knew the rules and etiquette of golf (e.g., marking his ball on the green, playing when farthest away from the hole), reflecting access to well-established semantic knowledge. On the other hand, the patient's episodic memory for the ongoing events of the round was virtually absent: He did not recall his shots on a hole when I tested him as we walked off the green and would often forget where he had hit the ball—or even that he had hit the ball—if there was any delay between executing the shot and walking after it. The extent to which the patient's amnesia affected his episodic memory in this everyday context was surprising even to me. Of course, the areas in which the patient performed well (golf skills and jargon) reflect preservation of old knowledge and skills acquired before the onset of dementia, whereas his impaired performance reflected impaired new knowledge. Thus, it was not possible to draw any firm theoretical conclusions regarding differential preservation of episodic, semantic, and procedural memory in this case study. Nonetheless, I was pleased with the positive reception accorded my write-up of this unusual case study.

Another striking and partially related kind of memory loss that I explored around the same time was one that I had initially read about during my stint in Herb Crovitz's lab: a curious phenomenon demonstrated in studies of hypnotized subjects known as *source amnesia*, in which subjects sometimes successfully recalled novel facts that an experimenter had just told them, but failed to recall that the experimenter was the source of the new information. Source amnesia resembled phenomena

that had previously been observed clinically in brain-damaged patients with amnesia, but had never been formally investigated in these patients. We initiated such a study with the patient population we had assembled at the Unit for Memory Disorders, as well as in an experiment with healthy young adults that was part of an honors thesis performed by a University of Toronto undergraduate, Joanne Harbluk. We used made-up "facts" about famous people as our target items that were presented initially in the form of a question by one of two experimenters seated across from the patient (e.g., "What job did Bob Hope's father have? *Fireman*) and then recurred later in the sequence of similar "facts." When participants provided the correct answer on the second occurrence of a question, they were asked "How do you know that"? We distinguished between *source amnesia*, in which an individual provides a source outside the experiment for a fact acquired within the experiment, and *source forgetting*, in which an individual recalls that a new fact came from the experiment but fails to recall the exact source within the experiment (e.g., which of two experimenters provided the fact).

We demonstrated robust source amnesia for recalled facts in a group of patients with severe memory disorders after brief study-test delays of a few minutes; by contrast, healthy young adults, even when tested at a long study-test delay (i.e., one week), almost never exhibited source amnesia, but they did exhibit considerable source forgetting (Schacter, Harbluk, and McLachlan, 1984). Interestingly, we observed correlational evidence linking source amnesia in the patient group with poor performance on neuropsychological tests sensitive to frontal lobe dysfunction, a finding that was demonstrated more directly in subsequent research from Larry Squire's lab. I was able to pursue issues related to the role of frontal lobe dysfunction in memory in more detail in a theoretical paper that was initiated during a six-week visit to Squire's lab at the University of California–San Diego/VA Medical Center during the winter of 1983. Many stimulating discussions with Larry and other members of his lab helped to shape the paper, which was published several years later in *Psychobiology* (Schacter, 1987b).

Peter Graf, who led important work on the topic of priming with Larry Squire and George Mandler in San Diego, had moved to the University of Toronto shortly after we opened the Unit for Memory Disorders. Recognizing our common interests, we collaborated on a study of priming in healthy individuals and memory-impaired patients. In the resulting paper, we coined a new term for the form of memory that was characterized by an impact of a prior experience in the absence of conscious recollection for the prior occurrence of that experience: *implicit memory*, which we contrasted with *explicit memory*, involving conscious recollection of past experiences (Graf and Schacter, 1985). Graf and I went on to publish a series of articles providing novel experimental evidence for dissociations between implicit

and explicit memory, and many other researchers began to work on similar issues. Witnessing what appeared to be the beginnings of a significant new subfield of memory research, and seeking to place this new work in the context of earlier related observations, I wrote a historically based review that attempted to delineate key issues for this emerging research area and point the way toward the future, published in the *Journal of Experimental Psychology: Learning, Memory & Cognition* (Schacter, 1987a).

Our experimental work on implicit memory also inspired a line of research at the Unit for Memory Disorders in which we attempted to tap preserved implicit memory capacities in patients with memory disorders for purposes of memory rehabilitation. At the time, most studies of memory rehabilitation focused on trying to restore lost memory abilities, but unfortunately did not achieve much success. In studies led by Elizabeth Glisky, who joined the Unit for Memory Disorders after completing her doctoral research working with Fergus Craik at the University of Toronto, we attempted to draw on preserved priming abilities in our patients to teach them what we called "domain-specific knowledge": knowledge and skills that could be helpful to them in their everyday lives, despite their general memory impairments.

We focused on teaching patients how to use personal computers, which had only recently come on the scene, but were increasingly commonly used at home and at work. Using a priming-based technique that we called "the method of vanishing cues," we demonstrated that patients could acquire a large amount of computer vocabulary and programming skills and could retain that information across a one-year delay (Glisky, Schacter, and Tulving, 1986). These effects were especially impressive in the case of perhaps the most severely amnesic patient in our sample, a young man who had suffered a closed head injury and was known mainly in the literature by the initials KC (Kent Cochrane, who passed away in 2014). Kent had sustained damage to a number of brain regions, including prefrontal, parietal, and medial temporal regions, resulting in an inability to remember any specific episode from his personal past (Rosenbaum et al., 2005). Nonetheless, Kent showed robust learning of computer knowledge and skills that persisted for a year, even though when questioned at the beginning of each of his twice-weekly learning sessions, Kent did not recall ever having worked on a computer previously. In our most direct application of this work, we were able to train another, almost equally severely impaired patient who had become amnesic as a result of viral encephalitis, to learn a complex real-world job involving data entry into a computer (Glisky and Schacter, 1989).

In parallel with this more applied line of work, I put a lot of time into thinking through the theoretical issues raised by the striking phenomena of implicit memory, in particular the question of whether dissociations between implicit and explicit memory in amnesic patients and healthy

individuals reflected the operation of distinct memory systems or different processes operating within a single memory system. This issue has been discussed at length over the past 40 years by myself and countless others, and I do not propose to adjudicate it here. Most relevant for the present purposes is that concern with this issue led me to have lengthy discussions with the late David Sherry, an animal behavior researcher at the University of Toronto with expertise in evolutionary biology, about whether evolutionary considerations could help us to frame or perhaps resolve the debate over whether dissociations between implicit and explicit memory require the postulation of multiple memory systems. Our discussions resulted in a theoretical formulation that featured the construct of what we called *functional incompatibility*: when an evolutionary adaptation that serves a particular function cannot, because of its specialized nature, serve other functions.

We believed that functional incompatibility was a key concept that was missing from the ongoing multiple memory systems debate. Putting together our respective areas of expertise in memory dissociations and evolutionary processes, we wrote a theoretical paper that was published in the *Psychological Review* (Sherry and Schacter, 1987). We stated: "The reason, we will argue, that the evolutionary outcome has been multiple memory systems rather than a single system capable of serving many functions is that the memory system that effectively solves some environmental problems may be unworkable as the solution to others" (Sherry and Schacter, 1987, 443). The basic idea was very similar to one later advanced in the influential complementary learning systems framework of Jay McClelland, Bruce McNaughton, and Randy O'Reilly, and although these authors did not cite our work initially, this oversight was acknowledged and rectified over two decades later in an overview of the complementary learning systems perspective (O'Reilly et al., 2014).

Into the Desert: Tucson and the University of Arizona

By 1986, our work at the Unit for Memory Disorders was going well, I enjoyed my collaborations with other young researchers at the University of Toronto such as Peter Graf and David Sherry, and I had received funding from the Natural Science and Engineering Council of Canada (NSERC) to complement our internal Connaught Fund support. But I had been in Toronto for a decade and was still working (albeit to a limited extent) with my doctoral supervisor. Was it time for a change? That question became quite salient when, in February 1986, I participated in a cognitive science conference at the University of Arizona. I spent some time there with the neuroscientist Lynn Nadel, who had recently moved to Tucson along with the cognitive psychologist Lynn Cooper. Other big names had committed to become part of a new and ambitious cognitive science program at the

University of Arizona and would be moving there soon, including John Kihlstrom from Wisconsin, Merrill Garrett from Massachusetts Institute of Technology (MIT), and Ken Forster from Monash University. Nadel asked if I might also be interested, and the prospect of joining such an illustrious group was enticing, so I responded positively. It did not hurt that this initial conversation took place in the idyllic weather conditions characteristic of Tucson in February, which contrasted sharply with the cold and snow of Toronto.

Long story short, the recruitment was successful, and I joined the faculty in the Department of Psychology at the University of Arizona in summer 1987, beginning a tenured appointment at the associate professor level. Happily, I was accompanied in Tucson by my fiancé, Susan McGlynn (we married in January 1988), who had decided to pursue a career in clinical neuropsychology and was admitted to the University of Arizona's clinical psychology doctoral program. Another positive feature of the move was that the University of Arizona also recruited my colleague at the Unit for Memory Disorders, Elizabeth Glisky, and we were excited to be able to continue the research we had been doing on memory rehabilitation once we established an appropriate patient population in Tucson, a task that was facilitated by the cooperation of Tucson-based neuropsychologists and neurologists, including Al Kaszniak, Alan Rubens, and Steve Rapcsak.

