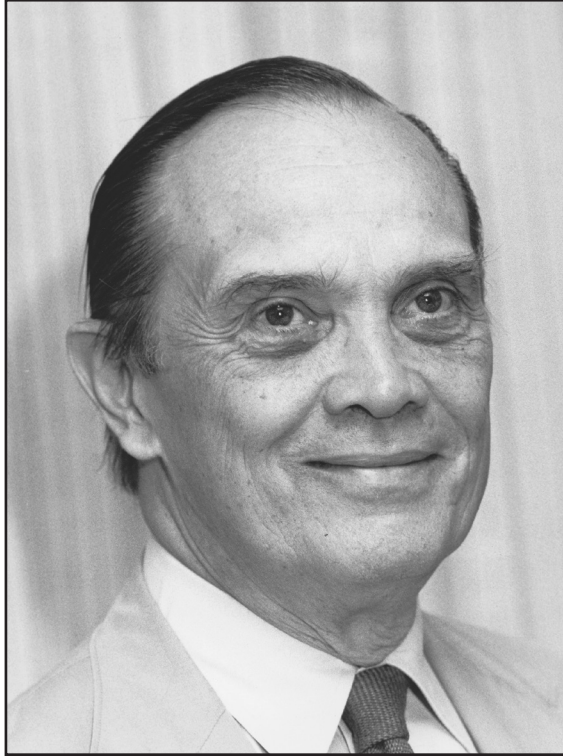

GEORGE ARMITAGE MILLER



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MY FIRST EXPOSURE TO GEORGE MILLER was during my 1951–55 graduate studies at Yale. The two psychology colloquia that most inspired me at Yale were both given by George. One was on his soon-to-become famous “The Magic Number Seven, Plus or Minus Two,” which he presented, without notes, and with all the elegance and dramatic flair of a professional actor. I wondered: Had he committed his entire *Psychological Review* manuscript to memory? His other colloquium presentation was on his *tour de force* study, with Patricia Nicely, on frequencies of auditory confusions among sixteen consonant phonemes under many different conditions of noise and filtering. It still stands, today, as the most extensive and orderly set of confusion data known to me, and it provided me with data that later enabled me to demonstrate, most fully, the revelatory power of the nonmetric methods of multidimensional scaling and clustering I was subsequently developing at the Bell Laboratories in the 1960s.

Meanwhile, when it came time for the defense of my 1955 doctoral dissertation (on “Generalization during Paired-Associates Learning”), Yale’s psychology faculty faced a problem: Apart from those already on my dissertation committee, there was no mathematically inclined member left to serve on the examining committee. So, the members of the department took the unusual step of bringing in a suitable examiner from another university. They chose Harvard’s George Miller, who had so impressed the Yale department with the quantitative brilliance of his two recently presented colloquia. (Incidentally, the approach I had taken in my dissertation was eventually to lead both to my 1962 invention of nonmetric multidimensional scaling and, later, to my 1987 empirical establishment and mathematical derivation of a “universal law of generalization for psychological science.”)

After I had spent a year extending my dissertation work on generalization (as a National Academy of Sciences–National Research Council Postdoctoral Research Associate), George invited me to join him at Harvard, as a postdoctoral fellow for the following academic years 1956–58. That was an exciting time to be in the Cambridge area. Dick Neisser and I shared an office/lab adjacent to George’s office in the basement of Harvard’s Memorial Hall. When George’s first submission to *Scientific American* was then accepted for publication, George (half-jokingly) told me this was part of his recently conceived “MMF” (or “Make Miller Famous”) plan. Noam Chomsky had given George a prepublication manuscript of his *Syntactic Structures*, many sections of which George had spread out across a table for close study and some sections of which I, too, was perusing with great interest. I

was also having my first experience in computer programming, on the Univac that had just been given to Harvard. I also taught, one-on-one, an “Introduction to Psychology for Graduate Students in Other Departments” to the sole philosophy student who required that course that year: Susan Sontag. What with Harvard’s Departments of Psychology and Social Relations, and the nearby MIT, BBN, and Lincoln Labs, there were many young researchers who were beginning to advance psychological science in new directions. Along with Miller and Neisser, there were many others whose contributions would subsequently be recognized by election to the National Academy of Sciences—including Marvin Minsky, Duncan Luce, David Green, John Swets, Philip Teitelbaum, Roger Brown, the more senior J. C. R. Licklider, Frederick Mosteller, and the then Harvard graduate students George Sperling and Saul Sternberg. Several of us regularly met at MIT in an informal evening group we called “The Pretzel Twist.” And some of us were privileged to meet informally with J. Robert Oppenheimer, during his psychology-sponsored William James Lectures at Harvard. At the end of these two years at Harvard, George facilitated my participation in the Santa Monica workshop by Allen Newell and Herbert Simon on their new computer simulation approach to the building of cognitive theories of human problem solving.

George continued to play a significant role for me during the next eight years, while I was a member of the technical staff at the Bell Telephone Laboratories (in Murray Hill, New Jersey)—in a small basic research psychology group (established, in part, by my Yale dissertation advisor, Carl Hovland). For the first time, I now had access to powerful computer facilities. Inspired by the Newell and Simon workshop, I thought at first of using the Bell Labs facilities for computer simulation of cognitive processes of perceptual learning. But, when I mentioned artificial intelligence to John R. Pierce, the executive director a couple of levels above our little group, Pierce leaned back and exclaimed, “Ah yes, AI. There is no holding that area up; it keeps hitting new lows!” I quickly decided to use the computer facilities, instead, to further develop the possibilities I had opened up in my Yale dissertation on generalization. Pierce turned out to be much more accepting of nonmetric multidimensional scaling than of AI. George Miller, also, appreciated the results I was able to obtain by analyzing various kinds of data, including his own extraordinarily rich phoneme-confusion data. Despite Pierce’s initially negative assessment of AI, I later helped to arrange a series of visits to the labs by George Miller, Noam Chomsky, and Marvin Minsky. Our intention was to inform interested researchers about recent developments and future prospects for

artificial intelligence and for what would come to be called *cognitive science*. The visits of the Chomsky-Minsky-Miller triumvirate stimulated an unusual amount of interest, discussion, and controversy at the Bell Labs.

