

McCULLOCH'S PUBLICATION ON
MAPPING OF CORTICAL CONNECTIONS BY
STRYCHNINE NEURONOGRAPHY

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Warren McCulloch was, as all who knew him were keenly aware, a lover of the paradoxical. Indeed he might himself have argued that paradox grew out of the very nature of the brain, that great collection of interlocking nervous networks whose chief hereditary endowment is the capacity to organize itself, and by so doing, to know itself. Somehow it never quite achieves its end fully, and the discrepant truth-tables of the different loosely bound networks come to the surface from time to time in the form of the paradox. And yet each paradox is curiously satisfying, since it drives this great thinking machine into new and more exciting attempts to organize its own logical structure in a new way.

It is therefore perhaps no surprise that McCulloch spent a major portion of his professional career, first with Dusser de Barenne, and later with Percival Bailey and other coworkers in Chicago, in a field of research about whose results he held, simultaneously, two strongly contradictory views. This activity recorded in over 40 papers was the mapping of the connections of the cerebral cortex, and in particular the connections between different cortical regions, by the method of physiological neuronography by the use of locally applied strychnine.

The logic of the method was simple enough. Strychnine applied to the cell body would lead to electrical spiking at its

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terminals. It thus became possible to map the efferent projections of any area of the exposed cortex by applying strychnine to it.

Oddly enough McCulloch and his coworkers (especially Percival Bailey and Gerhard von Bonin) had decided that long cortico-cortical connections had no physiological significance. They were thus engaged in the activity of mapping an elaborate but orderly pattern of connections which apparently had no role in the everyday workings of the brain, but which served perhaps only as routes over which epilepsy might spread, or perhaps only the even lowlier function of serving to hold the brain together like a series of chains.

I came on this curious situation when, back in the early 60's I had become deeply interested in the connections of the cerebral cortex. I soon became aware that destruction of these connections could give rise to dramatic clinical pictures, such as the syndromes of callosal disconnection, first discovered in the early 1900's by Liepmann and then somehow forgotten for nearly 30 years. The anatomy of the cerebral cortex, I soon discovered, had not been of particular interest to anatomists and information on the subject was difficult to find. It was Elwood Henneman, himself a former collaborator of McCulloch's, who called my attention to the monographs on the brain of the monkey and the chimpanzee that had come out of the laboratories of Chicago. I read these volumes and the many original papers they referred to with enormous interest and used the information extensively in my first writings on the significance, both in normal brains and in damaged ones, of the interconnections of the cerebral cortex, both those connecting the two sides of the brain, and those connecting cortical areas within the same hemisphere. These papers of Bailey, McCulloch, von Bonin and Bucy, remained a major source of information on cortical connections until the application of newer anatomical approaches (either silver staining by the method of Nauta, or later techniques making use of active transport of amino acids or proteins along the nerve fiber) brought a new measure of refinement. I was perplexed as to how McCulloch and his coworkers, but especially McCulloch, could have devoted so much time to an activity without obvious relevance to function. I put the question

directly to him and got a remarkably direct, non-circumlocutory answer. The influence of Karl Lashley had been so great that they had all been hypnotized. Somehow he had convinced them that the intercortical connections were of little importance. But, I asked, if they were thought not to be important, why did they put in so much effort over so many years? McCulloch indeed admitted that he would sometimes wonder why they were doing this, when far into the night he would be in the operating room, applying strychnine-soaked pledgets to the brain of a monkey or chimpanzee (running the experiment as long as the brain of the valuable animal continued to function). But, he added, underneath it all he was driven by a curious faith that somehow this knowledge would be important. This underlying faith was, thus, eventually justified. In the end one can only say that of the two contradictory views, the one which has eventually taken root is the one that in the end must have been most satisfying to McCulloch. The believer in the great importance of the organization of the nerve net could hardly ignore those parts of the net that span the hemispheres and disturbed regions within the hemisphere.