Three scientific endeavors stand out from my time in Tucson. The first concerns a collaboration with the late Lynn Cooper, who had done pioneering work on visual object processing. We discussed common interests and quickly converged on the idea of combining Lynn's expertise in visual object processing with my research on priming and implicit memory, which had used verbal material exclusively. The result was a new behavioral paradigm for investigating implicit and explicit memory in which we first exposed subjects to a series of novel shapes, half structurally possible and half structurally impossible (i.e., a two-dimensional object drawing contained lines and angles that could not exist in the real three-dimensional world). After a delay, explicit memory was tested with a standard old–new recognition task, whereas implicit memory was tested with an object decision task in which participants had to judge whether previously presented objects and new objects were structurally possible or impossible. We observed evidence of priming on this test—enhanced object decision performance for previously presented possible objects but not for previously presented impossible objects. This occurred, however, only when participants performed encoding tasks focused on the overall or global shape of the possible objects and not when encoding tasks focused on their local features (Schacter, Cooper, and Delaney, 1990). Moreover, we provided evidence in several studies that various experimental manipulations had different effects on priming and explicit memory for possible objects, and further, we found that patients with memory disorders exhibited intact

priming despite impaired explicit memory (Schacter et al., 1991). These and related observations led us to seek guidance from the neuropsychological literature on visual object processing, in which investigators such as Glynn Humphreys and Jane Riddoch had proposed that visual object processing relies on a *structural description system* linked to the ventral visual processing stream, which represents global object form and structure, but not their semantic and associative properties (e.g., how an object might be used in the real world). We proposed that priming on the object decision task relies primarily on this structural description system, consistent with its preservation in cases of patients with memory disorders, who typically do not have problems processing the form and structure of visual objects. This line of thinking led me to the more general idea that perceptual representation systems that had been identified in neuropsychological research played a critical role in various priming effects we and others had been observing, with a visual word form system that had been identified initially in research in reading disorders contributing importantly to visual word priming (Schacter, 1990, 1992). In a *Science* paper, Endel Tulving and I proposed the existence of a perceptual representation system in addition to four other major memory systems (i.e., working, episodic, semantic, procedural; Tulving and Schacter, 1990).

A second scientific endeavor from the Arizona years is related to the object decision work and involved my introduction to functional neuroimaging. Soon after I landed in Tucson, Eric Reiman, a psychiatrist with research interests in memory and expertise in positron emission tomography (PET) imaging, arrived in Phoenix from Washington University in St. Louis with plans to set up a PET center. Eric contacted me to explore joint interests. We discussed plans for a PET study using our recently established possible–impossible object decision paradigm. It took several years for the study to be completed, but the results provided early neuroimaging evidence selectively linking the hippocampus with explicit but not implicit memory, a result that was sufficiently novel to merit publication in *Nature* (Schacter et al., 1995).

A third important scientific endeavor from the Tucson years concerns an activity that is necessary to have a successful research career—obtaining external funding. Having just moved from Canada and my secure funding there, I was warned about the possible difficulties of breaking into the U.S. granting system. Fortunately, these concerns were quickly allayed. I began to develop ideas about research on aging memory, focusing mainly on issues related to source recollection, and with the collaboration of my University of Arizona colleagues Al Kaszniak and John Kihlstrom, submitted a proposal for an NIH R01 grant that was funded by the National Institute on Aging. With Lynn Cooper, I was also successful in obtaining funding from the Air Force Office of Scientific Research to support our work on object decision priming. In addition, shortly after my arrival in Tucson,

the McDonnell and Pew Foundations announced a new joint program to establish a set of centers in the area of cognitive neuroscience. I participated in the University of Arizona proposal that resulted in one of those centers being established in Tucson.

In addition to these positive scientific developments, my wife Sue and I enjoyed living in Tucson, especially the amazing weather there from October through May (we survived but did not love the summers). I returned to playing golf with regularity in a fun faculty foursome that included the late Dick Bootzin, Merrill Garrett, and Ken Forster. Sue and I had no plans to leave anytime soon, but in the fall of 1989, I received a phone call from Stephen Kosslyn in the Department of Psychology at Harvard, inquiring whether I would be interested in being considered for a position there. I was intrigued and honored, realizing that such expressions of interest from Harvard do not come around every day. As much as we liked Tucson, both of us had family ties in the east, and the prospect of being closer to family as we began thinking about starting our own family was attractive. So I gave Kosslyn the green light, visited Harvard for a talk in November 1989, and accepted their offer of an appointment as professor of psychology in May 1990, with plans to begin the position in early 1991.

The timing of our upcoming geographical transition matched that of another personal transition: our first child, Hannah Lindsay Schacter, was born in Tucson on December 12, 1990, just six weeks before we moved to the Boston area. Sue was in the midst of completing her doctorate in clinical psychology at the University of Arizona, so there was no lack of stress in our lives during this period. We managed to buy a house—rare new construction in Newton, about a 20-minute drive from the Department of Psychology at Harvard—and moved into our new home on February 1, 1991.

Back East: Transition to Harvard

Although moving with a six-week old baby is challenging, in other respects, moving from Tucson to Boston was not as disruptive as moving from Toronto to Tucson. I had already secured external funding for my research, and a graduate student from my University of Arizona lab, Barbara Church, also moved, thus enabling continuation of a promising line of research we had started on the underexplored phenomenon of auditory implicit memory. I had also already established collegial relationships with several researchers at the VA Medical Center in nearby Jamaica Plain—Laird Cermak, Bill Milberg, and Mieke Verfaellie—who were interested in memory disorders and were willing to provide access to a well-established population of amnesic patients, as well as other patients with different kinds of neuropsychological deficits.

I was eager to continue my involvement with neuroimaging and began a collaboration with the neuropsychologist Marilyn Albert, who was becoming involved in PET research, and the physicist Nat Alpert, who ran the PET lab at Massachusetts General Hospital and was already collaborating on studies of mental imagery with Stephen Kosslyn. We initially focused on trying to sort out issues concerning the conditions in which the hippocampus showed increased activity during an explicit recall test, providing evidence that hippocampal activation was related to characteristics of successful conscious recollection, rather than to the cognitive effort involved in trying to recall a past experience (Schacter et al., 1996a).

Work in my lab during the first few years at Harvard also remained focused on issues related to the distinction between implicit and explicit memory. With Barbara Church, we published studies that delineated properties of auditory priming effects in young and older adults, and dissociated these effects from explicit memory (e.g., Church and Schacter, 1994). In a study of amnesic patients, we provided evidence for spared auditory priming despite impaired explicit memory (Schacter, Church, and Treadwell, 1994). Bill Milberg referred to us a patient with brain damage with the relatively rare diagnosis of "word meaning deafness": The patient could process auditory properties of spoken words but lacked comprehension of their meaning. In a collaborative study, we were able to show that the patient nonetheless showed intact priming on an auditory identification test, supporting the idea that such priming operates at a presemantic level and is supported in a perceptual representation system (Schacter et al., 1993). Pulling together these lines of research with broader developments in the field, graduate students Peter Chiu, Kevin Ochsner, and I published an *Annual Review of Neuroscience* article that updated research on implicit memory and fleshed out key issues and questions (Schacter, Chiu, and Ochsner, 1993).

In parallel with these scientific developments, during my initial years at Harvard, I also spent time pursuing a relatively recently developed interest: works by visual artists who were interested in exploring memory through their artwork. This interest was born in Tucson, when I stumbled across a multimedia piece in an art exhibition titled "The Color of Memory" by the Tucson artist Richard Schaefer. The piece presented a visual comparison between computer memory and biological memory, and interested me enough to purchase it. I became acquainted with Schaefer and subsequently commissioned another work, this one on the theme of preserved implicit memory in amnesia, which the artist realized in a multimedia piece with abstract shapes representing memory traces and a tear through the center of the piece representing a brain lesion. After moving to Boston, I began looking for other artists who focused on memory, by reading art magazines and going to local galleries, where I identified some promising artists. I was motivated to purchase some of these artworks and

soon found a way to make that financially feasible. In 1991, I was fortunate to receive the Troland Award from the National Academy of Sciences, which came with a sizeable cash stipend. Recipients were supposed to use the stipend for something related to their work, and I thought that funding a collection of art around the theme of memory was a novel and appropriate use of the funds. Over the next few years, that's what I did. The resulting collection included both local Boston artists, notably Ben Freeman, Catherine McCarthy, and Cheryl Warrick, and others from various locations, including California (Mildred Howard), New York (Laurie Novak), and Ontario, Canada (the late Carl Beam). Although I included artists working in a variety of styles in this collection, the works that I found most effective in evoking characteristics of memory often involved the use of reworked photographs of people and places from the artist's past. Working with a local art professional, Mary Olmstead, we assembled a show based on this "memory art collection" that was exhibited at the New Art Center in Newton during the fall of 1993. The show was titled "Fragile Power: Explorations in Memory," and it received a positive review from the *Boston Globe*'s art critic at the time, the late Christine Temin. Fortuitously, the Memory Disorders Research Society met in Boston when the exhibit was up, and several conference attendees made the short trip to Newton to view it. I found it satisfying to see this coming together of the art and science of memory, and I further realized that intersection when I began in the fall of 1993 to write *Searching for Memory: The Brain, the Mind, and the Past* (Schacter, 1996). I included reproductions of various works from the "memory art collection" that depicted aspects of memory I highlighted through text, which I felt would add a novel dimension to the book. I was pleased that many readers and reviewers appreciated this distinct feature. That fall was notable for another reason: On November 16, 1993, we welcomed a second daughter to our family, Emily Anne Schacter. Thankfully, Emily was an "easy baby," and I managed to sleep enough during the next few years to complete the book on schedule.

False Memories: Mind, Brain, and Society

In December 1993, shortly after the memory art exhibit closed, I gave an invited talk in a memory symposium held at the Museum of Fine Arts in Boston on the contentious topic of recovered memories of childhood sexual abuse. The other speakers were Elizabeth Loftus, well-known for her experiments and ideas on false memories, and James Chu, a clinician who worked with dissociative amnesia. I did not know much about recovered memories at the time and was asked to speak about my work on implicit memory. I was taken aback as I approached the entrance to the auditorium where the symposium was to be held and encountered a picket line of individuals holding placards that protested the involvement of Loftus in

the symposium. Security in the auditorium was tight and the atmosphere was tense. Loftus spoke first and the protestors made their feelings known by coughing loudly throughout her talk in an attempt to disrupt it. Not to be deterred, Loftus gave a typically lucid and compelling talk. I spoke next and, to my surprise, the coughing continued. Even though I had not taken any position on recovered memories, the protestors in the audience seemed to have assumed that as an experimentalist, I would be aligned with Loftus and thus in opposition to their views. When the clinician Chu spoke about dissociative amnesias, the coughing stopped.

