



Elio Secondo Raviola



Photograph courtesy of Giuseppe Raviola

An understated titan of both neurobiology and medical education, Elio Raviola (1932-2023) was a singular figure at Harvard Medical School, with seven decades of contributions across research, education, and medicine. Raised in the Piedmont town of Asti, Italy, and trained at the University of Pavia (M.D. 1957, Ph.D. 1963), Elio joined the laboratory of Don Fawcett at Harvard Medical School as a Research Fellow from 1965 to 1966. Fawcett recruited Elio to return as Associate Professor of Anatomy in 1970, and he was promoted to Professor of Anatomy in 1974, Bullard Professor of Neuroanatomy and Professor of Ophthalmology in 1989, Bullard Professor of Neurobiology in 1993, and Professor Emeritus in 2013. Even in retirement, he came to the laboratory almost daily up to his final year. He dedicated himself to research on the nervous system for sixty-six years, making steady contributions to our understanding of the ultrastructure of the retina of the eye. He was also a revered teacher of anatomy for more than three

decades, known in particular for his remarkable lectures, each a dramatic and artistic performance, cherished by students.

Elio remembered his childhood in Asti, the village of his ancestors, as a happy one. Asti is known for its rolling hills of grass, fruit trees and vineyards, and Elio would ride bicycles with his father to gather fruit, gaining a deep respect for the beauty of the natural world. Although neither his father nor mother were educated past fifth grade, both were very intelligent and accomplished. His father managed factories, and was also politically active in the period between the wars. He supervised a clandestine communist, anti-fascist brigade from 1922 to 1945, especially during Mussolini's dictatorship; as a boy Elio served as a lookout during the meetings. Elio held vivid memories of German soldiers stationed near his house during the Second World War, and American planes bombing the city. During his high school years, Elio's parents moved to Morbegno, about 100 miles away, and Elio lived in Asti under the loose supervision of his grandmother. Enjoying his independence, he traveled alone to Vienna and other cities, and—without his parents' knowledge or approval—scaled many of the peaks of the Valmasino Alps in Italy.

*In tribute to their dedicated efforts to science and medicine, deceased members of the Harvard Faculty of Medicine (those at the rank of full or emeritus professor) receive a review of their life and contributions with a complete reflection, a **Memorial Minute**.*

Elio was a good student, and although he was expected to work in the factory, he entered the University of Pavia with his father's blessing at age 19. Based on his entrance exam scores, he was elected to the ancient and exclusive Collegio Ghislieri, linked to the University, which provided a scholarship, housing, and cultural opportunities. He graduated from the University with an M.D., with perfect grades and honors at age 25. Elio then trained in neurology and psychiatry and managed a unit at the local mental hospital. But he also developed a passion for research and studied neuroanatomy, learning the Golgi method for staining individual cells directly from Camillo Golgi's student Antonio Pensa, and completing a Ph.D. at age 31. He was appointed Assistant Professor in the Institute of Human Anatomy, a position he held up to age 39.

Frustrated by the pace of his academic progress and seeking mentorship, Elio approached a well-known Italian professor for advice. The professor, of the competing school of neuroanatomy inspired by Santiago Ramón y Cajal, suggested foreign training and arranged an introduction to Rita Levi-Montalcini, the noted discoverer of nerve growth factor then at Washington University, who in turn recommended Elio to Don Fawcett, chair of Anatomy at Harvard Medical School. Fawcett initially turned down Elio's request for research training, but, following a persuasive letter from Elio, accepted him as a Research Fellow in 1965. Elio never forgot how he had been welcomed to Harvard in 1965 by a number of senior colleagues, including Fawcett, Susumu Ito, and other cherished mentors and colleagues in the Department of Anatomy. By then Elio was married to Giuseppina d'Elia, who had been a student at the Collegio Castiglioni-Brugnatelli, across the street from the Collegio Ghislieri. A gifted anatomist herself, Giuseppina joined Fawcett's laboratory as well. The year went well and Elio was offered a faculty position, but Giuseppina's illness forced a return to Italy. In 1970, after her recuperation, they returned to Harvard, with Elio joining as Associate Professor of Anatomy and Giuseppina soon becoming Associate Professor of Anatomy at Boston University.

