John Senders (1920—2019)

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John Senders (1920–2019)

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We here survey and applaud the life and scientific contributions of John W. Senders. Encompassing almost a century of experience, Senders's interests embraced vast swathes of knowledge, and he was at home in all of them. Most concerned with the application of solid experimental methods in pursuit of solutions to highly practical, real-world problems, Senders conceived of and created many of the approaches we today consider standard. His work on visual scanning still resonates in our modern world through the promulgation of national and international standards. His principled work on the practicalities of human error are considered crucial, especially because the area had been largely collections of ad hoc observations before his formalizations. His latter works in support of medical safety and the mitigation of transportation accidents continue to save the lives of unaware thousands. In such shadows do true heroes lie.

Professor Senders, a pioneer of human factors and applied experimental psychology, died on February 12, 2019, just two weeks short of his 99th birthday. John was a generous man with a huge heart, a polymath, and a stubborn individualist. He was called the "Professor of Everything" by laudatory colleagues at the University of Toronto, where he began teaching in 1973. This appointment followed positions at the University of Minnesota, the Massachusetts Institute of Technology, Brandeis University, and the

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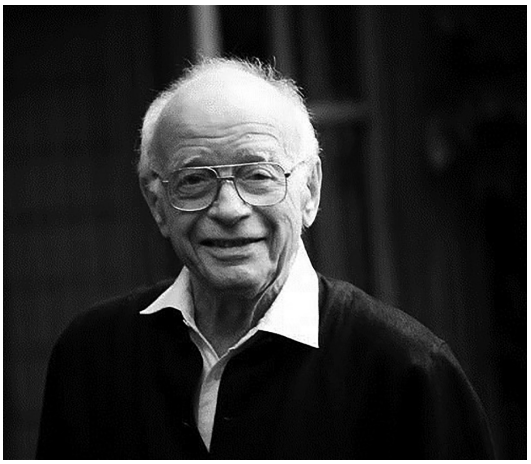

John Senders (1920–2019)

University of California. His academic record is one of stellar achievement, but it was built on an earlier life of distinction.

Senders's Early Life

Born on February 26, 1920, to Russian immigrant parents in Cambridge, Massachusetts, John was the youngest of five children and the only boy. His four older sisters were both fiercely competitive with him and protective of him. His early family life was full of word games, puns and arguments with his sisters, and playing to win at chess, backgammon, and Scrabble. His parents, especially his father, proposed that most things could be learned from books. As a result, from a very young age John devoured every issue of *Popular Science,* and by the age of 7 had read all of the *Encyclopedia Britannica* (but only through to the letter *S,* as he once said). As a child, he also demonstrated signs of mathematical genius and antiauthoritarian leanings in equal proportions, excelling in academic tasks—but only if he really felt like it!

Accepted as an undergraduate at Antioch College in 1936, John was sent home a year later for his refusal to take a required first-year math course, saying, "I've known this stuff since I was seven, and I'll be damned if I'll do it again." In expelling him, Antioch's administration made an exception to its famously lenient policies and thereby established a pattern that persisted throughout his long and singular career. As his father said to him on that occasion, "They will always make an exception for you." After he left Antioch, John spent a year working in a lumber yard before moving on to naval engineering, the manufacture of aircraft generators, and a stint as a production manager of a small company in Boston. About this time he met Virginia "Ginny" Loftus, at the time a graduate student in psychology at Harvard, who convinced him to apply. He graduated in 1948, and the two were married that same year.

Senders's Applied Psychology Contributions

Given John's remarkable intelligence, curiosity, and drive, it is no surprise that he achieved many accomplishments across his diverse scholarly interests. Bolstered by these admirable qualities, John had an enviable arena in which to grow academically, both as a student at Harvard and in his later academic and professional appointments. Giants in the fields of psychology, philosophy, mathematics, computer science, economics, and astronomy—who to us seem like figures from a far-removed and now bygone age—were Senders's teachers, colleagues, friends, and dinner guests. His anecdotes would frequently and casually comment on how his thinking was affected by interactions with the likes of Wiener, Boring, Allport, Fitts, Licklider, Skinner, Miller, Harlow, Postman, Maslow, von Mises, Whipple, Parsons, Bigelow, Shockley, McCulloch, Selfridge, Sarton, Quine, Schumpeter, and Putnam, to name only a few such legends. In achievement, Senders stood alongside these giants in differing fields of science.