That symposium was a jarring introduction to the heated debate over recovered and false memories that continued throughout the 1990s. At around the same time, two ostensibly unrelated developments led me to focus on questions concerning accuracy and distortion in human memory. First, my colleagues and I began to study a patient (BG), referred to us by Bill Milberg. BG had experienced a stroke in his right frontal lobe. Issues concerning the role of the right frontal lobe in memory were prominent in the early 1990s as a result of early PET studies from Tulving, Craik, Moscovitch, and their colleagues revealing preferential right frontal lobe activation during episodic memory retrieval (vs. encoding). We discovered, unexpectedly, that BG showed pathologically high levels of false recognition across several standard memory paradigms: After studying a list of words or pictures, he claimed with high confidence to have detailed recollections of novel items that had not appeared in the list (Schacter et al., 1996b). Our findings led me to contemplate more generally the neural basis of memory distortions and other constructive aspects of memory—a topic that I came to realize was quite underdeveloped in the cognitive neuroscience of memory.

Second, in the early 1990s, Harvard established a new interdisciplinary initiative called Mind, Brain, and Behavior that brought together interested faculty from different parts of the university. As part of this initiative, I participated in a small working group concerned with memory, which quickly became focused on issues related to memory distortion, stimulated in part by the raging debate in society concerning the accuracy of recovered memories of childhood sexual abuse. Our group organized a conference on the broad topic of memory distortion that brought together an impressive group of scientists and scholars from disciplines, including cognitive psychology, psychiatry, neuroscience, history, sociology, and religious studies for a meeting at the American Academy of Arts and Science in May 1994. The meeting stimulated considerable interest and resulted in the publication of a volume composed of chapters based on conference presentations on which I served as the primary editor (Schacter, 1995).

My involvement in this conference and book, together with our observations of heightened false recognition in right frontal patient BG, led me to focus increasingly on the cognitive neuroscience of constructive

memory—the title of an *Annual Review of Psychology* article that I coauthored with then–graduate student Ken Norman and postdoctoral fellow Wilma Koutstaal (Schacter, Norman, and Koutstaal, 1998). The theoretical framework we proposed in that article helped to shape the focus of my lab's research for the next decade and more, in which we combined neuroimaging studies, neuropsychological investigations of amnesic patients, and cognitive studies of young and older adults in an attempt to paint a broad picture of the neurocognitive processes that play an important role in memory construction. A useful tool for exploring these issues emerged in 1995 when Roddy Roediger and Kathleen McDermott published an important paper in which they rescued from obscurity a word-list paradigm for inducing false recall of semantic associates of words presented on a study list. The study had been initially published in 1959 by the psychologist James Deese. Roediger and McDermott extended the paradigm to false recognition, demonstrating a surprisingly high level of confident false recognition for a nonstudied "critical lure" word (e.g., *sweet*) that was a strong associate of previously studied words (e.g., *candy, sour, sugar, bitter, good, taste*). Using this Deese-Roediger-McDermott (DRM) paradigm, we conducted neuroimaging and neuropsychological studies that helped to characterize the role of the medial temporal lobe (and other regions as well) in false recognition.

We found, for example, that amnesic patients with medial temporal lobe damage showed reduced false recognition for critical lure words compared with age-matched controls, which we interpreted as evidence for their lack of memory for the semantic gist of previously studied lists of semantic associates that converged on the critical lure item (Schacter, Verfaellie, and Pradere, 1996). In subsequent studies of patients with Alzheimer's disease conducted in collaboration with Andrew Budson, we documented similar reductions in false recognition related to semantic gist (Budson et al., 2000) as well as perceptual gist (i.e., reduced false alarms to perceptually similar novel objects in Alzheimer's patients; Budson et al., 2001). We also found evidence in PET and fMRI studies for medial temporal activation during false recognition of critical lure items in healthy young adults (Schacter et al., 1996c; 1997). In addition, we and others found healthy older adults showed *increased* false recognition of critical lure items compared with young adults, likely reflecting their preserved memory for, and reliance on, the semantic gist of previously studied lists (Norman and Schacter, 1997). A study led by Wilma Koutstaal provided converging evidence by demonstrating that older adults showed dramatically higher levels of false recognition for nonstudied pictures from a studied category than did young adults, again reflecting reliance on semantic gist in the older adults (Koutstaal and Schacter, 1997).

These and related studies led us to conclude that the DRM false recognition effect, and similar perceptual false recognition effects

demonstrated in fMRI work with Scott Slotnick (Slotnick and Schacter, 2004), can be expected to occur when people retain and rely on general or gist-like features of previously studied information. A natural corollary of this perspective is that these kinds of gist-based false recognition effects should be reduced following conditions that favor encoding of specific or distinctive features of target information. And, indeed, we showed that when DRM lists are encoded in the form of pictures that emphasize distinctive perceptual information about each studied item, false recognition of critical lure items is greatly reduced. We proposed that this reduction reflects reliance on a *distinctiveness heuristic*: a retrieval orientation in which people expect to remember vivid details of a past experience and make recognition judgments based on this metacognitive expectation. We conducted several studies documenting the use of a distinctiveness heuristic in young and older adults (Israel and Schacter, 1997; Schacter, Israel, and Racine, 1999). In subsequent years, studies led by postdocs Chad Dodson (Dodson and Schacter, 2002) and David Gallo (Gallo, Weiss, and Schacter, 2004) extended this work on the distinctiveness heuristic in novel directions using innovative methods for assessing its use in both age-groups. Impressed by the robustness of age-related effects in memory distortions, in subsequent years we attempted to understand their neural underpinnings using fMRI (Giovanello et al., 2010; Paige et al., 2016) and suggested theoretical ideas for characterizing the key processes at play (Devitt and Schacter, 2016).

My research focus on constructive memory led me to think broadly about different kinds of memory errors. Although psychologists had studied forgetting since the groundbreaking nineteenth-century studies of Herman Ebbinghaus, and there was a burgeoning literature on memory distortions, it struck me that that there had been few, if any, attempts to organize or classify the different ways in which memory can go astray. Beginning in 1998, I buried myself in this literature and came away convinced that memory's malfunctions could be organized into seven basic categories, which in homage to the ancient seven deadly sins, I called the seven "sins" of memory: three sins of omission that refer to different kinds of forgetting (*transience*, *absent-mindedness*, *blocking*) and four sins of commission that refer to forms of memory distortion (*misattribution*, *suggestibility*, *bias*) and intrusive memories (*persistence*). I laid out my ideas initially in an *American Psychologist* article (Schacter, 1999) and followed that with a book (Schacter, 2001b; for an updated edition, see Schacter, 2021). Considering all these sins together, and the havoc that they can wreak in everyday life—the large number of wrongful convictions based on eyewitness memory errors is alone sufficient to raise serious doubts about the reliability of memory—could easily lead one to conclude that human memory is fundamentally flawed. But it simply does not make sense that evolution could have produced such a defective system. I therefore proposed that

each of the seven sins could be viewed as by-products of otherwise adaptive features of memory. For example, I argued that the memory sin exemplified by the phenomenon of false recognition—misattribution—arises because we typically do not need to remember every detail of every experience and are often better served by holding on to the central meaning, or gist, of our experiences. This focus on adaptive aspects of memory errors helped me to move forward with the next phase of my research program by focusing my attention on questions concerning the *functions* of a constructive memory.

I wrote the first few chapters of *Seven Sins* toward the end of a full year sabbatical during academic year 1998–1999—a much-needed break after serving the first of what turned into three three-year terms as chair of the Department of Psychology at Harvard. I spent the final few months (May–August 1999) of that sabbatical as a visitor in the recently formed Institute for Cognitive Neuroscience at University College London (UCL). Happily, my family (wife Sue, eight-year-old daughter Hannah, and five-year-old daughter Emily) accompanied me to London. We lived in a UCL flat just off of Russell Square and had many wonderful experiences during our time there. I will always be indebted to Tim Shallice, Mick Rugg, and others at UCL for making my time in London so rewarding, from both a scholarly and family perspective.

During the 1990s, an emerging focus on constructive aspects of memory was not the only research going on in my lab. One notable development was led by two of the emerging young leaders in fMRI research in the late 1990s, Anthony Wagner, then a recent Stanford doctoral graduate doing a postdoc with me, and Randy Buckner, then a recent Washington University doctoral graduate based at the branch of the Massachusetts General Hospital in the Charlestown Navy Yard, one of the centers that played a key role in the development of fMRI. Randy and his collaborator Anders Dale were key players in the development of methods for doing *event-related* fMRI, which allows researchers to link brain and behavioral responses to stimuli presented on individual trials (as opposed to analyzing brain activity across a block of trials). We applied this technique to the analysis of encoding processes, in a study in which participants made encoding judgments about a long list of words while in the scanner and were given a recognition test the next day. The key question concerned whether brain activity during encoding was greater for words that participants successfully remembered the next day compared with those they forgot. The answer was a resounding "yes": Increased activity in two regions previously linked with deep or semantic encoding—the left inferior frontal lobe and left parahippocampal region—occurred for remembered versus forgotten items. The finding was important enough that the paper describing it was published in *Science* (Wagner et al., 1998), together with a paper from John Gabrieli's lab at Stanford reporting similar findings with pictorial materials. In addition to the specific findings from this work,

we were able to put to use this "subsequent memory" paradigm in a variety of later studies on issues, including how encoding processes can sometimes contribute to later memory distortions (Aminoff, Schacter, and Bar, 2008; Garoff, Slotnick, and Schacter, 2005), the role of the hippocampus in successful associative encoding (Chua et al., 2007), and the effects of reactivating a memory on the accuracy of subsequent recognition of the original experience (St. Jacques, Olm, and Schacter, 2013). We were also able to apply event-related fMRI to studying retrieval failures in which the ability to sort fMRI data as a function of participants' responses on specific trials was critical, such as the "tip-of-the-tongue" phenomenon, in which retrieval fails but people have a strong subjective sense that recall is imminent (Maril, Wagner, and Schacter, 2001), and the related "feeling of knowing," in which retrieval fails but people feel that they would be able to recognize the information on a later test (Maril et al., 2003). As mentioned earlier, my doctoral thesis experiments had attempted to elucidate cognitive characteristics of the feeling of knowing, and so it was of interest to observe via fMRI that specific patterns of activity in left prefrontal and parietal cortices were associated with the subjective features of the feeling of knowing that I had only been able to study behaviorally in my doctoral thesis.