In the early 1970's Elio and Giuseppina had a son, Giuseppe Raviola (known also as Bepi), of whom Elio was immensely proud. Bepi attended Dartmouth College and Harvard Medical School, and trained in adult, child and adolescent psychiatry. He developed a career as both a clinician, and as a contributor to a new field of global mental health delivery, building service delivery, training and research programs across countries that include Haiti, Rwanda, Sierra Leone, Liberia, Malawi, Lesotho, Peru, the United States and elsewhere. He teaches undergraduates, students at the medical school and school of public health, and resident physicians at Harvard, as well as being on the HMS Faculty as Associate Professor of Psychiatry, and Global Health and Social Medicine. After the passing of Giuseppina in 1986, Elio married Trude Kleinschmidt, also on the Harvard Psychiatry faculty.

In his career at Harvard, Elio bridged two broad arcs of scientific evolution across Anatomy and Neurobiology. The Department of Comparative Anatomy was created in 1906 under Charles Sedgwick Minot and later combined with the Department of Anatomy in 1912. The Department of Neurobiology at HMS was established in 1966 by Dr. Stephen W. Kuffler, who had previously recruited a group of young scientists to Johns Hopkins, and who in 1959 moved with them to Harvard to start a new research unit in neuroscience. Kuffler combined physiology, biochemistry, histology, neuroanatomy, and electron microscopy in a single group, shifting the focus of research from techniques found in separate departments to a study of the brain as a system. In doing so, Kuffler invented a new field that he called Neurobiology, and later he founded the first Department of Neurobiology. Integrating what he learned of the use of various cell biological techniques in the "Golgi School" in Italy and then in the Department of Anatomy at HMS, Elio was an early pioneer in this frontier area of research.

Elio evolved continuously to become an expert of cell biological, electrophysiological, and molecular

techniques, solving problems of structure, connectivity, and physiology of the retina, the part of the eye that received and processes signals from light. He was interested in how the retina is able to encode information from the visual scene and then send the encoded information to the brain. To study this complex problem, he employed multiple methods and applied them to studies in primates, rodents, and rabbits. Adept in anatomical methods, he went on to become an expert in the electrophysiology of the retina as well as in some of the newest molecular approaches.

With Dr. Torsten Wiesel, 1981 Nobel laureate in physiology or medicine, Elio developed not only a wonderful friendship, but also an experimental model of myopia (near-sightedness). They studied how alterations of the visual experience during the postnatal growth of the eye leads to myopia. They discovered that the eye elongation that leads to myopia is mediated by the nervous system, specifically by growth-regulating chemicals produced in the retina itself. Also, with Ramon Dacheux II in the 1980s, he studied the functional role of different classes of nerve cells, in part through microscopic analyses of how the cells connect with each other, and in part by recording their electrical responses to light. The experiments lasted from early in the morning through most of the following night. After days of wakefulness Dacheux would sleep at Raviola's house. Elio shared of their friendship and collaboration: "Very few things in life are as rewarding as sharing the joys and frustrations of scientific discovery with a trusted colleague of great intellectual integrity and the same aspiration for excellence. When the work becomes a silent, graceful, well-choreographed ballet of precise, perfect gestures; when there is little or no need to speak and the collaborators complete each other's sentences because they have become one with their object of study" (Visual Neuroscience, 2007;24:445-447).

Through the 1980s and 90s, Elio transitioned from anatomist to cell biologist to molecular biologist. Constance L. Cepko, Bullard Professor of Genetics and Neuroscience at HMS remembers when Elio approached her at the turn of the 1990's about her supporting his learning newer methods in her laboratory. While he was a visiting professor down the hall, he behaved as a visiting post-doctoral student: "He came to my lab to learn molecular biology. He kept the most beautiful, neat, and complete lab notebook that I had ever seen. I used it as an example to my students. and he was so courageous, at his august stage in life, to become a novice in a new field. He was driven to this by his desire to understand more about retinal circuitry. He felt he had exhausted the approaches that he had been using, and wanted to try something new, methods that he had come to understand would provide powerful new avenues to achieve his goals. He was able to learn enough to return to his lab and use the new methods to make a transgenic mouse that labelled the dopaminergic neurons that he wanted to understand. It led to a beautiful study of the synapses of that cell type, made possible by his mastery of anatomy and physiology, combined with molecular biology."

