The papers of Warren Sturgis McCulloch are available for scholarly use at the American Philosophical Society, in Philadelphia, Pennsylvania.

# TABLE OF CONTENTS

### **VOLUME I**

		Page
For	face by Heinz von Foerstereword by Rook McCullochroduction by Jerome Y. Lettvin	1
1	Recollections of the Many Sources	
	of Cybernetics [213]*	21
2	Jerome Y. Lettvin: Strychnine Neuronography	50
3	An Extinction Phenomenon on Stimulation	
	of the Cerebral Cortex [6]	59
4	A Photokymographic Method with Continuous	
	Cathode Ray Oscillograms [11]	63
5	On the Nature and Distribution of Factors	
	for Facilitation and Extinction in the	
	Central Nervous System [17]	66
6	Functional Activity and pH of the	
	Cerebral Cortex [19]	68
7	Functional Organization in the Sensory Cortex	
	of the Monkey (Macaca Mulatta) [20]	81
8	The Direct Functional Interrelation of	
	Sensory Cortex and Optic Thalamus [21]	98
9	Irreversibility of Conduction in the	
	Reflex Arc [24]	109
10	Observations on the pH of the Arterial	
	Blood, the pH and the Electrical	
	Activity of the Cortex [26]	111

Numbers in brackets [ ] following articles by W.S. McCulloch refer to the list of his publications in the Appendix.

11	Factors for Facilitation and Extinction	
11	in the Central Nervous System [28]	117
12	The Knee-Jerk Following Facilitation	
	and Extinguishing Stimulation of the	
	Related Cortical Foci [30]	154
13	Physiological Delimitation of Neurones	
	in the Central Nervous Systems [32]	155
14	The Sensory Cortex of the Chimpanzee [34]	164
15	Sensory Cortex of Chimpanzee [38]	16/
16	The Motor Cortex of the Chimpanzee [41]	184
17	Functional Interdependence of Sensory	
	Cortex and Thalamus [42]	201
18	Suppression of Motor Response Obtained from	
	Area 4 by Stimulation of Area 4s [43]	208
19	Functional Organization of Sensory and	221
	Adjacent Cortex of the Monkey [44]	221
20	Cortical Origin and Distribution of	
	Corpus Callosum and Anterior Commisure	220
	in the Monkey (Macaca Mulatta) [45]	228
21	Physiological Neuronography of the	
	Cortico-Striatal Connections [47]	237
22	Excitability of Cerebral Cortex in Infant	
	Macaca Mulatta [48]	264
23	Joannes Gregorius Dusser de Barenne	
	(1885-1940) [37]	270
24	Henk van der Tweel: A Center Around	
	One Person	274
25	A. Verveen: A Personal Account	280
26	The Uses of Strychnine [177]	283
27	The Functional Organization of	
20	Occipital Lobe [49]	290
28	Motor Response to Stimulation of Cerebral	
	Cortex in Absence of Areas 4 and 5	
20	(Macaca Mulatta) [50]	318
29	Long Association Fibers in Cerebral Hemispheres	
20	of Monkey and Chimpanzee [54]	326
30	Jerome Y. Lettvin: Warren as a Teacher	332
31	Manuel Blum: Notes on McCulloch—Pitts'	
	A Logical Calculus of the Ideas Immanent in	
	Nervous Activity	339

32	Michael Arbib: Comments on McCulloch-Pitts'	
	A Logical Calculus of the Ideas Immanent in	
	Nervous Activity	341
33	A Logical Calculus of the Ideas Immanent	
	in Nervous Activity [51]	343
34	Rook McCulloch: On F.S.C. Northrop	362
35	F.S.C. Northrop: On W.S. McCulloch	363
36	A Statistical Consequence of the Logical	
	Calculus of Nervous Nets [52]	370
37	Rapid Changes in the O, Tension of Cerebral Corte	ex
11/19	during Sleep Induced Convulsions [55]	
38	Norman Geschwind: McCulloch's Publication on	
	Mapping of Cortical Connections by	
	Strychnine Neuronography	378

# ARTICLES IN VOLUME II

- Functional Organization of the Medial Aspect of the Primate Cortex [56]
- 40 The Functional Organization of the Cerebral Cortex [57]
- 41 Cortico-Cortical Connections [58]
- 42 Physiological Neuronography of Some Cortico-Subcortical Connections in the Chimpanzee [62]
- 43 The Modern Concept of Schizophrenia [65]
- 44 Changes of Noble-Metal Electrode EMF of Cerebral Cortex [66]
- 45 A Heterarchy of Values Determined by the Topology of Nervous Nets [67]
- 46 A Letter to the Editor [68]
- 47 Michael Arbib: A Note on A Heterarchy of Values
- 48 Rapid Changes in Cerebral Oxygen Tension Induced by Altering the Oxygenation and Circulation of the Blood [69]
- 49 A Cortico-Bulbo-Reticular Pathway from Area 4-s [70]
- 50 The Projection of the Frontal Lobe of the Hypothalamus [71]
- 51 A Suppressor Cerebello-Bulbo-Reticular Pathway from Anterior Lobe and Paramedian Lobules [72]
- 52 Sundry Changes in Physiology of Cerebral Cortex Following Rapid Injection of Sodium Cyanide [74]
- Valentino Braitenberg: Comments on Modes of Functional Organization of the Cerebral Cortex
- Modes of Functional Organization of the Cerebral Cortex [75]
- 55 Michael Arbib: A Note on How We Know Universals
- 56 Jerome Y. Lettvin: Warren and Walter
- 57 How We Know Universals: The Perception of Auditory and Visual Forms [76]
- 58 The Statistical Organization of Nervous Activity [80]
- A Recapitulation of the Theory with a Forecast of Several Extensions [81]
- 60 Mallory Selfridge: W.S. McCulloch and the Foundations of Al
- 61 The Brain as a Computing Machine [86]
- 62 A Cerebello-Bulbo-Reticular Pathway for Suppression [88]
- 63 Physiological Processes Underlying Psychoneuroses [90]