Little wonder that John demonstrated original thinking throughout a career that spanned seven decades. One of the first scientists to apply mathematical models to human behavior in real-world contexts, he spent time in academia, in the industrial world, and in multiple military research laboratories. This included working at Honeywell, Wright–Patterson Air Force Base, and Bolt, Beranek and Newman, among others. Latterly, John acted mostly in the role of a private consultant, globetrotting lecturer, and forensic expert witness focusing on the various nuances of human behavior in accidents and incidents. Throughout this time, his work contributed enormously to human well-being. Senders's research has advanced theoretical understanding in many diverse areas including mental workload, attention and visual scanning, eye movements, queuing theory, control

theory, and human error modeling (see Monty & Senders, 2017; Senders & Monty, 1976). Applications from these basic insights ranged from the design of space vehicles (including the *Mercury, Gemini,* and *Apollo* capsules), modeling of driver behavior, highway safety, pilot behavior, aircraft cockpit design, medication errors and patient safety, nuclear power plant safety, and even electronic publishing. It was for these many achievements that he won the Franklin V. Taylor Award of the American Psychological Association.

To highlight just a selection of Senders's achievements, we note the following:

He was the first to postulate, in the 1950s and 1960s, the mathematical relationship between the bandwidth of a signal and frequency of visual attention to that signal. To demonstrate this relationship, John famously wore a helmet that cut off his vision as he drove around the busy streets of Cambridge, Massachusetts. Using a foot switch to lift the visor, he could gain the occasional glimpse of the road allowing him to measure the frequency with which he needed to look. This groundbreaking work on driving safety led to the occluded vision paradigm, now an International Standard essential to instrument panel design in airplane cockpits, nuclear power plants, and automobiles. This research also led to the award of an IgNobel Prize in 2011. It was a semihumorous award John cherished as much as the more orthodox forms of recognition from the scientific community.

He was one of the first to conceive of and write about the electronic journal, including the organization of a test journal. For this, he was later awarded the KMDI Pioneer Award for an outstanding contribution to the field of electronic publishing in 2008 by the University of Toronto. This work stemmed from earlier research with J. C. R. Licklider in the 1960s estimating the digital storage capacities for all the world's libraries (Senders, 1963).

He was one of the founders of the academic study of human error, especially in applied operational contexts. Senders and his wife, Ann Crichton-Harris, established the field's first conference in Maine in the 1980s, bringing together key researchers in this growing area of importance. These "Clambake Conferences" are now seen as seminal foundations for the modern study of error in all its forms (see, for example, his book on human error with Neville Moray in 1991)

Senders applied his theoretical and synthetic work on human error to become a key figure in patient safety and medication errors, founding the Institute for Safe Medication Practices in Canada and receiving an award from the American Institute for Safe Medical Practices (ISMP) in 2001. John also introduced the failure mode and effects analysis technique into medication and medical safety through the ISMP in 1994. He was a much-sought-after expert witness in cases of human error in medicine, the professor of safety science at the University of Miami Medical School, and the James March Professor-at-Large at the University of Vermont. Michael Cohen, president of the ISMP, stated that Senders's work "saved many thousands of people from medical errors and harm, so they could go on with their families and careers."

Contributions to the American Journal of Psychology

John's first contribution to the *American Journal of Psychology* was a two-page treatise on human visual perception (Senders, 1966). This article explored the underlying and seemingly contradictory perceptual issues regarding an image whose angular size appears to decrease dramatically while moving farther away, despite the fact that the object is in fact approaching the observer. John was able to see a world of illumination levels, disparate visual angles, and size (in)constancy, where others would merely have seen reflections of light in their inveterate cup of coffee. (As it happens, visual illusions held a lifelong fascination for John and later helped seal a friendship with Richard Gregory, fueling many lively discussions between them.)

Senders's second publication in the *American Journal of Psychology* was a collaborative experiment on human cognition, specifically the structure and function of memory (Loftus, Senders, & Turkletaub, 1974). Building on previous memory work examining blocking and the tip-of-the-tongue phenomenon (Brown & McNeill, 1966) as well as rhyming paired associations (Bower & Bolton, 1969), John and his colleagues examined the effect of phonetic similarity on the ease and speed with which paired words or concepts are brought to mind upon recall. Their results indicated that shorter recall times were ob-

served when the word pairs were both categorically and phonetically similar.

John's final contribution to this journal was an article sadly very much like the present one. It was a cooperative and retrospective commentary on the life and scholarly work of one of his dear friends, Neville Moray (Hancock, Senders, & Lee, 2018). In this article, he expounded on his professional interactions, common research interests, and longstanding personal friendship with Moray, pioneer of human factors and groundbreaking researcher of the cocktail party effect (Moray, 1959).