Elio directed his efforts to characterizing the role of each retinal neuron cell type, focusing on the ways in which amacrine cells in the retina uniquely release the neurotransmitters dopamine and GABA, as well as seeking to understand the specific function of this mechanism in human adaptation to light. Using a multidisciplinary approach, with colleagues he identified all the transcripts present in dopamine amacrine cells, discovered the presence of the common clock-related proteins in those cells (with Stefano Guscini et al.), showed that some amacrine cells spontaneously release dopamine and GABA through different mechanisms (with Michelino Puopolo et al., and Hajime Hirasawa et al.), and described a unique set of synaptic contacts made by dopamine amacrine cells at nodal points of the retinal network needed to shape retinal light adaptation optimally (with Massimo Contini et al., and Richard Masland et al.). Elio's natural proclivity for art, nature, and beauty is evident in the scientific imagery he produced, with his incredible skills in capturing light microscopic and ultrastructural images of his retinal specimens.

In addition to practicing his science, Elio taught anatomy for more than thirty years. His excellence as a teacher was recognized instantly by students and faculty alike. In 1972 he received the Boylston Society Award for excellence in teaching at HMS, as well as multiple subsequent preclinical teaching awards. From 1972 to 2002 he directed the Introduction to Anatomy course for entering first-year medical students, also known as “The Body Block.” Elio would come to the lecture hall early in the morning and draw detailed, beautiful pictures in color on the blackboard, using French art chalks. He saw lecturing as performance art, the purpose of which was to transmit just the right amount of information that the class could absorb in one hour, to make the material interesting, to convey a sense of intellectual or practical necessity. The lecture, he felt, should hint at the further existence of a world of detail, moving from surface structure to molecular and genetic depth, and promise a whole world that a student could learn through a lifetime of professional study and practice. He was called by some students “The Italian Master,” for his weaving of cultural and intellectual foundations into his teaching and for encouraging personal authenticity from the students themselves. He also lectured extensively in Histology and Neurobiology to both medical and graduate students. In sharing the art of human dissection, he conveyed to first-year medical student the importance of humanity and humility and of the sacred calling of medicine. Elio helped students familiarize themselves with and appreciate the physical presence of human beings who had generously donated their bodies to their education at the medical school.

Elio’s service to the medical school extended to the fostering of partnerships outside of the Harvard ecosystem. Elio was very active in efforts to strengthen Italian science, including the establishment of the Giovanni Armenise-Harvard Foundation and the creation of the Italian Institute of Technology. In advising the Armenise-Harvard Foundation, which supports basic scientific research at HMS and in Italy, he worked in a focused way to nurture the careers of young, promising Italian scientists.

Elio enriched the lives of others primarily with his kindness and generosity of spirit. He loved life deeply amidst life’s everyday challenges. He expressed an interest in all people. His generosity was rooted in respect for others and a spirit of sacrifice that he learned from his parents growing up in Asti, in northern Italy, in the tumultuous interbellum and Second World War periods. When he saw injustice, he spoke up. He often quoted an old Roman adage: “Est modus in rebus,” that is, "everything in proportion", or moderation in all things. He led a disciplined life with regular, day-to-day routines—with his life in the lab, and his relationship with his family, as the foundation.

Elio Raviola felt deeply that his main purpose in life was to advance human discovery. He was a mainstay of the Harvard Medical School quadrangle for more than fifty years. He touched the lives of everyone with whom he interacted across his decades of service to the Departments of Anatomy and Neurobiology, and to HMS. The fact that a single person could have such an extraordinary impact across different sectors of the ongoing mission of the medical school is remarkable and a triumph. His legacy will live on forever.

Respectfully submitted,

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