From the Past to the Future

In 2005, a new postdoc arrived in my lab, Donna Rose Addis, who had just completed her doctorate at the University of Toronto, using fMRI to study autobiographical memory. We began to discuss the possibility of extending this approach to exploring how people imagine future experiences. My interest in this topic dated back to the 1980s and the Unit for Memory Disorders, where we studied a severely amnesic patient I described earlier named Kent Cochrane. While my research interest in Kent stemmed mainly from his intact implicit memory capacities despite not being able to explicitly remember a single episode from his entire life, a rather different kind of observation from a testing session in the early 1980s caught my attention. Endel Tulving and I were seated across the table from Kent, and Endel asked him a simple question: What will you be doing tomorrow? Kent could not conjure up any particular experience that might happen tomorrow, instead saying that his mind was blank—the same kind of response he would give when asked to recall what he did yesterday. Both Tulving and I were dumbstruck by Kent's response, which suggested that his profound episodic memory deficit encompassed both his past and his future (Tulving, 1985).

That observation stuck with me, and from time to time over the ensuing years, I thought about how to investigate the role of episodic memory in imagining future experiences, but it was not until Donna's arrival in the

lab that a path forward became clear. We came up with an fMRI paradigm in which participants received word cues and were asked to remember a past personal experience, imagine a future personal experience, or perform control tasks involving nonpersonal visuospatial or semantic processing. We observed strikingly similar increases for the past and future event tasks, compared with the control tasks, in brain regions, including medial temporal and frontal lobes, posterior cingulate and retrosplenial cortex, and lateral parietal and temporal areas (Addis, Wong, and Schacter, 2007). We suggested that these regions together composed a core neural network, largely overlapping with the default mode network (Buckner, Andrews-Hanna, and Schacter, 2008) that supports the ability to remember past experiences, imagine future experiences, and engage in related forms of what we called "episodic simulation" (Schacter, Addis, and Buckner, 2007, 2008). Although we initially made this suggestion based on our own and a couple of other neuroimaging studies, research on this issue accelerated soon after 2007, and by 2015, a meta-analysis of our and others' neuroimaging studies led by Roland Benoit confirmed the role of this core network in supporting episodic simulation based on a much larger sample of studies (Benoit and Schacter, 2015). We and others also produced purely behavioral evidence that highlighted similarities between past and future events. For instance, Donna Addis and I initiated a behavioral line of research comparing young and older adults that documented similar age-related declines in the number of episodic details when young and older adults remembered past and imagined future experiences (Addis, Wong, and Schacter, 2008).

Conceptually, thinking about this new line of work in light of my theorizing about adaptive aspects of memory sins and the functions of a constructive memory suggested an intriguing idea: Episodic memory enables elements of past experiences to be flexibly recombined to imagine novel future scenarios, which is an adaptive ability because it allows people to mentally simulate different ways of dealing with novel future situations without having to engage in any actual behaviors. This same flexibility could be responsible for memory errors that result from mistakenly combining elements of imagination and memory. We referred to this idea as the constructive episodic simulation hypothesis (Schacter and Addis, 2007a, 2007b).

During the two decades since beginning this line of research, we have attempted to test the constructive episodic simulation hypothesis in various ways, and I will briefly mention a few of them. First, we have attempted to *manipulate* the involvement of episodic retrieval in future imagining with a procedure we call episodic specificity induction (ESI): brief training in recalling episodic details from a recent experience. Following an ESI or a control induction that does not involve recalling episodic details, participants engage in tasks that we hypothesize draw on episodic retrieval, such as imagining a future experience, or tasks that

we do not think draw on episodic retrieval, such as describing a picture or generating semantic associations. The logic is simple: If ESI affects a subsequent task (compared with the control induction), we infer that the task draws on episodic retrieval. In studies spearheaded by two graduate students in my lab, Kevin Madore and Helen Jing, we consistently found that ESI selectively affects a variety of tasks that involve imagining future experiences (e.g., Madore, Gaesser, and Schacter, 2014; Jing, Madore, and Schacter, 2016). Results from an fMRI study showed that core network regions, including the hippocampus, showed increased activity when people imagined a future experience following the ESI versus a control induction (Madore et al., 2016).

Second, we also attempted to manipulate episodic retrieval by using transcranial magnetic stimulation (TMS) to inhibit activity in one of the key core network regions, the angular gyrus. A study led by Preston Thakral when he was a postdoc in the lab showed that TMS to the left angular gyrus (compared with TMS to a control region) similarly reduces the number of episodic details that participants generate when they remember past experiences and imagine future experiences, while having no effect on nonepisodic details or on a semantic association control task (Thakral, Madore, and Schacter, 2017). Third, fMRI studies led by Thakral using multivariate pattern classification analyses provided evidence that neural patterns linked to elements of autobiographical memories (people and places) are preserved when these elements are recombined into imagined future experiences, with key effects documented in the hippocampus and angular gyrus (Thakral et al., 2020a). Fourth, studies led initially by Karl Szpunar and later by Roni Setton and Jordana Wynn, adapted the technique of fMRI repetition suppression—where repetition-related reductions in fMRI signal implicate specific brain regions in processing particular types of stimuli—to tease apart the contributions of specific core network regions to episodic simulation. In experiments in which participants initially imagined future events involving familiar people and locations, and subsequently imagined either events involving the same people and places or novel recombined versions, repetition suppression data linked core network structures including retrosplenial, parahippocampal, and posterior parietal cortices to imagined locations and medial prefrontal cortex to imagined people (Setton, Wynn, and Schacter, 2024; Szpunar et al., 2014).

Fifth, we have attempted to dissociate the *temporal* aspect of episodic representations—that is, whether they refer to the past or the future — from the "mnemicity" of an event—that is, whether an event is remembered or imagined (Mahr et al., 2023; Mahr and Schacter, 2024). Temporality and mnemicity are often correlated—episodic representations of the future are always imagined, whereas episodic representations of the past are typically, but not always, remembered: We can generate counterfactual

versions of how actual past events might have turned out differently (De Brigard et al., 2013) and construct entirely imagined events that might have occurred in the past (Schacter et al., 2012). Johannes Mahr led a series of cognitive experiments in which we provided evidence that despite their close relationship, temporal orientation and mnemicity can be dissociated experimentally (Mahr and Schacter, 2022). These findings, along with other empirical and theoretical considerations, led Mahr and I to argue that episodic recombination processes need to be distinguished from the mechanisms that determine the temporal orientation of episodic representations (Mahr and Schacter, 2024).

In ongoing research, we are using recently developed denoising techniques that allow participants to speak aloud in the scanner when they are remembering a past event or imagining a future event; in all of the aforementioned fMRI studies, participants remained silent during scanning in an attempt to minimize motion artifact. These denoising techniques were initially used in studies led by Adrian Gilmore (a former research assistant in my lab) and Alex Martin at National Institute of Mental Health (NIMH), in collaboration with my lab, to study autobiographical memory (e.g., Gilmore et al., 2021a, 2021b). In current work, postdoc Sarah Kalinowski is leading an extension of this work to episodic future simulation, with preliminary results revealing striking similarities between remembering past and imagining future experiences at the level of category-selective cortex for actions, objects, and locations (Kalinowski et al., 2025)—a level of detail that was not available when we were restricted to obtaining participants' reports only after scanning had concluded.

Taken together, the foregoing studies have advanced our understanding of neural and cognitive processes that support episodic simulation and memory. But what about the key idea in the constructive episodic simulation hypothesis that flexible episodic recombination processes supporting such simulations also contribute to memory errors? Studies led by Alexis Carpenter when she was a graduate student in my lab used an associative inference paradigm to get at the issue. Associative inference refers to a process that links separate experiences that share a common element. For example, if you see an elderly man walking a poodle in your neighborhood, and the next day you see an elderly woman walking the same poodle in a different part of your neighborhood, you can infer that the man and woman are probably a married couple. We developed a paradigm to capture this kind of associative inference and found that when participants successfully made an inference linking two distinct but related episodes, they were more prone to mixing up contextual elements of those episodes than when they failed to make the appropriate inference. In this paradigm, individuals were linked to one another because each was paired with the same object in a different background setting (e.g., a man and a toy in a living room with a white couch; a boy and the same toy in a different

living room with a brown couch). When asked about details of the setting in which each person appeared, participants who made the correct inference also made more context memory errors in which they mixed up elements of the two background settings (Carpenter and Schacter, 2017). Returning to the example of the elderly man and woman walking the same poodle in different parts of your neighborhood, this experimental result implies that if you correctly infer that the two people are a couple, you would be more likely to misremember seeing the man in the part of the neighborhood where you actually saw the woman (or vice versa) than if you had not made that correct inference. In a subsequent fMRI study, we found evidence that when participants made a contextual memory error following a correct associative inference, there was neural evidence for activation of the "wrong" context—for example, evidence that the pattern of brain activity associated with the "brown couch living room" was present when participants who had seen a man in a living room with a white couch incorrectly claimed that they had seen a man in a living room with a brown couch (Carpenter et al., 2021). To my mind, these studies linking associative inference, episodic recombination, and memory errors provide some of the clearest experimental evidence for what I have termed an "adaptive constructive process" (Schacter, 2012; Schacter, Guerin, and St. Jacques, 2011), which not only plays a functional role in memory and cognition but also can produce distortions as a consequence of doing its main job.