Our Personal Reflections

I (P.A.H.) first met John Senders in person at the Twenty-First Annual Conference on Manual Control (Annual Manual) in 1985, in Columbus, Ohio. Even then, as a beginning assistant professor, I was aware of John's fearsome reputation and influence, for who in the area was not? Senders was never one to suffer fools gladly or quietly. I had to present some of my work on body temperature and time perception (Hancock, 1993), an esoteric topic for any gathering, but for scientists concerned primarily with movement control, it was, I thought, a bit of a stretch. Not a bit of it. I had barely finished my presentation when John was on his feet. I shall not recount the precise exchange, but suffice to say that my memory stood me in good stead, and I was able to recall not only the exact paper (Hoagland, 1933) but also the precise location on the page that was the source of our immediate disputation. A ripple ran through the audience at this point—counterpoint interaction, for few were the academics who would go toe to toe with John. After all, he had lived much of what, to many of us, was history. John could have taken this retort in differing ways. He could have played the "great man," finessing the interaction to portray it as a superior schooling a naive junior. But that was not John's way. He came up to me immediately after the paper—mine had been the last in the session—and in his legendary stentorian voice, he let the whole auditorium know just how much he appreciated the proof of scholarship that my responses had shown. I am sure that my academic standing was elevated significantly in our community by those kind words, spoken so none could ignore them. For me, they were the manifest proof that here was a true scholar, one for whom the work is everything and the flummery of science, nothing. I liked him immediately and on many occasions I sought to model my own behavior and responses in that same generous vein.

It is no surprise that in the decades that followed, I have learned not simply from John's personal approach but also from his fecund mind and fertile scholarship. I even summoned up the temerity to work with John on a number of articles (see Hancock, Mouloua, & Senders, 2008). He and my daughter, who conducted an extensive recorded interview with John, shared a similar level of disdain for my use of commas as they battled to make our collaborations readable. Most recently we interacted, rather poignantly, to present a recognition of the life of Neville Moray (Hancock, Senders, & Lee, 2018; Hancock, Senders, Stanton, & Lee, 2018). Our interaction continued up to the very last months of his life. At the Transportation Research Board meeting in January 2019, I was honored to present an invited address. It is a source of some minor consolation that I was able to dedicate that presentation to John and his contributions to traffic safety. In small part, it represented long overdue recognition of his efforts to save people from roadway collisions. At the time of his death, John and I were working on "attribution effects research," an area he was again pioneering, at the forefront of science. I can only state that I hope to bring these mutual endeavors to a publishable conclusion. As a personal valediction, I have to note that each time one spoke to John it was to learn and progress. I shall miss his mentorship, and most especially his friendship.

I (G.M.H.) met John in passing numerous times at various conferences after having been raised hearing about his experiments and exploits. My own father (P.A.H.) held—and very evidently still holds—a great deal of respect for John and the impressive breadth and depth of his knowledge, which he was always so generously willing to share, and a common response to virtually any question during my formative years was, "You know who knows a lot about that? Senders. You should ask him the next time you see him." I am happy to say that I often followed through on this advice and was always happier and more knowledgeable for it.

I grew to appreciate John's mentorship far more after a few years of graduate study, as I was then much more capable of having a meaningful dialog with him. For the benefit of future ergonomists being trained at my alma mater, I was asked to record an interview with John in which I asked him about his scientific development, his role models and inspirations for research, and his informed projections about the future courses of the field. He graciously accepted. Once the camera was turned off after our almost 2-hour conversation, John—in very Senders style—turned the tables on me and said, "Now let me ask you a question." This sentence struck fear in my heart. As P.A.H. observed earlier, John always demanded a degree of precision in any answer you offered that was at least equal to the amount of precision he had expended in crafting the question. He asked me, "What is it like having Peter for a father?" Relieved, I replied, "We're going to need another two hours, Professor Senders." I was rewarded with his cheerful chuckle.

John was my (A.J.S.) stepfather, teacher, lifelong advisor, and strongest supporter, both personally and throughout my career. Looking back, I realize that John's life work rested largely on the assumption that people are, after all, just extremely complex machines. An engineer to the core, he believed that not only can we model humans in this way, but ultimately we can understand them by "looking under the hood" and uncovering the mechanisms by which they work. This is perhaps not unusual, as the history of psychology, of human factors engineering, and even my own field, human–computer interaction rests largely on similar assumptions. But John was one of the first psychologists to show that one can get a very long way viewing people like machines, and many aspects of human behavior become tractable and predictable when you do this. This is especially the case when humans become expert at engaging with some complex system, when everything is routine and goes to plan. Under these circumstances, people do become a part of the technological system in a sense, and they do act in predictable, compliant ways.