I left the Bell Labs after both George and his Harvard colleague Dick Herrnstein approached me about returning to Harvard. The prospect was thrilling, but also daunting. Although this time I would be a full professor, I had never before taught in a classroom nor (while working on computer methods of data analysis at the Bell Labs) had I kept up with substantive developments in psychology in academic departments. But after my move back to Harvard, as I was anxiously on the way to deliver my first lecture in a multidisciplinary course held in a large lecture hall, I encountered George in the psychology parking lot. He asked where I was going in such a rush. Striving to mask my trepidation, I replied that I was about to give my first lecture in SocSci 8. "Oh yes," said George, "But do remember, you are now at Harvard. No matter what you lecture about, there will probably be someone in the audience who knows more about the subject than you do." Not exactly what I needed to hear at just that moment. Having now become a nominally coequal member of George's department, and probably as a reflection of my own insecurity, I sometimes began to wonder whether George, whom I still regarded as my mentor, might, despite his universally recognized towering stature, be beginning to perceive me less as a mentee and more as a potential competitor.

A year later, when I mentioned to George that I had just received an offer from Stanford (my alma mater), George remarked, "People do speak of Stanford as 'the Harvard of the West,' but have you noticed that they never refer to Harvard as 'the Stanford of the East'?" Nevertheless, and to the astonishment of some, I did leave Harvard for Stanford. But I refrained from calling it to George's attention that it was just following that move that in the published rankings of academic departments of psychology, Stanford moved into the first place previously held by Harvard. By then, though, George himself had left Harvard for Rockefeller University and, subsequently, for Princeton. Many years later, I met with George for the last time. While he was sitting in my Stanford office, he confessed to me that if Stanford's department of psychology were to offer him a faculty position, he would come.

I fondly remember George's wife, Kitty, and their two young children, Nancy and Don. I remember an amusing anecdote about when George was at the Institute for Advanced Study in Princeton, before I knew him. While Nancy and Don had been home on a school

break, a skunk (perhaps having been attacked by another animal) had died under their house. The powerful stink of skunk had pervaded their whole house. But in a few days, the Millers had become so inured to the smell that they were hardly aware of it. When the break was over, they blissfully sent the two kids off to school. The teachers and administrators, though, took one sniff and immediately sent the two children back to their home. Much later, after I had recently seen Nancy at the Miller house, I remarked to George on what a bright, lively, and engaging teenager she had become. George, radiating his own amazement and pride, exclaimed, "Yes! Sometimes I marvel that I could have produced that!" An amusing dream that I had in 1966 featured George, and Nancy as a teenager. (I have long been intrigued by dreams in which someone in my dream says something that surprises me—as if another mind had been working independently of my consciousness but presumably within my own brain.) In this particular dream, I am visiting George in his house in Five Fields, Lexington, Massachusetts and have just been remarking to George that everyone should have an administrative assistant, when the telephone rings. George picks it up and says, "Hello, this is Nancy's administrative assistant." The George in my dream is evidently joking, knowing that the caller is most likely one of his daughter's teenage friends. I am surprised and delighted by his little joke, which I take to have been enacted both for my benefit and for the benefit of the presumed teenage caller.

I was always in awe of George's mental quickness, the cleverness of his verbal skills, and the wonderful examples he used to illustrate his points. He enjoyed word play, as when he described a problem as being solved "in one fell swoop . . . or full sweep," or the example he gave to illustrate both how the same vocalization could have two totally different interpretations and how the interpretation determined where the continuous sound stream was perceptually broken into distinct words—as in "The good can decay many ways" versus "The good candy came anyways." I believe George's unsurpassed effectiveness as a speaker stemmed from his natural talent for acting. This was brought home to me when I was present at an evening enactment of a Greek tragedy performed in open air on a grass field in, as I recall, the Five Fields community where the Millers then lived. As I recall, both George and his wife, Kitty, performed in that tragedy, with George providing a spoken commentary in lieu, I believe, of a Greek chorus.

In addition to being a preeminent founder of cognitive psychology, George enriched psychological science through his insightful introduction of formal and quantitative developments from other language- or communication-related fields. A few examples of such

developments included Chomsky's formal theory concerning syntactic structures, Claude Shannon's mathematical theory of information, and George Kingsley Zipf's inverse power law, which stated that the frequency of any word in a natural language corpus is inversely related to the rank of its frequency.

The day before I learned of George's death, he had come to my mind "out of the blue," along with the thought that I really should write to him—to express, however belatedly, my thanks for the enormous role his example, his help, and his mentorship had played in launching my own career in cognitive psychology. I am saddened by the realization that during just the last 20 years, we have lost so many of the major founders and shapers of cognitive science. With the deaths of Allen Newell (1992), Amos Tversky (1996), Herbert Simon (2001), David Rumelhart (2011), William Estes (2011), Ulric Neisser (2012), and now, particularly, George Miller (2012), I acknowledge the powerful inspiration and lasting influence each had contributed to my own creative efforts in cognitive science.

Elected 1971

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