Obituary

George A. Miller

Christiane Fellbaum
Princeton University

George Armitage Miller died on July 22, 2012, at the age of ninety-two. He led a rich life full of accomplishments in the three areas of activity that he had chosen as a young man: psychology, writing, and golf.

Miller was not only a witness but a key player in the major paradigm shift of the 20th century that came to be known as the cognitive revolution. Incredible as it may seem today, his teachers at Harvard followed the behaviorist dogma and recognized neither the autonomy nor the significance of the human mind. It took two courageous young scientists—George Miller and Jerome Bruner—to assert, each in their own domain of investigation, that the mind is a worthwhile subject of study. They started out by teaching a course boldly entitled "Cognition" and eventually established the Center for Cognitive Studies, ultimately making behaviorism obsolete.

Miller drew an analogy between the human mind and a computer, noting that both store and process huge amounts of information. At the same time, human short-term memory is limited, as his most celebrated paper on the "Magical Number Seven" demonstrates (Miller 1956/1994). Miller showed that chunking information into meaningful units helps recall, though the number of units that can be memorized seems to hover around seven. For example, U.S. telephone numbers are broken down into three groups of three, three, and four digits (area code, local exchange, and individual number). Chunk parsers (Abney 1991) build on the idea that sentence processing proceeds in phrases, reflected in prosodic patterns.

Among our cognitive faculties, it was language in particular that fascinated George, a gifted writer. One attraction was that linguistic behavior could be observed, tested, and evaluated quantitatively with the experimental paradigms available to psycholinguists at a time when brain imaging techniques had not yet been developed. The rules of language, with their recursive aspects, could be seen as a kind of program. Although he collaborated with Noam Chomsky on the formal aspects of language, Miller in later life harbored a suspicion of highly abstract theories of syntax. His interest lay primarily in the lexicon, not only because of his authorial love of words, but also because of its size, open-endedness, and dynamic aspects. Moreover, the growth of children's lexicons offered a window into their cognitive development.

Miller is probably best known to readers of *Computational Linguistics* for his creation of the large lexical database WordNet (Miller 1995). WordNet's use as a resource for natural language processing was in fact unintended, and its rapid adoption by the NLP community came as a surprise. George was interested in human semantic organization and wanted to test the then-fashionable concept of semantic networks, which allowed for plausible and elegant models of semantic representation and seemed supported by experiments testing lexical access and retrieval (Collins and Quillian 1969). Miller wondered whether a semantic network could in fact be built for the bulk of the English lexicon. In the mid 1980s, he recruited a group of colleagues, students, and his wife Kitty and, without much further instruction, asked them to cluster nouns, verbs, and

adjectives into "synsets" that could be interrelated with a handful of semantic relations. Relying on conventional lexical resources and intuition, the WordNet team created tens of thousands of entries manually, a fact that provokes head-shaking among the new generation of WordNet builders, who proceed fully or semi-automatically. Each senior member was assigned a different part of speech; Kitty was the "Adjective Lady," and George took charge of the noun lexicon. Both would come to the Cognitive Science Laboratory every day and patiently perform their lexicographic labor. Once or twice a week, George would leave in the afternoon for the golf course. Well into this eighties, he participated in tournaments and, more often than not, his team was among the winners.

A government sponsor's requirement that the database be publicly released was duly followed, but the response from the budding NLP community was entirely unanticipated by the WordNet team, which was unaware of the challenge of word sense disambiguation. WordNet turned out to be a tool that promised help with the vexing task of word sense discrimination, and its graph structure became the basis for a number of algorithms that measured semantic similarity among words in terms of their distance in the network. Being unique in coverage and design, WordNet not only survived but continued to grow, though its claims to modeling human semantic memory were largely abandoned. George was proud to say that WordNet defined a new kind of electronic lexicography, and WordNet became a common noun. WordNets have been built for dozens of genetically and typologically unrelated languages (`http://www.globalwordnet.org`).

While working on WordNet, George became interested in children's literacy. He believed that children did not learn words and their meanings from dictionaries, as they were instructed to do in school. To test this hypothesis, he asked children to look up unfamiliar words in a dictionary and write sentences using the new words. As George had guessed, the results were both appalling and amusing. For example, when asked to write a sentence with the word *meticulous*, children would produce sentences like *she was meticulous about falling off the cliff* after having seen a dictionary entry that defined this adjective as *careful, scrupulous, fastidious*.

Moreover, George guessed that children enjoy reading but, when encountering an unfamiliar word, are generally disinclined to put their books down and consult a dictionary. His idea was to present new words in their contexts, based on evidence that context-based learning was both natural and efficient (Miller and Gildea 1987). He and his team began to manually annotate a digitized book with entries from WordNet; an interface would allow the children to read the book on the screen, click on unfamiliar words and be presented with the context-appropriate WordNet sense. It should be remembered that George's idea of reading books on a screen was long before the invention of e-readers!

The text-to-WordNet link gave birth to the idea of the semantic concordance. A large team of Princeton students manually annotated nouns, verbs, and adjectives from texts in the Brown Corpus against the corresponding WordNet senses. George thought that this would be a straightforward task: Just as lexicographers create dictionary entries based on tokens in a text, their entries should be mappable back to words in texts in a one-to-one fashion. We learned that dictionaries with enumerative, discrete word senses are in fact not a particularly good way of modeling speakers' lexicons. Today, research into semantic annotation and measurements of inter-annotator agreement is a lively area of investigation.

Although he had to transfer to emeritus status at the then-mandatory retirement age, George did not give up teaching. He organized an informal course on the lexicon and for each of twelve weekly meetings prepared beautifully written lectures that

the participants would discuss and critique. The lectures would become *The Science of Words*, a prize-winning book on the lexicon that was translated into numerous languages. In this and several other books (including *Language and Communication* [1963] and *Spontaneous Apprentices* [1977]), George's lively, lucid prose made a scientific subject accessible to the general public and conveyed his fascination with language and cognition. His landmark book *Language and Perception* (1976), co-authored with Philip Johnson-Laird, remains a classic among psycholinguists to this day. Co-authoring a paper with George invariably involved a final editing step on his part, which he referred to as "Millerizing."

George collected many prizes, medals, and honorary doctorates. He was modest about it and only very occasionally did a new frame appear on his office walls alongside graduation and wedding pictures of former students and the fake Renoir that he had kindly bought from a street vendor.

References

Abney, Steven. 1991. Parsing by chunks. In *Principle-Based Parsing*. Kluwer Academic Publishers, pages 257–278.

Collins, Allan M. and M. Ross Quillian. 1969. Retrieval time from semantic memory. *Journal of Verbal Learning and Verbal Behavior*, 8(2):240–247.

Miller, George A. 1956/1994. The magical number seven, plus or minus two: Some limits on our capacity for processing information. *Psychological Review (special centennial issue)*, 101:343–352.

Miller, George A. 1963. *Language and Communication*. McGraw Hill, New York.

Miller, George A. 1977. *Spontaneous Apprentices*. Seabury Press, New York.

Miller, George A. 1995. WordNet: A lexical database for English. *Communications of the ACM*, 38(11):39–41.

Miller, George A. and Patricia M. Gildea. 1987. How children learn words. *Scientific American*, 257(3):94–99.

Miller, George A. and Philip Johnson-Laird. 1976. *Language and Perception*. Belknap Press, Cambridge, MA.