Of course, this approach to life does not work so well with teenagers, as my brothers, my stepbrothers, and I can easily confirm. One day when I was 13, the front door opened and John, like the force of nature he is, blew into our household, pretty much turning it upside down. Coming into a household rife with surly teenage children probably was not John's idea of paradise either. After all, he already had two adolescents of his own, and now he had to deal with three more. If only we had had off switches or mute buttons, obeyed predictable rules, and were not overflowing with irrationality and emotion!

But throughout these challenging times, I learned more life lessons than I can remember. John not only taught me science, but he taught me to drive, to cook, and to play competitive Scrabble. As for science, the seeds of my later career were sown quite early on. As a teenager, I remember how going to the bank with John meant a lecture in queuing theory. Back in those days, instead of standing in the queue checking out Facebook on my phone I was busy calculating the mean wait time as a function of queue length and service time. Even being on holiday was an opportunity to apply mathematical models. While sitting by a swimming pool, John explained how the frequency with which a mother has to look at her toddler to ensure it did not end up drowning was based on the toddler's mean velocity, direction, and time since last looking. John also showed me many other ways in which life could be described mathematically: Control theory, chaos theory, and various probability functions could all be used to understand the world. This made life tractable and simpler. It also presented challenges and puzzles, something he and I both loved trying to solve.

Since those early days, I have strayed into the much more fuzzy world of the social sciences, where human aspirations and values are central to how one can approach the design of new technologies. The things I worry about these days are more closely tied to the social and cultural fabric of life, things that begin to unravel as soon as you try to pick them apart or subject them to any systematic description. But the fact that I do not subscribe to his view of the world anymore is not a criticism so much as tribute to him. John taught me to be a critical thinker, to question received wisdom, to argue, and to have confidence. So this is an opportunity for me to say thank you to a truly remarkable person whom I miss more than I can ever say.

Having a Man Who Knows Everything for a father was, for me (W.S.) not without its complications.

Certainly the need to find something (anything!) that John could not do was a strong motivator for my own peculiar career path, which eventually found me specializing in Indian classical singing (an idiom of which my father had no knowledge and little appreciation). But from another perspective, everything I have done in my life as a musician and educator owes a huge debt to his career as a self-defining and self-educated man for whom epistemological boundaries were irrelevant or nonexistent.

He taught me—by example—the centrality of rigor and skepticism and encouraged me to be wary of received knowledge, to interrogate my own understanding as well as that of others. And in his readiness—nay, eagerness—to take paths less traveled by, he reinvented common facts and relationships, showing how they could reveal new phenomena when viewed from other vantage points. Senders's Law states that "when dealing with a sufficiently large organization, you can always get things done if you're prepared NOT to go by the book." This axiom is equally valid when dealing with a body of knowledge or intellectual discipline, yielding creative and sometimes epiphanically beautiful solutions. I am grateful to John Senders for this wonderfully quirky, exasperating, individuated, and joyfully profound approach to the world, for if there is one thing you cannot learn from a book, it is how NOT to go by the book. Thanks, Dad.

Goodbye, Professor of Everything

This brief article cannot do justice to the complexity of one of nature's true polymaths. When Senders was invited to join the University of Toronto's Department of Industrial Engineering in 1973, a meeting was called to discuss whether he should receive tenure. One skeptic noted that Senders had only a BA, and at age 55 he was very old for a tenured position. That person, obviously without knowing John too well, asked, "Just how productive is he likely to be?" A colleague, better acquainted with John's fire and energy, retorted, "Your only concern should be that he might run you all ragged." Senders eventually received his PhD in 1982, from Tilburg University in the Netherlands; it was in obvious recognition of previous work.

John was still running people ragged and working well into his 90s, never truly retiring. And in all the other ways that mattered, he never slowed down. He was a lifelong gourmet cook and expansive host, and he and his wife were always welcoming friends and colleagues into their home. A raconteur with a vast repertoire, John continued to astonish listeners with humorous anecdotes and tales from his career and travels and with a ceaseless proliferation of new insights and ideas. His duet with Neville Moray in serenading Tom Sheridan at Sheridan's own retirement from the Massachusetts Institute of Technology was a sight for the ages. John is survived by his wife, Ann Crichton-Harris of Toronto; by his first wife, Virginia Loftus Senders of Amherst, Massachusetts; and by five children and nine grandchildren. More on the life on John Senders can be accessed at www.johnwsenders.net/.

NOTES

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