- 64 How Nervous Structures Have Ideas [93]
- 65 Machines That Think and Want [95]
- 66 Why the Mind is in the Head [97/98]
- 67 An Electrical Hypothesis of Central Inhibition and Facilitation [99]
- 68 Positivity in Ventral Horn during Bulbar Reticular Inhibition of Motoneurons [99.1]
- 69 Brain and Behavior [100]
- 70 Donald M. Mackay: Introductory Note to The Limiting Information Capacity of a Neuronal Link
- 71 The Limiting Information Capacity of a Neuronal Link [104]
- 72 A Confession of Ignorance [105]
- 73 The Past of a Delusion [107]
- 74 Jack Cowan: Epilogue

# ARTICLES IN VOLUME III

- 75 Heinz von Foerster: Circular Causality
- 76 Introductory Remarks [109]
- 77 Summary of the Points of Agreement Reached in the Previous Nine Conferences on Cybernetics [110]
- 78 Investigation on Synaptic Transmission [108]
- 79 The Colloquy of Living Things [162]
- **80** Knower Known... [216]
- 81 Through the Den of Metaphysician [120]
- 82 M. Vasalis: Introduction to Poetry
- 83 The Natural Fit [143]
- 84 Poetry
- 85 One Word After Another [215]
- 86 Mysterium Iniquitatis of Sinful Man Aspiring into the Place of God [124]
- 87 Information in the Head [116/117]
- 88 R.C. Gesteland: The Olfactory Adventure
- 89 P.D. Wall: An Assessment of the Significance of the Physiological Contributions after 1950
- 90 Reflex Inhibition by Dorsal Root Interaction [127]
- 91 Effects of Strychnine with Special Reference to Spinal Afferent Fibers [128]

- 92 The Terminal Arborization of the Cat's Pyramidal Tract Determined by a New Technique [129]
- 93 Limits on Nerve Impulse Transmission [130]
- 94 Toward Some Circuitry of Ethical Robots [133]
- 95 Factors Limiting the Maximum Impulse Transmitting Ability of an Afferent System of Nerve Fibers [136]
- 96 The Biologist, the Physicist and the Engineer [138a]
- 97 Biological Computers [138b]
- 98 Membrane Currents in Clamped Vertebrate Nerve [139]
- 99 Jack Cowan: Neuronal Nets
- 100 The Stability of Biological Systems [140]
- 101 Agathe Tyche, of Nervous Nets the Lucky Reckoners [144]

#### ARTICLES IN VOLUME IV

- 102 What the Frog's Eye Tells the Frog's Brain [146]
- 103 Two Remarks on the Visual System of the Frog [155]
- **104** The Reliability of Biological Systems 149]
- 105 Where Is Fancy Bred? [152]
- What Is a Number That a Man May Know It, and a Man That He May Know a Number? [153]
- 107 Abracadabra [154]
- 108 The Utility of Anastomotic Nets [157]
- 109 Neurological Models and Integrated Processes [158]
- 110 The Imitation of One Form of Life by Another Biomimesis [159]
- 111 Anastomotic Nets Combating Noise [160]
- 112 Reliable Systems Using Unreliable Units [170]
- 113 J.D. Fortuyn: Reticular Formation and Choice of Behavior
- 114 The Command and Control System of the Vertebrates [182]
- 115 Regenerative Loops [205]
- 116 A. Scheibel: Warren and the Brain Stem Reticular Core
- 117 The Reticular Formation Command and Control System [208]
- 118 Control of Posture and Motion [210]
- 119 M.A. Arbib: Note on Control of Posture and Motion
- 120 Studies in Carbohydrate Metabolism [169]
- 121 Norbert Wiener and the Art of Theory [171]

- 122 What's in the Brain That Ink May Character? [172]
- 123 W.L. Kilmer: Postscript to What's in the Brain That Ink May Character?

xi

- 124 Cybernetics Problems of Learning [183]
- 125 S. Kauffman: Behavior of Gene Nets
- 126 Circularities in Nets and the Concept of Functional Matrices
  [199]
- 127 Of I and It [204]
- 128 Ragnar Rokr: The Effects of Conscious Purpose on Human Adaptation [211]

## **APPENDIX**

Contributors
List of Photographs
Biographical Dates
Publications by W.S. McCulloch
Index