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## Psychobiology—Behavioral Problems Seeking Biological Solutions

**Review By:** NORMAN M. WEINBERGER

**Review of:** Handbook of Psychobiology

**By:** Michael S. Gazzaniga; Colin Blakemore, . New York: Academic Press, 1975. Pp. xvi + 639 \$29.50.

The field of psychobiology, like Topsy, has simply "grewed and grewed." Contemporary psychobiology is a coalescence of parts of psychology, physiology, anatomy, biochemistry, zoology, neurology, and anthropology. Its scientists are generally conversant with more than one of these fields while its students are now explicitly educated as interdisciplinary problem solvers. The problem that draws upon such a wide range of science, that even demands it, is the problem of the biological bases of behavior, both human and nonhuman. Michael Gazzaniga and Colin Blakemore have provided a survey of much of this field in the *Handbook of Psychobiology*. While hoping to impart the vitality and indicate the rapid developments of psychobiology, the authors have also tried to give some timelessness to this volume by asking the 31 authors (themselves included) to discuss central issues in general terms, rather than to provide detailed data on narrowly denned topics. Their success is not uniform; several chapters fall short of this goal but are nonetheless informative and sometimes provocative.

The book contains 21 chapters, divided into four sections: "Foundations of Psychobiology," "The Chemistry of Behavior," "Vertebrate Sensory and Motor Systems," and "Integration and Regulation in the Brain." The level of discourse is generally beyond the purely introductory; in some cases it is quite advanced (e.g., "The Chemical Senses ..."). A few offerings do not demand prior knowledge of brain structure or function (e.g., "Do We Need Cognitive Concepts" by R. L. Gregory) but in most cases the reader is expected to have at least a general acquaintance with the brain. Space limitations preclude mention, much less discussion, of all chapters. Rather, I will try to indicate the scope and flavor of the book and touch upon a few important issues in psychobiology.

The initial chapter by Graham Hoyle concerns the psychobiology of invertebrates. However, its scope transcends any one animal form as Hoyle considers the point and counterpoint of reflexive behavior versus centrally programmed behavior, behavior that is governed mainly by sensory or motor "tapes," the role of environmental feedback in behavior, biological rhythms and behavior, and the genetic control of behavior. The writing is exemplary but Hoyle, an obviously ardent and enthusiastic booster of invertebrates, may hope for too much. He argues that fundamental principles of neural organization are obtainable at the cellular level only in invertebrates. While the successes in understanding the nerve impulse in the squid giant axon and visual transduction in the *Limulus* eye should be appreciated and applauded, one may question the extent to which general organizational principles will prove to be the same for animals having a relatively small number of neurons (many of them highly specialized) and those mainly backboned creatures having a much larger complement of neurons. For example, Hoyle's review reveals something of the way decisions to act are made in invertebrates. The common mechanism is exceeding the threshold for firing of either a key interneuron, or a cluster of interneurons that act as a single unit because of extensive electrotonic coupling among themselves, (p. 46). Is this likely to hold for the vertebrate brain, which apparently has few if any command interneurons?

In the next chapter, Land finds apparently remarkable similarities in the ways that the hover fly and man use vision in performing similar kinds of behavior. Land points out that one might have expected different strategies of visual control between the two animals because of the independent motility of eyes, head, and body in man; a fly has to move its body to change its view. He also points out that these similarities need not imply that visual motor control in fly and man have a common ancestor, but rather that visual processing itself has specific requirements (e.g., maintenance of a clear image). Thus, while it is intriguing that vastly

different animals have solved common problems in the same general way, it does not always follow that the "simple" animal can serve to explain the "complex" animal.

The authors' decision to begin this handbook with two chapters on invertebrates presumably reflects their view that the foundations of psychobiology lay therein. If one views the field of psychobiology as the biological bases of behavior, then the study of invertebrates becomes part of the field, rather than holding primacy as a foundation. This view reduces the tendency to see invertebrate psychobiology as being particularly critical to the understanding of *homo sapiens* and indeed relegates the latter to its appropriate place in the scheme of things, a particularly interesting species to be sure, but nevertheless not the pinnacle of evolution much as we may wish it were so.

Hirsch and Jacobsen, writing on neuronal development, hypothesize that neuronal invariance and variance are the properties of two types of neurons, "macro" and "micro" neurons, respectively. Large neurons with long axons are seen as providing the relatively inflexible structural matrix of the nervous system whereas small interneurons are considered to be highly modifiable during development, and to provide the flexible brain components that provide plasticity. This is an intriguing conjecture that, if true, would unify a vast amount of findings from disparate areas. The theme of behavioral and neural plasticity is echoed throughout this volume.

The second section contains three chapters relating to the chemistry of behavior, a field that has grown enormously in size and interest during the past decade. The first two chapters by the Iversens are devoted to the mapping of chemical pathways in the brain and relationships between neurotransmitters and behavior; the two could easily have been combined into one. The material is current but the first chapter would have benefited from additional references that would allow the reader to pursue a topic. The second chapter presents an extensive array of findings and possible interpretations, largely of studies in which pharmacological agents are used to modulate neurotransmitter function. Unfortunately, in many cases the field has not yet developed to the point where all of the effects of a drug are known. Also, drugs often have less specific effects on neurotransmitters than desirable. Thus, interpretations of drug action on behavior often involve equally strong evidence on both sides of the issue. The Iversens' discourse alerts the reader to this situation.

