

Warren McCulloch's search for the logic of the nervous system.

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Warren Mcculloch's Search for the Logic of the Nervous

Introduction

The 1940s saw the beginning of the computer age, building on the logical investigations of the 1930s, and leading to the development of artificial intelligence in the 1960s and of neurally-inspired paradigms for neurally inspired methods of adaptive, parallel computing in the 1980s and 1990s [1]. Among the key players in these developments was the neurologist Warren Sturgis McCulloch (1898-1968). With Walter Pitts [2], he showed how to formalize the brain as a network of neurons viewed as logical processing elements—a key element in the definition of the classical computer architecture based on stored programs that was devised by John von Neumann, and in the cybernetics of Norbert Wiener. With the addition of learning rules built on the ideas of Donald Hebb and Frank Rosenblatt, this formalization also led to the resurgence of artificial neural networks as a new computing technology from the mid-1980s onwards, a resurgence coupled with that in the computational modeling of the brain, thus closing the circle back to McCulloch's original source of inspiration.

Certainly, McCulloch was concerned with computer technology, as is reflected in his concerns for reliable computing from unreliable neuron-like elements and for redundant, distributed computing by larger modules. However, throughout his life he was driven less by the demands of technology than by the quest to understand how we think. Specific experimental techniques were always secondary to the basic questions: what is the logic of thought? what is a person? what is a man that he may know a number? As a young man worrying about the fundamental questions of philosophy, metaphysics, and epistemology, McCulloch set himself the **[End Page 193]** goal of developing an "experimental epistemology": how can one really understand the mind in terms of the brain? More particularly, he sought to discover "A Logical Calculus Immanent in Nervous Activity" [3]. The present paper will seek to provide some sense of McCulloch's search for the logic of the nervous system, but will also show that his papers contain contributions to experimental epistemology which provide great insight into the mechanisms of nervous system function without fitting into the mold of a logical calculus. Moreover, McCulloch was not only a scientist but also a storyteller, poet, and memorable "character." I will thus interleave a number of characteristic anecdotes into the more objective attempts at scientific history that follow.

Towards a Biography

Before providing a biographical sketch of Warren McCulloch, let me say a few words on sources for this material. The primary source is my own experience. I read McCulloch's papers as an undergraduate at Sydney University; worked with McCulloch's group while I was a graduate student at MIT from January 1961 to September 1963; met McCulloch a number of times thereafter; know and have worked with many of his colleagues; and have reflected on his work in making my own contributions to cybernetics and computational neuroscience. Several publications have proved particularly useful in supplementing my personal perspective. Heims's book describes the Macy Foundation meetings on cybernetics and devotes many pages to biographical information concerning McCulloch, who was chairman of the series [4]. McCulloch's reflections on his intellectual development and its relation to the development of cybernetics provides an autobiographical view [5]. His wife Rook and his protégé and long-time friend Jerry Lettvin add important personal perspectives to the biography [6-8]. In addition, I benefited from many conversations with, and presentations by, friends and colleagues of McCulloch who took part in the 1995 meeting in Gran Canaria entitled "An International Conference in Honor of W. S. McCulloch 25 Years After His Death." I wish to

record here my debt to Roberto Moreno-Díaz for organizing this conference and for his hospitality in Las Palmas. In what follows, if no source is given, the material is either my own, or is from Heims or McCulloch [4, 5]; other...

WARREN McCULLOCH'S SEARCH FOR THE LOGIC OF THE NERVOUS SYSTEM

MICHAEL A. ARbib*

Introduction

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