Book review of Tara Abraham's *Rebel Genius: Warren S. McCulloch's Transdisciplinary Life in Science*. (2016 MIT Press) in CSHPM *Bulletin* 61 (2017), pp. 23-25.

Book Review: Rebel Genius

Rebel Genius: Warren S. McCulloch's Transdisciplinary Life in Science, by Tara H. Abraham. MIT Press, 2016, 320 pp. ISBN 978-0-262-03509-5. £32.95, US$40.00.

Warren Sturgis McCulloch (1898–1969) was a prominent figure in American neurophysiology and neuropsychiatry from the 1930s to the 1960s. Although not himself a mathematician, he advocated a quantitative mathematical approach to human biology. He is best known for a paper he published in 1943 with Wallace H. Pitts (then barely out of his teens) developing a theoretical model of the nervous system using the logical notion of a neural network. This paper influenced John Von Neumann and played a role in the creation of theoretical computer science, and it was also foundational for various strands of thought that eventually united under the broad rubric of cognitive science and artificial intelligence.

Tara Abraham is an historian of science at the University of Guelph in Canada. Her biography documents McCulloch's childhood and education and the successive stages of his career in science, as he went from neurophysiologist to neuropsychiatrist, then on to a promoter of cybernetics, and finally to a kind of engineer investigating the neurocircuitry of animal brains. She views McCulloch as someone who "self-fashioned" a succession of "performative identities." In so doing

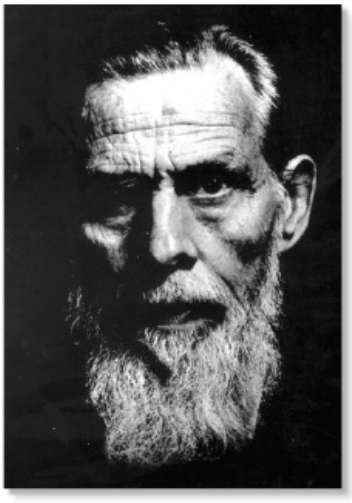

Figure 9: Warren Sturgis McCulloch (1898–1969)

he exhibited a new form of "transdisciplinarity" that brought together, at the middle of the century, disparate strands of research in science, medicine and philosophy. (The terms in quotes are ones that appear as interpretative constructs in recent biographical writings in the history of science.) Abraham's book is the product of extensive research and is informed by the substantial historical and philosophical literature that exists on various facets of McCulloch's scientific work. It is the most detailed and perceptive account of his life and scientific thought to date.

McCulloch grew up in Orange, New Jersey, the son of an estate manager of comfortable means. While an undergraduate major in philosophy and psychology at Yale University, he showed an interest in mathematics. His senior thesis in psychology focused on whether human subjects showed an esthetic preference for geometric figures such as rectangles that involved the golden section. (Figures that did so were said to display "dynamic symmetry.") McCulloch continued this project in his Masters work at Columbia University and went on to Columbia's medical school, becoming licensed as a physician in 1927. In the following years he carried out research in experimental neurology at Columbia and New York hospitals.

In 1934 McCulloch moved to Yale and began a series of researches with Dusser de Barenne on the functional organization of the cerebral cortex of primate brains. In 1941 he moved to the Illinois Neuropsychiatric Institute where he assumed administrative duties overseeing a range of research programs. At INI his own work centered on convulsive therapies for treating major mental illnesses such as schizophrenia. He collaborated with the émigré Hungarian researcher Ladilas J. Meduna on metrazol therapy (involving induced convulsions), and he tried to explain the efficacy of this therapy in terms of carbohydrate metabolism. This form of treatment of mental illness anticipated the more widely used electroshock therapy that emerged in the 1950s. McCulloch and Meduna were firm adherents to a biological approach to psychiatry that was at odds with the then influential Freudian paradigm.

At Illinois McCulloch came into contact with Nicolas Rashevsky and his Committee on Mathematical Biology at the University of Chicago. During this period his scientific interests also took on a somewhat more abstract and philosophical character. McCulloch and his family (wife Rook and four children) assumed the role of mentor for younger researchers and their families and took under their wing the student Wallace Pitts. McCulloch and Pitts' 1943 paper was published in Rahevesky's *Bulletin of Mathematical Biophysics*. In the immediate post-war years McCulloch became involved in the cybernetics movement and served as chair of the famous Macy Conferences on Cybernetics from 1946 to 1951. In the latter year he moved to the Massachusetts Institute of Technology to carry out research on the brain circuitry of frogs and cats with his former Illinois colleagues Pitts and Jerry Lettvin.

McCulloch and his like-mined contemporaries saw in cybernetics a way of providing a naturalistic explanation of such notions as teleology and purpose. Before the war linguistics was the basis of philosophical conceptions of the unity of science, a fact expressed in the writings of philosophers such as Rudolf Carnap. After the war researchers turned to cybernetics as a unifying theme. Abraham summarizes the prevailing belief (p. 131): "Understanding purposeful systems in terms of negative feedback would result in greater understanding across disciplines." During the later 1950s the cyberneticists with their emphasis on brain modeling and analog processes became somewhat isolated from what would become the mainstream of research in cognitive science. The latter relied on the metaphor of the computer-mind and employed information-processing mechanisms in their models. While the 1943 paper

on neural networks was arguably encompassed within such an approach, McCulloch's emphasis on brain physiology and experimental neurology was at odds with the developing direction of research.

In 1965 McCulloch published *Embodiments of Mind*, a collection of article reprints, lectures and miscellanea on various aspects of his work in science. Included was the essay, "What is a number, that a man may know it, and a man, that he may know a number," originally published in 1961 in the *Bulletin of Cybernetics*. McCulloch found it easy to define what number is, adopting the logicist conception (attributed to Bertrand Russell but in fact originating with Gottlob Frege) of a whole number as the set of all sets that can be put in one-to-one correspondence with a set containing the given number of elements. The major part of the essay was devoted to the title's second question, examining how humans come to know numbers, a question that McCulloch believed could ultimately be explained in terms of brain modeling and the logic of neural networks. One colleague at MIT remarked that McCulloch "looked and talked like God." He and Rook continued to play an active role in mentoring younger investigators, including taking them into their Cambridge home and the McCulloch family farm in Old Lyme, Connecticut. McCulloch's support of junior colleagues and his generosity towards them were acknowledged in the tributes to him following his death. Always of a somewhat expansive temperament, in the last decade or so of his life he began to think of himself as kind of a sage of science and an *éminence grise* to younger researchers.

From his student days until his death McCulloch dabbled in poetry, favoring the sonnet form, and he crafted a slim volume of poems that was published in limited edition in 1959. Abraham ends her biography with a poem McCulloch wrote in his last years, where he mused on his legacy:

> *When I am dead let no man say*
> *That, I had lived, I had done so and so:*
> *For I was always on an unknown way*
> *To mine own ends, the which they could not know!*

Acknowledgment: I would like to thank Hardy Grant for comments on a penultimate draft of this review.

Craig Fraser