Etingh and five other authors provide a highly perceptive and critical review of biochemical approaches to memory. The authors urge extreme caution in interpreting findings as demonstrations of neurochemical bases of memory and provide guidelines for recognizing "learning-related cerebral neurochemical events." Although the memory-transfer and memory-molecule claims of some workers are not directly reviewed, the lesson of this chapter is clear and unambiguous; determining that memory is chemically based is an extraordinarily difficult task that has yet to be achieved. Together, these chapters adequately reflect much of the current state of affairs in one of the "hottest" areas of psychobiology. One is left wishing for more (e.g., consideration of neurochemistry and human behavior).

The third section has seven chapters confined to vertebrate sensory and motor systems. Blakemore and Stuart Antis, in successive chapters, each examine problems of visual sensation and perception. Recent years have seen an extraordinary amount of research on the visual system, particularly on the receptive field properties of single neurons. Much of this research, reviewed by the authors, has been interpreted as indicating that single neurons function as specific "feature detectors." Both Blakemore and Antis point out, however, that higher visual processes (i.e., much of what is considered "perception") cannot be explained by even the most complex connectionistic schemes that rely on feature detectors alone.

Wall's chapter on the somatosensory system is confined largely to the mainline dorsal column subsystem, but this is used in an elegant manner to investigate attempts to assign function of a submodality to a particular anatomical component of the nervous system. Wall concludes that the classical view that "each sensory modality has its own sensory projection system" is inadequate. He further states that the roles of both the ascending and descending

components of the somatosensory system need to be investigated in behaving animals during both learning and the process of discrimination, "not an easy task." These conclusions reinforce the continuing advance of the field of sensory physiology from the purely neurophysiological to the truly psychobiological.

This section ends with Bizzi's discussion of control of eye-head movement. Bizzi reiterates an important issue raised by Hoyle at the beginning of the volume (i.e., the extent to which a given behavior is under the control of sensory feedback as opposed to being run off as a "motor tape" which is completely specified by central processes). He shows that eye-head coordination is controlled differently according to different behavioral situations. Land's chapter on visuomotor behavior in the fly and man might better have been placed with this one.

The final section, "Integration and Regulation in the Brain," covers diverse topics, all anchored in psychology. Berlucchi and Buchtel review the neural bases of learning from a highly narrow and uncritical point of view. Changes in visual neuron receptive fields due to sensory deprivation are taken to indicate that "a decrease in synaptic efficiency" is a "basis for learning." Current research in learning does involve a great deal of effort in electrophysiology, including attempts to relate the activity of single neurons or groups of neurons to acquired behavior; regrettably this approach is not discussed. References' to reviews that do cover this and other approaches to learning simply do not serve as adequate substitutes.

Schacter considers one facet of motivation and emotion, the James-Cannon controversy between peripheral (visceral) and central (brain) explanations of emotion, respectively. Schacter points out that neither view accounts for experimental findings; even behavioral patterns evoked by central (e.g., hypothalamic) stimulation through the same electrode will vary according to the context (situational stimuli) in which an animal finds itself. While this chapter comes close to realizing the editors' hopes for fundamental consideration of central issues (no pun intended), it seems a bit dated; the most recent paper cited was published in 1966.

Gazzaniga deals with perhaps the most far-reaching issue in psychobiology, localization of function, and asks just what is supposed to be localized? He finds that "... systems in the brain which are involved in conducting primary input (and output) messages are susceptible to dramatic breakdowns in function and these can be easily localized and detected." But, he adds, when behavior involves concept formation, logical capability, etc., the information channels involved are not easily, if at all, identified. Gazzaniga implies that despite the acquisition of data from the "split-brain" human, and the like, apparently we still require a "far more sophisticated set of concepts and ideas ... to penetrate ... the problem of brain and behavior."

While this volume does provide a good view of much contemporary psychobiology, it may not be regarded as a "handbook" in the sense of the term as generally used in that it ignores large segments of the discipline (e.g., behavioral genetics and the use of genetics as an analytic tool to understand behavior, species-specific behavior including territoriality, aggression, sexual behavior, eating, drinking, and relevant aspects of neuroendocrinology). A specific consideration of organismic adaptation and the evolution of behavior would certainly be obligatory in a handbook of psychobiology. The present volume is useful in depicting much of current research in the discipline, and because several of the chapters deal broadly with fundamental conceptual problems as well as contemporary data, it may have a certain timelessness.

**Biographical Information for Authors:** Michael S. Gazzaniga is Professor of Psychology at the State University of New York, Stony Brook. A PhD of California Institute of Technology, he has held previous faculty positions at New York University and at the University of California, Santa Barbara. Gazzaniga is author of *The Bisected Brain* and of *Fundamentals of Psychology*. Colin Blakemore is University Lecturer in Physiology at the University of Cambridge, England. A PhD of UC Berkeley where he held a Harkness Fellowship, he has been a Visiting Professor in Psychology at NYU and at MIT. Blakemore received the 1976 Robert Bing Prize for Research in Neurology from the Swiss Academy of Medical Sciences. He contributed a chapter to R. L. Gregory and E. H. Gombrich's *Illusion in Nature and Art* and another to F. O. Schmitt and F. G. Worden's *The Neurosciences: Third Study Program*.

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