If this kind of error is a price we pay for a flexible memory system, what kinds of adaptive, future-oriented behaviors can such a system support? We have approached this question in several ways. For example, in studies led by Nathan Spreng and Kathy Gerlach, participants were scanned while they performed planning and problem-solving tasks that involved considerably more cognitive work than simply imagining a possible future experience, such as formulating a plan including specific steps to achieve a personal goal (e.g., freedom from debt). These studies revealed that the core network shows increased activity during these goal-directed tasks and, importantly, also demonstrated that its activity is coupled with executive control regions, including dorsolateral prefrontal cortex, that were previously implicated in various kinds of goal-directed cognition (Gerlach et al., 2011; Spreng et al., 2010; Spreng and Schacter, 2012). Thus, the brain regions that support episodic simulations could be enlisted in the task of generating complex plans to achieve valuable everyday outcomes. Further support for this idea came from a study of brain networks involved in building personality models in which my lab collaborated with Demis Hassabis when he was doing postdoctoral research at MIT (he is currently the chief executive officer of Google DeepMind and recipient of the 2024 Nobel Prize in Chemistry). Personality models are important for predicting future behavior, and our fMRI study used pattern classification techniques and functional connectivity analyses to implicate several core network regions,

including medial prefrontal cortex, lateral temporal cortex, and posterior cingulate, in imaginative activity that supports the building of functionally useful personality models (Hassabis et al., 2014). In purely behavioral studies, Helen Jing used the ESI procedure described earlier in studies of how people deal with worrisome future events. College students, for example, worry about how to do well on exams or attain social goals. Following an ESI, students came up with more steps relevant to addressing their worrisome problems than following a control induction and also experienced reduced anxiety about that problem (Jing, Madore, and Schacter, 2016).

A parallel series of studies led by Brendan O'Connor (formerly Gaesser) provided evidence that when presented with situations of people in need (e.g., locked out of a house), episodic simulations focused on helping the individual produced an increase in participants' subsequent prosocial intentions (i.e., their rated willingness to help the individual) compared with various control conditions (Gaesser and Schacter, 2014; Gaesser, Dodds, and Schacter, 2017). An interesting extension of this work conducted during the COVID-19 pandemic in collaboration with former postdoc Karen Campbell's lab extended this effect to COVID-related scenarios in both young and older adults (Ryan et al., 2023). Other, related functions of episodic simulation are discussed in review and theoretical papers by Bulley and Schacter (2020); Szpunar, Spreng, and Schacter (2014); and Schacter, Benoit, and Szpunar (2017).

While research on constructive episodic simulation and related processes has occupied center stage in my lab's research during the 2000s, we have also continued with some previous lines of investigation and initiated other new ones. Although no longer focused on priming and implicit memory as I had been during the 1980s and 1990s, a collaborative project led by Ian Dobbins and David Schnyer shifted my previous focus on perceptual factors driving priming effects to the role of response factors. In an fMRI study, participants made initial judgments about characteristics of visual objects (e.g., bigger than a shoebox?) and later made either the same response to a repeated object or a different one (e.g., smaller than a shoebox?). Repetition of an object produced expected reductions in fMRI signal in fusiform cortex but, rather unexpectedly, changing the required response eliminated this neural priming effect. The findings pointed toward a contribution of response factors to neural priming, which was sufficiently surprising that the paper describing this work found its way into *Nature* (Dobbins et al., 2004). Subsequent studies led by postdocs Gagan Wig and Dale Stevens explored other features of neural priming (Stevens et al., 2012; Wig, Buckner, and Schacter, 2009), but in my lab, as in the field of memory research more generally, the study of priming has been placed on the back burner, at least for now.

Research on the relation between emotion and memory has been a major focus in both cognitive and neuroscientific studies of memory for

several decades. My interest in the topic was sparked initially by Kevin Ochsner when he was a graduate student in the lab, and we synthesized much of the relevant cognitive neuroscience literature in a book chapter (Ochsner and Schacter, 2000). But the empirical study of emotion and memory really took off in my lab when Elizabeth Kensinger, who had previously done research in the lab on false recognition as a Harvard undergraduate (Kensinger and Schacter, 1999), returned as a postdoc. Elizabeth spearheaded both cognitive and neuroimaging studies that revealed new information about memory accuracy, distortion, and specificity as a function of emotional valence in young and older adults. For instance, one of the intriguing fMRI findings documented by Kensinger and Schacter (2008) was a stronger association in old adults than in young adults between memory for emotionally positive information and activity in the medial prefrontal cortex, a region that numerous studies had already linked to self-referential processing. We explored the link to self-referential processing in a subsequent study led by postdoc Angela Gutchess, who had already worked on self-referencing and aging before coming to my lab. This research documented age differences in the recruitment of regions involved in self-referential processing, likely reflecting differences in the kinds of elaborative encoding processes utilized by young and older adults (Gutchess, Kensnger, and Schacter, 2010).

We managed to link up our interest in emotion and episodic simulation in a couple of different ways. Focusing on the contributions of the ventromedial prefrontal cortex (vmPFC) to episodic simulation, Roland Benoit led an fMRI investigation that provided evidence that the vmPFC contributes to the affective quality of imagined future episodes—activation in the vmPFC was greater when participants imagined more positive future scenarios (Benoit, Szpunar, and Schacter, 2014). Moreover, we adapted the repetition suppression technique discussed earlier to the study of emotional future simulations in young and older adults, an approach that revealed some interesting age differences—for example, older adults engaged regions including the temporal pole to a greater extent than younger adults when they imagined negative future events (Devitt et al., 2020). Given extensive evidence linking this region with semantic processing, this result suggested to us that older adults might attempt to down-regulate negative emotion by "semanticizing" negative future simulations, consistent with much evidence showing positivity biases in older adults that sometimes extend to thinking about the future (Devitt and Schacter, 2019). We recently attempted to organize our and others' work on emotional future simulations to highlight key empirical and theoretical issues that require further study (Schacter, Kalinowski, and Wilson, 2025).

Another line of research that is closely related to our work on the neural underpinnings of episodic simulation concerns the phenomenon of mind wandering: task-unrelated thought that is typically associated with

increased activity in the default network. My initial interest in mind wandering stemmed from a study led by postdoc Karl Szpunar in which we focused on the role of intermittent quizzing during lectures on subsequent retention. The key finding was that, when students were given intermittent quizzes during a lecture, not only was subsequent retention of lecture content increased, but the incidence of mind wandering during the lecture was cut in half (Szpunar, Khan, and Schacter, 2013). That study was one of the reasons why two postdocs whose work focused on mind wandering, Paul Seli and David Maillet, joined the lab and led several empirical and theoretical projects, including explorations of the relation between mind wandering and future goals (Seli et al., 2018), the contributions of default and executive control networks to different kinds of mind wandering (Seli et al., 2016), and the role of past and future events in mind wandering (Maillet and Schacter, 2016; Maillet, Seli, and Schacter, 2017). I found it satisfying that these projects emerged from an overarching concern regarding how memory (mainly episodic) supports a variety of cognitive activities that we do not typically think of as "memory phenomena" strictly conceived.

Episodic Creativity?

Our theoretical approach to the concept of episodic simulation emphasizes the flexible recombination of elements of past experiences to address novel future situations. That conceptualization sounds a lot like the way that creativity researchers define *divergent creative thinking*: generating creative ideas by combining diverse types of information in novel ways. Do episodic simulation and divergent creative thinking draw on some of the same underlying processes? We found some initial correlational evidence suggesting a link between the two: When people imagined future scenarios, the amount of episodic detail that they included (i.e., details about what might happen and where) was positively correlated with their performance on the Alternate Uses Test (AUT), a standard test of divergent thinking in which people generate novel but appropriate uses of common objects, such as a brick or a coin (Addis et al., 2016). Consistent with this result, we also found that after receiving an ESI, participants generated more novel uses of objects on the AUT, compared with AUT performance following a control induction (Madore, Addis, and Schacter, 2015); a subsequent fMRI study showed that this boost was accompanied by increased activity in the hippocampus (among other regions), just as we had observed for episodic future simulation (Madore et al., 2019). Notably, the fMRI study also revealed that ESI produced increased activity during AUT performance in prefrontal regions associated with cognitive control, as well as increased connectivity between the core network and these control regions. This observation fits well with other neuroimaging studies that have consistently shown connectivity increases between default and control networks

during divergent-thinking tasks—a point that we highlighted in a review led by Roger Beaty, a creativity researcher who joined my lab as a postdoc when we embarked on this line of work (Beaty et al., 2016).

Converging evidence for a link between episodic simulation and divergent thinking emerged from a combined TMS-fMRI study showing that AUT performance, just like episodic future simulation, is impaired by the application of inhibitory TMS to the angular gyrus about 5–10 minutes before task performance in the scanner (Thakral et al., 2020b). Importantly, this study exploited the fact that TMS can affect regions connected to the stimulation site as well as have direct effects on the region directly below the stimulation site. We focused on one of those connected regions (the hippocampus) and showed that following TMS to the left angular gyrus, hippocampal activity was similarly reduced during episodic future simulation and AUT tasks, but not during a control task (generating sentences). Moreover, these activity reductions were positively correlated with the observed performance reductions. Taken together, these findings indicate that future simulation and divergent thinking draw on some of the same episodic retrieval and recombination processes, which are supported by the hippocampus and other core network regions. And, in a confirmation of the idea from the constructive episodic simulation hypothesis that the same recombination processes that serve adaptive functions also contribute to memory errors, we reported that higher performance on the AUT is correlated with increased susceptibility to false recall in the DRM false memory paradigm (Thakral et al., 2021).

One of the benefits of embarking on this line of creativity-oriented research has been the opportunity to collaborate with some of the emerging leaders in the cognitive neuroscience of creativity. Roger Beaty completed a productive postdoc in my lab before moving on to a faculty position at Penn State and, through Roger, I have collaborated on several projects that also include Mathias Benedek at the University of Graz and Yoed Kenett at the Technion in Israel. Together, we wrote a theoretical paper that pulled together various strands of the literature on creativity and memory (Benedek et al., 2023) in support of what we call the "Memory in Creativity" (or MemIC) framework. The framework includes ideas about the respective roles of episodic and semantic memory, controlled or strategic and automatic or associative processes, as well as generation and evaluation phases of creative cognition. This framework has already informed the direction of research in my lab. For example, while research in my lab and others has attempted to delineate the contributions of episodic memory and simulation to the *generation* phase of the creative process, there is no corresponding research regarding the role of memory or simulation in the *evaluation* phase—that is, the stage at which the novelty and effectiveness of a creative idea is assessed.

