

# BOOK REVIEWS

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## Neural Mechanisms in Behavior

D. McFadden, Ed.

Springer-Verlag, New York, 1980.

viii + 308 pp. Price \$24.90.

This volume is the edited version of a symposium held at the University of Texas, Austin, in March, 1978, partly to mark the thirtieth anniversary of the famous Hixon Symposium on *Cerebral Mechanisms in Behavior*, organized by Lloyd Jeffress. Seven chapters are contributed: One on hearing, three on vision, and three on learning and motor function. All the contributions are impressive, and the discussions that follow each chapter are interesting and provocative.

J. E. Rose presents the first chapter in the volume, on "Neural correlates of some psychoacoustic experiences." He describes some elegant findings on responses of single auditory nerve fibers in the squirrel monkey, and of single neurons in the anteroventral cochlear nucleus of the cat. The behavior of these neurons is shown to parallel certain classical psychoacoustical observations in humans concerning masking, combination tones, the dependence of threshold on tone duration, and the pitch of tonal complexes. Rose argues persuasively that these psychoacoustical phenomena reflect the form in which the cochlea originates information.

The next three chapters concern visual processing. R. M. Boynton, in "Design for an eye" presents a beautiful account of the problems involved in designing an optical instrument that is capable of extracting a maximal amount of information about objects in the environment, and how these problems are solved in the way the eye is designed. For example, the wavelength range of electromagnetic radiation to which we are sensitive appears optimal; the fact that photopigments are insensitive to light is handled cleverly in the design of photoreceptors; the broad tuning of photopigments conveys distinct advantages; and so on. In "Form and function: linear and nonlinear analyses of neural networks in the visual system," F. Ratliff reviews some elegant work on spatial and temporal interactions in lateral inhibitory networks. The review focuses for the most part on studies of single receptor units in the compound eye of *Limulus*. Next, H. Barlow presents a chapter on "Cortical function: a tentative theory and preliminary tests," in which he argues that the function of the sensory cortex is not simply to represent information, but rather to extract knowledge from it. He maintains that this process must involve the application of statistical tests to the activities of groups of neurons, and describes some psychophysical measurements designed to determine how well such statistical decisions are made. Barlow also speculates about the neural mechanisms underlying such decisions.

The final three chapters in the volume are on learning and motor function. In "The search for the engram, II," R. F. Thompson presents evidence that the growth of the hippocampal response during learning correlates highly with subsequent behavioral learning; and so argues that the hippocampus is part of the system involved in the establishment of engrams. E. V. Evarts presents a chapter on "Brain mechanisms in voluntary movement," in which he discusses characteristics of neuronal activity during motor performance in the primate. He argues that neurons of the pyramidal tract are driven both by a servosystem that stabilizes movement and posture, and also by a second set of inputs underlying internally generated motor programs; these programs themselves resulting from activity in the basal ganglia and cerebellum. Finally, E. R. Kandel, in "Cellular insights into the multivariate nature of arousal," describes some beautiful work on sensitization in *Aplysia*, examining the consequence of different sensitizing stimuli on different response sys-

tems. Since these invertebrates have nervous systems consisting of very few cells which tend to be large and identifiable, and since their behavioral repertoire is simple and limited, it has proved possible to arrive at an impressive level of understanding of the neural mechanisms involved.

The volume not only presents some of the best work to date on the relationship between physiology and behavior, but, perhaps more importantly, emphasizes the substantial problems that lie ahead for the neurophysiologist. As Barlow points out, when recording from peripheral cells it is clear to the experimenter what tasks these cells are required to perform, so that good questions can be posed that can usefully be answered. However neurophysiologists recording from cortical neurons are in quite a different position, since "we do not have even the first hint of a sensible theory of cortical function." Ratliff expresses related concerns, arguing that although the current analytic and reductionistic approach to neurophysiology has great strengths, it also has great weaknesses; the major weakness being the inability to show how the different parts of the nervous system are integrated into the behavior of the whole.

These concerns formed the basis of the discussion at the end of the symposium, which was skillfully led by McFadden. Many questions concerning information integration in the nervous system were raised, but few satisfactory answers emerged. There appeared to be a general consensus that major theoretical work will be required before a true understanding of the behavior of cortical neurons can be reached. As Barlow put it: "Sooner or later one's got to start thinking of what the nervous system does in logical terms, and not in terms of linear variables or variables that can be treated as linear."

Altogether this is a superb volume, informative and provocative. It is highly recommended for researchers in the fields of psychological and physiological acoustics.

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## Encyclopedia of Physics

Rita G. Lerner and George L. Trigg, Eds.

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XVI + 1157 pp. Price \$99.50.

The enormous expansion of the literature of physics during the twentieth century has made compact reference books on the field of great help to both students and lay persons desiring some acquaintance with the subject but unable to spend a lot of time delving into the standard texts and treatises. The present compendious volume is a welcome addition to the books of this kind. Its coverage is thorough but carefully chosen, and the articles are all of reasonable length. The contributors are competent and in many cases are distinguished physicists well known for their researches in the fields about which they are writing.

The person interested in acoustics will find twenty-five well written articles having a specific relevance to this field, and there are many others bearing in some degree on the subject of sound. Most of the principal articles on acoustics have been prepared by well-known members of the Acoustical Society.