

XXIV. NEUROPHYSIOLOGY*

W. S. McCulloch
M. A. Arbib
F. S. Axelrod
M. Blum
J. E. Brown
R. C. Gesteland

M. C. Goodall
W. L. Kilmer
K. Kornacker
J. Y. Lettvin
Diane Major

L. M. Mendell
N. M. Onesto
W. H. Pitts
J. A. Rojas
A. Taub
P. D. Wall

RESEARCH OBJECTIVES

The aims of this group can be stated best under three main headings:

1. Basic Theory

Our purpose is to develop the necessary logical and mathematical theory for an understanding of computation such as the brain performs, and thus lay foundations for an attack on the problem of decision making in the presence of a redundancy of potential command such as that encountered in the reticular formation.

M. A. Arbib, M. Blum, N. M. Onesto,
W. L. Kilmer, W. S. McCulloch

2. Project Plans

(a) Olfactory Physiology. We expect to go to the second-order neurons now in an attempt to unravel the categories of the first order.

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(b) Electrodes. We shall prosecute the study of specifically sensitive O₂, pH, and other sorts of electrodes, partly for oceanographic application, partly for biological application.

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(c) Instrumentation. Various electronic devices will be built as the need arises.

J. Y. Lettvin, R. C. Gesteland

(d) Visual Processes. We are branching into the study of form-function relations and color vision, as well as into further octopus work.

H. R. Maturana, J. Y. Lettvin

(e) Visual Processes of the Rat. We plan to study the organization of receptive fields in rodents.

J. E. Brown, J. A. Rojas

(f) Physiological Optics. We are working on schemes to track the position and focus of an eye from a distance.

B. H. Howland, R. C. Gesteland, J. Y. Lettvin

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3. Problems of Sensory Projection Pathways

During the past year, we have concentrated on two major lines of approach to the problems of cutaneous sensory mechanisms. The first has dealt with the control system situated about the first central synapse where nerve fibers from the skin converge on cells in the dorsal part of the spinal cord. We have shown that the very small cells scattered throughout the region of these synapses and which make up the substantia gelatinosa are involved in modulating the transmission of impulses across this first junction. This censorship of arriving nerve impulses is affected by previous activity in the same pathway, by activity in neighboring areas of skin, by intense activity in distant areas, particularly in paws and face, and by stimulation of the cerebellum, mid-brain, pons, and medulla. The censorship mechanism seems to be in continuous action, and we believe that it is best studied by steady stimuli, rather than by sudden brief changes in the environment. The mechanisms that we have seen in the cat would predict interactions between various types of skin stimuli, and we have carried out concomitant experiments on man to examine these hypotheses. These psychological experiments have shown that there is a most interesting interaction in man between light-pressure stimuli and electrical stimulation. We have published some of this work in Brain and in the Journal of Physiology, and two other papers will appear, in 1963, in Experimental Neurology. In the coming year, we shall pursue the study of the censorship mechanism in an attempt to find something of its role in the normal functioning of the animal.

Our second line of approach is an attempt to discover the language used by the skin in telling the brain about the location of the stimulus. We are studying two reflexes that require the motor mechanisms to know the exact location of the stimulus. The first is the scratch or swipe reflex, and the second is the eye blink. We are studying the pathways over which the information is carried both in normal animals and in frogs and salamanders who have been operated on in their youth. If dorsal and ventral skin are reversed in the tadpole, the scratch reflex of the adult frog is aimed at the embryological position of the skin, and not at its actual position, so that it is evident that some message is going from skin to central nervous system which tells the nature of the skin rather than its position. We hope to discover the nature of this message by microelectrode studies of the cord. Similar work is being done on amphibia in which an additional eye is implanted on the head. The extra eye will generate a blink reflex in the normal eye if it is touched, and so we know that nerves are somehow capable of telling the brain that they are in cornea and not in ordinary skin. This problem has been studied in normal frogs, a paper will soon appear in Experimental Neurology, and this work will be pushed vigorously during the next year.

A. Taub, K. Kornacker, Diane Major, P. D. Wall