To address the issue, Will Orwig, then a graduate student in my lab, led a project in which participants rated the novelty and effectiveness of actual AUT responses, and provided a brief verbal description of how they made this evaluation (Orwig et al., 2025). Novelty and effectiveness ratings were negatively correlated, replicating previous findings (e.g., AUT responses for "brick" that receive high novelty ratings, such as using it as chalk to draw on a sidewalk, tend to receive lower effectiveness ratings than less novel responses such as using a brick as a doorstop). Analyses of the verbal descriptions using a computational linguistic model revealed that participants referred more to the past when evaluating familiar and effective ideas, whereas they referred more to the future when they evaluated highly novel although less effective ideas. Moreover, evaluations of these more novel but less effective ideas contained more perceptual details than those of more effective ideas, suggesting that when people evaluate highly novel ideas, they may be relying on perceptually detailed episodic simulations to assess whether those ideas could actually work.

Although much research on divergent creative thinking in my lab and elsewhere has relied on the venerable AUT, we have also tried to move beyond this test. For example, when Ruben van Genugten was a graduate student in my lab, he led a study that combined the ESI procedure with a creative writing task, and provided evidence for increased episodic details in participants' stories following ESI compared with a control induction, thus adding to the evidence for an episodic contribution to creative thought (Van Genugten et al., 2022). Given the recent emergence of interest in the relationship between the cognitive capacities of humans and artificial intelligence (AI)—for example, large language models (LLMs) such as ChatGPT—and my own interest in links between memory and technology (I provide a detailed treatment of this issue from the perspective of the seven sins in the inaugural article for the journal *Memory, Mind, and Media*; Schacter, 2022), we initiated a study of factors that affect creative writing by people and by ChatGPT (Orwig et al., 2024). In two experiments, humans and Chat GPT-3 (Experiment 1) or Chat GPT-4 (Experiment 2) were given three-word prompts and instructed to write a five-sentence story that included those prompts. As measures of creativity, we assessed the extent to which a story connected semantically distant ideas using an established measure of semantic diversity and also assessed the extent to which stories incorporated perceptual details linked to the sensory experiences of story characters that potentially transport a reader into the world of the story. For humans and the LLMs, increased semantic diversity and more perceptual details were both highly predictive of creativity, and we observed little overall difference in the rated creativity of the stories generated by people and by the LLMs. These findings contribute to a growing literature exploring the creative abilities of humans and LLMs, and although it is too soon to reach any firm conclusions, results to

date suggest that those conclusions will depend on exactly how creativity is assessed. For example, in a study by Si, Hashimoto, and Yang (2025), computer science research proposals generated by an LLM were rated as more original than those suggested by experts. However, when researchers actually carried out the proposed studies, the LLM-generated ideas were less effective than those generated by experts. We plan to continue with studies comparing creative abilities of humans and LLMs, and we also soon hope to examine the neural underpinnings of creative thinking in the fMRI scanner, making use of the speaking-in-the-scanner protocol that I discussed earlier.

Educational Outreach

While most of my professional time and effort has focused on the empirical and theoretical research endeavors summarized in the preceding pages, I also take pride in what I think of as outreach efforts. Writing two trade books intended for a broad audience (*Searching for Memory* and *The Seven Sins of Memory*) has resulted in many interviews, lectures, and related activities focused on explaining the significance of basic science research on memory to individuals who are not themselves scientists. I think that such activities have great value, especially in the current climate in which support for basic research is under threat. A related endeavor concerns my role as an author on an introductory psychology textbook, imaginatively titled *Psychology*. I began work on that book in late 2000 with two close Harvard colleagues, Daniel Gilbert and Daniel Wegner, and the first edition of our "three Dans" text was finally published in 2008. A few years later, Wegner was diagnosed with ALS, and he passed away in 2013. That was a severe blow both personally and professionally, but we were fortunate to be able to add our Harvard colleague Matthew Nock to the author team, and we have marched on despite greatly missing Wegner. We recently completed our seventh edition (Schacter et al., 2027), in which we are joined by the Yale psychologist Laurie Santos, one of the world's experts on the topic of happiness, which is the title of the chapter she added to our text. Much like writing a trade book, writing an introductory text allows one to reach an audience that is probably not spending much of their time reading articles published in scientific journals.

Another outreach activity that has been an important one for me concerns my long-standing role as associate editor of the *Annual Review of Psychology*. In 1999, the social psychologist Susan Fiske was appointed as the new editor of the *Annual Review*, and when she asked me to serve as associate editor, I enthusiastically agreed—but had no inkling that I would still be serving as associate editor in 2026. I told Susan that I would continue as associate editor as long as she continued as editor, and although we are probably approaching the conclusion of our respective terms, incredibly we

have now passed our 25th anniversary. I consider working on the *Annual Review* as a kind of outreach activity because of the broad range of readers it serves. We are certainly proud that the *Annual Review* has maintained its position as the highest impact factor journal in psychology during our tenure (2025 IF = 29.4), but we are also proud that through the efforts of Richard Gallagher, president and editor-in-chief of *Annual Reviews*, the journal is available through open access worldwide with the use of an innovative "subscribe to open" model in which library subscriptions above a certain threshold enable the journal to remain open access (https://www.annualreviews.org/S2O). The result has been a dramatic uptick worldwide in downloads of all *Annual Reviews* articles during the past few years.

These kinds of efforts are related to the teaching activities in which I have engaged throughout my career: lecture courses in cognitive neuropsychology, cognitive neuroscience, and memory, as well as seminars addressing topics in memory research, including a long-running first-year seminar at Harvard titled *The Seven Sins of Memory*. In addition to the satisfaction that comes from interacting with talented students, my teaching responsibilities also encourage me to remain current with research topics that are relevant to whatever course I am teaching, thus expanding my scientific horizons. Coauthoring an introductory psychology text and serving as associate editor of the *Annual Review of Psychology* provide a similar benefit.

Conclusion

As much as I owe to students in my formal courses, my scientific debt is greatest to the many graduate students, postdocs, undergraduates, and lab managers who have been part of my research efforts since 1981. I hope that they have benefited from working with me, and I know how much I have benefited from working with them—most of the research discussed in this chapter simply would not have been done without their efforts. While I have cited publications featuring many of my lab members, of course it is difficult to include every project and every contributor. To those whose efforts are not represented in this chapter, I extend my sincerest thanks.

As we navigate 2026, my concern for the future focuses mainly on the young scientists who are about to enter, or hope someday to enter, the fields of neuroscience and psychology. I am grateful for the opportunities I have had to build a research career, including external funding from a variety of sources—the Connaught Fund and National Sciences and Engineering Research Council in Canada during much of the 1980s, and the McDonnell Foundation, National Institute on Aging, and National Institute of Mental Health among others since returning to the United States in 1987. It is widely recognized that federal support for scientific research in the United States is currently under threat, which in turn

imperils the scientific prospects of young researchers. On the encouraging side, the scientific community is mounting strong resistance to the current threat. Those efforts give me hope that young researchers just entering the field will still have the opportunity to build a scientific career that extends across decades and that significantly advances our knowledge of brain and mind.

References

Addis DR, Pan L, Musicaro R, Schacter DL (2016). Divergent thinking and constructing episodic simulations. *Memory* 24: 89–97.

Addis DR, Wong AT, Schacter DL (2007). Remembering the past and imagining the future: Common and distinct neural substrates during event construction and elaboration. *Neuropsychologia* 45: 1363–1377.

Addis DR, Wong AT, Schacter DL (2008). Age-related changes in the episodic simulation of future events. *Psychol. Sci.* 18: 33–41.

Aminoff E, Schacter DL, Bar M (2008). The cortical underpinnings of context-based memory distortion. *J. Cognit. Neurosci.* 20: 2226–2237.

Beaty RE, Benedek M, Silvia PJ, Schacter DL (2016). Creative cognition and brain network dynamics. *Trends Cognit. Sci.* 20: 87–95.

Benedek M., Beaty RE, Schacter DL, Kenett, YN (2023). The role of memory in creative ideation. *Nat. Rev. Psychol.* 2: 246–257.

Benoit RG, Schacter DL (2015). Specifying the core network supporting episodic simulation and episodic memory by activation likelihood estimation. *Neuropsychologia* 75: 450–457.

Benoit RG, Szpunar KK, Schacter DL (2014). Ventromedial prefrontal cortex supports affective future simulation by integrating distributed knowledge. *Proc. Natl Acad. Sci. USA* 111: 16550–16555.

Buckner RL, Andrews-Hanna JR, Schacter DL (2008). The brain's default network: Anatomy, function, and relevance to disease. *Annals NY Acad. Sci.* 1124: 1–38.

Budson, AE, Daffner, KR, Desikan, R, Schacter, DL (2000). When false recognition is unopposed by true recognition: Gist-based memory distortion in Alzheimer's disease. *Neuropsychology* 14: 277–287.

Budson, AE, Desikan, R, Daffner, KR, Schacter, DL (2001). Perceptual false recognition in Alzheimer's disease. *Neuropsychology*. 15: 230–243.

Bulley A, Schacter, DL (2020). Deliberating trade-offs with the future. *Nat. Human Behav.* 4: 238–247.

Carpenter AC, Schacter DL (2017). Flexible retrieval: When true inferences produce false memories. *J. Exp. Psychol. Hum. Learn. Mem.* 43: 335–349.

Carpenter AC, Thakral PP, Preston AR, Schacter DL (2021). Reinstatement of item-specific contextual details during retrieval supports recombination-related false memories. *NeuroImage.* 236: 18033.

Chua EF, Schacter DL, Rand-Giovannetti E, Sperling RA (2007). Evidence for a specific role of the anterior hippocampal region in successful associative encoding. *Hippocampus* 17: 1071–1080.

Church BA, Schacter DL (1994). Perceptual specificity of auditory priming: Implicit memory for voice intonation and fundamental frequency *J. Exp. Psychol.: Learn. Mem. Cog.* 20: 521–533.

De Brigard F, Addis DR, Ford, JH, Schacter, DL, Giovanello KS (2013). Remembering what could have happened: Neural correlates of episodic counterfactual thinking. *Neuropsychologia* 51: 2401–2414.

Devitt AL, Schacter DL (2016). False memories with age: Neural and cognitive underpinnings. *Neuropsychologia* 91: 346–359.

Devitt, AL, Schacter DL (2019). Looking on the bright side: Aging and the impact of emotional future simulation on subsequent memory. *J. Gerontol.: Series B, Psychol. Sci. and Social Sci.* 75: 1831–1840.

Devitt AL, Thakral PP, Szpunar KK, Addis DR, Schacter DL (2020). Age-related changes in repetition suppression of neural activity during emotional future simulation. *Neurobiol. Aging* 94: 287–297.

Dobbins IG, Schnyer DM, Verfaellie M, Schacter DL (2004). Cortical activity reductions during repetition priming can result from rapid response learning. *Nature* 428: 316–319.

Dodson CS, Schacter, DL (2002). When false recognition meets metacognition: The distinctiveness heuristic. *J. Mem. Lang.* 46: 782–803.

Gallo DA, Weiss JA, Schacter DL (2004). Monitoring false recognition with criterial recollection tests: Distinctiveness heuristic versus criterion shifts. *J. Mem. Lang.* 51: 473–493.

Gaesser B, Dodds H, Schacter DL (2017). Effects of aging on the relation between episodic simulation and prosocial intentions. *Memory* 25: 1272–1278.

Gaesser B., Schacter DL (2014). Episodic simulation and episodic memory can increase intentions to help others. *Proc. Natl Acad. Sci. USA* 111: 4415–4420.

Garoff RJ, Slotnick SD, Schacter DL (2005). The neural origins of specific and general memory: The role of the fusiform cortex. *Neuropsychologia* 43: 847–859.

Gerlach KD, Spreng RN, Gilmore AW, Schacter DL (2011). Solving future problems: Default network and executive activity associated with goal-directed mental simulations. *NeuroImage.* 55: 1816–1824.

Gilmore AW, Quach A, Kalinowski SE, Gonzalez-Araya E, Gotts S.J, Schacter DL, Martin A (2021a). Evidence supporting a time-limited hippocampal role in retrieving autobiographical memories. *Proc. Natl Acad. Sci. USA* 118: e2023069118.

Gilmore AW, Quach A, Kalinowski SE, Gotts SJ, Schacter DL, Martin A (2021b). Dynamic content reactivation supports naturalistic autobiographical recall in humans. *J. Neurosci.* 41: 153–166.

Giovanello KS, Kensinger EA, Wong AT, Schacter DL (2010). Age-related neural changes during memory conjunction errors. *J. Cognit. Neurosci.* 22: 1348–1361.

Glisky EL, Schacter DL (1989). Extending the limits of complex learning in organic amnesia: Computer training in a vocational domain. *Neuropsychologia* 27: 107–120.

Glisky EL, Schacter DL, Tulving E (1986). Computer learning by memory-impaired patients: Acquisition and retention of complex knowledge. *Neuropsychologia* 24:313–328.

Graf P, Schacter DL (1985). Implicit and explicit memory for new associations in normal and amnesic subjects. *J. Exp. Psychol.: Learn. Mem. Cog.* 11: 501–518.

Gutchess AH, Kensinger EA, Schacter, DL (2010). Functional neuroimaging of self-referential encoding with age. *Neuropsychologia* 48: 211–219.

Hassabis D, Spreng RN, Rusu AA, Robbins CA, Mar RA, Schacter DL (2014). Imagine all the people: How the brain creates and uses personality models to predict behavior. *Cereb. Cortex.* 24: 1979–1987.

Israel L, Schacter DL (1997). Pictorial encoding reduces false recognition of semantic associates. *Psychonomic. Bull. Rev.* 4: 577–581.

Jacoby, LL, Dallas, M (1981). On the relation between autobiographical memory and perceptual learning. *J. Exp. Psychol.: General.* 110: 306–340.

Jing, HG, Madore KP, Schacter, DL (2016). Worrying about the future: An episodic specificity induction impacts problem solving, reappraisal, and well-being. *J. Exp. Psychol.: General.* 145: 402–418.

Kalinowski SE, Gilmore, AW, Sokol C, Martin A, Schacter DL (2025). Dynamic recruitment of category-selective cortex during overt episodic retrieval and future thinking. *Annual meeting of the Cognitive Neuroscience Society*, Boston.

Kensinger EA, Schacter DL (1999). When true memories suppress false memories: Effects of aging. *Cognit. Neuropsychol.* 16: 399–415.

Kensinger EA, Schacter, DL (2008). Neural processes supporting young and older adults' emotional memories. *J. Cognit. Neurosci.* 20: 1161–1173.

Koutstaal W, Schacter DL (1997). Gist-based false recognition of pictures in older and younger adults. *J. Mem Lang.* 37: 555–583.

Madore KP, Addis, DR, Schacter DL (2015). Creativity and memory: Effects of an episodic specificity induction on divergent thinking. *Psychol. Sci.* 26: 1461–1468.

Madore KP, Gaesser B, Schacter, DL (2014). Constructive episodic simulation: Dissociable effects of a specificity induction on remembering, imagining, and describing in young and older adults. *J. Exp. Psychol.: Learn. Mem. Cog.* 40: 609–622.

Madore KP, Szpunar KK, Addis DR, Schacter DL (2016). Episodic specificity induction impacts activity in a core brain network during construction of imagined future experiences. *Proc. Natl Acad. Sci. USA* 113: 10696–10701.

Madore KP, Thakral PP, Beaty RE, Addis DR, Schacter DL (2019). Neural mechanisms of episodic retrieval support divergent creative thinking. *Cereb. Cortex* 29: 150–166.

Mahr JB, Schacter, DL (2022). Mnemicity vs. temporality: Distinguishing between components of episodic representations. *J. Exp. Psychol.: General* 151: 2448–2465.

Mahr J., van Bergen P, Sutton J, Schacter DL, Hayes C (2023). Mnemicity: A cognitive gadget? *Perspect. Psychol. Sci.* 18: 1160–1177.

Mahr J, Schacter DL (2024). Episodic recombination and the role of time in mental travel. *Philos. Trans. Royal Soc. B.* 379: 20230409.

Maillet D, Schacter, DL (2016). From mind wandering to involuntary retrieval: Age-related differences in spontaneous cognitive processes. *Neuropsychologia* 80: 142–156.

Maillet D, Seli P, Schacter DL (2017). Mind-wandering and task stimuli: Stimulus-dependent thoughts influence memory performance and are more often past- versus future-oriented. *Consciousness Cognit*. 52: 55–67.

Maril A, Simons JS, Mitchell, JP, Schwartz, BL, Schacter, DL (2003). Feeling-of-knowing in episodic memory: An event-related fMRI study. *NeuroImage* 18: 827–836.

Maril A, Wagner AD, Schacter DL (2001). On the tip of the tongue: An event-related fMRI study of retrieval failure and cognitive conflict. *Neuron* 31: 653–660.

Norman KA, Schacter DL (1997). False recognition in young and older adults: Exploring the characteristics of illusory memories. *Mem. Cognit*. 25: 838–848.

Ochsner KN, Schacter DL (2000). Constructing the emotional past: A social-cognitive-neuroscience approach to emotion and memory. In J. Borod (Ed.), *The neuropsychology of emotion*. Oxford University Press.

O'Reilly RC, Bhattacharya R, Howard MD, Ketz N (2014). Complementary learning systems. *Cognit. Sci.* 38: 1229–1248.

Orwig W, Beaty RE, Benedek M, Schacter DL (2025). Creative evaluation: The role of memory in novelty and effectiveness judgments. *Creativity Res. J.* 37: 514–522.

Orwig W, Edenbaum E, Greene JD, Schacter DL (2024). The language of creativity: Evidence from humans and large language models. *J. Creative Behav.* 58: 128–136.

Paige LE, Cassidy BS, Schacter DL, Gutchess, AH (2016). Age differences in hippocampal activation during gist-based false recognition. *Neurobiol. Aging* 46. 76–83.

Roediger HL III, Schacter DL, Craik FIM (2025). Endel Tulving: An appreciation of his scientific contributions. *Neuropsychologia* 220: 109274.

Rosenbaum RS, Kohler S, Schacter DL, Moscovitch M, Westmacott R, Black SE, Gao F, Tulving E (2005). The case of K.C.: Contributions of a memory-impaired person to memory theory. *Neuropsychologia* 43: 989–1021.

Ryan AD, Bo O'Connor B, Schacter DL, Campbell, KL (2023). Episodic simulation of helping behavior in younger and older adults during the COVID-19 pandemic. *J. Applied Res. Mem. Cognit.* 12: 443–456.

Schacter DL (1976). The hypnagogic state: A critical review of the literature. *Psychol. Bull.* 83:452–481.

Schacter DL (1977). EEG theta waves and psychological phenomena: A review and analysis. *Biol. Psychol.* 5: 47–82.

Schacter DL (1982). *Stranger behind the engram: Theories of memory and the psychology of science*. Lawrence Erlbaum.

Schacter DL (1983a). Amnesia observed: Remembering and forgetting in a natural environment. *J. Abnorm. Psychol.* 92: 236–242.

Schacter DL (1983b). Feeling of knowing in episodic memory. *J. Exp. Psychol.: Learn. Mem. Cognit.* 9: 39–54.

Schacter DL (1987a). Implicit memory: History and current status. *J. Exp. Psychol.: Learn. Mem. Cognit.* 13: 501–518.

Schacter DL (1987b). Memory, amnesia, and frontal lobe dysfunction. *Psychobiol.* 15: 21–36.

Schacter DL (1990). Perceptual representation systems and implicit memory: Toward a resolution of the multiple memory systems debate. *Ann. NY Acad. Sci.* 608: 543–571.

Schacter DL (1992). Understanding implicit memory: A cognitive neuroscience approach. *Am. Psychol.* 47: 559–569.

Schacter DL (Ed.) (1995). *Memory distortion: How minds, brains, and societies reconstruct the past*. Harvard University Press.

Schacter, DL (1996). *Searching for memory: The brain, the mind, and the past*. Basic Books.

Schacter DL (1999). The seven sins of memory: Insights from psychology and cognitive neuroscience. *Am. Psychol.* 54: 182–203.

Schacter DL (2001a). *Forgotten ideas, neglected pioneers: Richard Semon and the story of memory*. Psychology Press.

Schacter DL (2001b). *The seven sins of memory: How the mind forgets and remembers*. Houghton Mifflin.

Schacter DL (2012). Adaptive constructive processes and the future of memory. *Am. Psychol.* 67: 603–613.

Schacter DL (2021). *The seven sins of memory updated edition: How the mind forgets and remembers*. Houghton Mifflin Harcourt.

Schacter DL (2022). Media, technology, and the sins of memory. *Memory, Mind, Media* 1: e1.

Schacter DL, Addis DR (2007a). Constructive memory: The ghosts of past and future. *Nature* 445: 27.

Schacter DL, Addis DR (2007b). The cognitive neuroscience of constructive memory: Remembering the past and imagining the future. *Philos. Trans. Royal Soc. B.* 362: 773–786.

Schacter DL, Addis DR, Buckner, RL (2007). Remembering the past to imagine the future: The prospective brain. *Nat. Rev. Neurosci.* 8: 657–661.

Schacter DL, Addis DR, Buckner RL (2008). Episodic simulation of future events: Concepts, data, and applications. *Ann. NY Acad. Sci.* 1124: 39–60.

Schacter DL, Addis DR, Hassabis D, Martin VC, Spreng RN, Szpunar KK (2012). The future of memory: Remembering, imagining, and the brain. *Neuron* 76: 677–694.

Schacter DL, Alpert NM, Savage CR, Rauch SL, Albert MS (1996a). Conscious recollection and the human hippocampal formation: Evidence from positron emission tomography. *Proc. Natl Acad. Sci. USA* 93: 321–325.

Schacter DL, Benoit RG, Szpunar KK (2017). Episodic future thinking: Mechanisms and functions. *Curr. Op. Behav. Sci.* 17: 41–50.

Schacter DL, Buckner RL, Koutstaal W, Dale A, Rosen B (1997). Late onset of anterior prefrontal activity during true and false recognition: An event-related fMRI study. *NeuroImage* 6: 259–269.

Schacter DL, Chiu CYP, Ochsner KN (1993). Implicit memory: A selective review. *Ann. Rev. Neurosci.* 16: 159–182.

Schacter DL, Church BA, Treadwell J (1994). Implicit memory in amnesic patients: Evidence for spared auditory priming. *Psychol. Sci.* 5: 20–25.

Schacter DL, Cooper LA, Delaney SM (1990). Implicit memory for unfamiliar objects depends on access to structural descriptions. *J. Exp. Psychol. Gen.* 119: 5–24.

Schacter DL, Cooper LA, Tharan M, Rubens AB (1991). Preserved priming of novel objects in patients with memory disorders. *J. Cognit. Neurosci.* 3: 117–130.

Schacter DL, Crovitz HF (1977). Memory function after closed head injury: A review of the quantitative research. *Cortex* 13: 150–176.

Schacter DL, Curran T, Galluccio L, Milberg W, Bates J (1996b). False recognition and the right frontal lobe: A case study. *Neuropsychologia* 34: 793–808.

Schacter DL, Eich JE, Tulving E (1978). Richard Semon's theory of memory. *J. Verb. Learn. Verb. Behav.* 17: 721–744.

Schacter DL, Gilbert, DT, Nock, MK, Santos, LR (2027). *Psychology*. Macmillan Learning.

Schacter DL, Guerin SA, St. Jacques PL (2011). Memory distortion: An adaptive perspective. *Trends Cogn. Sci.* 15: 467–474.

Schacter DL, Harbluk JL, McLachlan DR (1984). Retrieval without recollection: An experimental analysis of source amnesia. *J. Verb. Learn. Verb. Behav.* 23: 593–611.

Schacter DL, Israel L, Racine C (1999). Suppressing false recognition in younger and older adults: The distinctiveness heuristic. *J. Mem. Lang.* 40: 1–24.

Schacter DL, Kalinowski SE, Wilson JM (2025). Emotional future simulations: Neural and cognitive perspectives. *Cereb. Cortex* 35: 77–83.

Schacter DL, McGlynn SM, Milberg WA, Church BA (1993). Spared priming despite impaired comprehension: Implicit memory in a case of word meaning deafness. *Neuropsychology* 7: 107–118.

Schacter DL, Norman KA, Koutstaal W (1998). The cognitive neuroscience of constructive memory. *Ann. Rev. Psychol.* 49: 289–318.

Schacter DL, Reiman E, Curran T, Sheng Yun L, Bandy D, McDermott, KB, Roediger HL (1996c). Neuroanatomical correlates of veridical and illusory recognition memory: Evidence from positron emission tomography. *Neuron* 17: 267–274.

Schacter DL, Reiman E, Uecker A, Polster MR, Yun LS, Cooper, LA (1995). Brain regions associated with retrieval of structurally coherent visual information. *Nature* 376: 587–590.

Schacter DL, Tulving E (1982). Amnesia and memory research. In LS Cermak (Ed.), *Human memory and amnesia.* Erlbaum.

Schacter DL, Tulving E (Eds.) (1994). *Memory systems 1994.* MIT Press.

Schacter DL, Verfaellie M, Pradere D (1996). The neuropsychology of memory illusions: False recall and recognition in amnesic patients. *J. Mem. Lang.* 35: 319–334.

Schacter DL, Wang PL, Tulving E, Freedman M (1982). Functional retrograde amnesia: A quantitative case study. *Neuropsychologia* 20: 523–532.

Seli P, Risko EF, Smilek D, Schacter DL (2016). Mind-wandering with and without intention. *Trends Cogn. Sci.* 20: 605–617.

Seli P, Smilek D, Ralph BWC, Schacter DL (2018). The awakening of the attention: Evidence for a link between the monitoring of mind wandering and prospective goals. *J. Exp. Psychol.: Gen*. 147: 431–443.

Semon R (1921). *The mneme*. George Allen and Unwin.

Semon R (1923). *Mnemic psychology*. George Allen and Unwin.

Setton R, Wynn JS, Schacter DL (2024). Peering into the future: Eye movements predict neural repetition effects during episodic simulation. *Neuropsychologia* 197: 108892.

Sherry DF, Schacter DL (1987). The evolution of multiple memory systems. *Psychol. Rev*. 94: 439–454.

Si C, Hashimoto T, Yang, D (2025). The ideation-execution gap: Execution outcomes of LLM-generated versus human research ideas. *arXiv:2506.20803v*.

Slotnick SD, Schacter DL (2004). A sensory signature that distinguishes true from false memories. *Nat. Neurosci*. 7: 664–672.

Spreng RN, Schacter DL (2012). Default network modulation and large-scale network interactivity in healthy young and old adults. *Cereb. Cortex* 22: 2610–2621.

Spreng RN, Stevens WD, Chamberlain JP, Gilmore AW, Schacter DL (2010). Default network activity, coupled with the frontoparietal control network, supports goal-directed cognition. *NeuroImage* 53: 303–317.

St. Jacques PL, Olm C, Schacter DL (2013). Neural mechanisms of reactivation-induced updating that enhance and distort memory. *Proc. Natl Acad. Sci. USA* 110: 19671–19678.

Stevens WD, Kahn I, Wig GS, Schacter DL (2012). Hemispheric asymmetry of visual scene processing in the human brain: Evidence from repetition priming and intrinsic activity. *Cereb. Cortex* 22: 1935–1949.

Szpunar KK, Khan NY, Schacter DL (2013). Interpolated memory tests reduce mind wandering and improve learning of online lectures. *Proc. Natl Acad. Sci.. USA* 110: 6313–6317.

Szpunar KK, Spreng RN, Schacter DL (2014). A taxonomy of prospection: Introducing an organizational framework for future-oriented cognition. *Proc. Natl Acad. Sci. USA* 111: 18414–18421.

Szpunar KK, St. Jacques P, Robbins CA, Wig GS, Schacter DL (2014). Repetition-related reductions in neural activity reveal component processes of mental simulation. *Soc. Cognit. Affect. Neurosci*. 9: 712–722.

Thakral PP, Devitt AL, Brashier NM, Schacter DL (2021). Linking creativity and false memory: Common consequences of a flexible memory system. *Cognition* 217: 104905.

Thakral PP, Madore KP, Addis DR, Schacter DL (2020a). Reinstatement of event details during episodic simulation in the hippocampus. *Cereb. Cortex* 30: 2321–2337.

Thakral PP, Madore KP, Kalinowski SE, Schacter DL (2020b). Modulation of hippocampal brain networks produces changes in episodic simulation and divergent thinking. *Proc. Natl Acad. Sci. USA* 117: 12729–12740.

Thakral PP, Madore KP, Schacter DL (2017). A role for the left angular gyrus in episodic simulation and memory. *J. Neurosci.* 37: 8142–8149.

Tulving E (1976). Ecphoric processes in recall and recognition. In J. Brown (Ed.), *Recall and recognition*. Wiley.

Tulving E (1985). Memory and consciousness. *Canadian Psychol.* 26: 1–12.

Tulving E, Schacter, DL (1990). Priming and human memory systems. *Science* 247: 301–306.

Tulving E, Schacter DL, Stark HA (1982). Priming effects in word-fragment completion are independent of recognition memory. *J. Exp. Psychol.: Learn. Mem. Cognit.* 8: 336–342.

Van Genugten RDI, Beaty RE, Madore KP, Schacter DL (2022). Does episodic retrieval contribute to creative writing? An exploratory study. *Creativity Res. J.* 34: 145–158.

Wagner AD, Schacter DL, Rotte M, Koutstaal W, Maril A, Dale AM, Rosen BR, Buckner RL (1998). Building memories: Remembering and forgetting of verbal experiences as predicted by brain activity. *Science*. 281: 1188–1190.

Wig GS, Buckner RL, Schacter DL (2009). Repetition priming influences distinct brain systems: Evidence from task-evoked data and resting-state correlations. *J. Neurophysiol.* 101: 2632–2648.