

aspects of the representation of a physical input to comply with different psychophysical tasks. He seems to be aiming toward a processing theory of psychophysics rather than the "true score" representation that seems to this writer to plague much of the formally interesting work in this area.

The second volume concludes with three comprehensive essays on vision, audition, and holographic memory models. The interesting way in which neural constraints interplay with mathematics is nicely illustrated, and these essays fill a void in the mathematical psychology literature.

Although the *Contemporary Developments* volumes do not accomplish their goal of assessing progress in the field, they do foreshadow a broader vision of what constitutes mathematical psychology. I do not know of any better source for acquainting readers with what has happened and what will happen in the applications of formal thinking in psychology.

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After Pavlov

Biology and Neurophysiology of the Conditioned Reflex and Its Role in Adaptive Behavior. PETER K. ANOKHIN. Translated from the Russian edition (Moscow, 1968). Samuel A. Corson, Ed. Pergamon, New York, 1974. xviii, 574 pp., illus. \$51. International Series of Monographs in Cerebrovisceral and Behavioral Physiology and Conditioned Reflexes, vol. 3.

Drawing mainly on classical Russian neurophysiology and over 40 years of experimental research, the late P. K. Anokhin here offers a synthesis of theory and data bearing on the nature of the conditioned reflex. Although published originally in 1968, the book will still be of interest to Western scholars. In it English-language psychologists and neuroscientists are treated to a thorough and unhurried survey of the study of higher nervous activity in the post-Pavlovian era by one of the most eloquent and influential workers in the Pavlovian tradition.

Heretofore, access to these developments has been piecemeal, being primarily by way of the reviews and surveys of the late G. Razran and the published proceedings of those symposia (starting around 1960), in which Anokhin invariably participated, which ushered in the age of East-West détente in the neurosciences. Though valuable, such sources do not adequately reveal to Westerners the issues that

have united and divided our Soviet colleagues. Konorski's books and translations of works by Bykov, Luria, and Sokolov provide clues, but in many ways these works seem too adulterated by Western viewpoints for this purpose.

Anokhin shows no lack of familiarity with Western neuroscience, but, although he attempts with varying success to incorporate information gathered from round the world, most of his arguments rest on the work of his own distinguished collaborators, who work in a wide range of fields including behavioral biology, developmental neurobiology, cardiovascular and respiratory physiology, experimental neurosurgery, clinical neurology, and electroencephalography.

Anokhin's thesis is that the conditioned reflex is a supreme expression of the adaptive evolution of the nervous system. Like all adaptive behavior, conditioned reflexes arise from a synthesis of two types of afferent information: input from the environment, with great emphasis on contextual factors, and feedback ("reverse afferentation"). These produce the pattern of preparatory reactions which constitute the conditioned reflex and assure its appropriateness to contingencies relevant to the survival of the organism.

I was struck by the similarity between Anokhin's viewpoints and those favored by Western cognitive psychologists and cyberneticists. For example, to Anokhin the essence of acquired adaptive behavior is the formation of an "action acceptor" responsible for harmonizing primary environmental information with feedback. The action acceptor is very much like the "plan" formed through TOTE (for "test, operate, test, exit") in the schema enunciated some years ago by Miller, Galanter, and Pribram. In short, Anokhin's conclusions about the processes involved in conditioning should be familiar to and sympathetically received by most learning theorists.

Equally comfortable are Anokhin's views on "internal" or conditioned inhibition. The Pavlovian dogma that inhibition originates at the analyzer of the conditioned stimulus is discarded. Instead, inhibition is regarded as resulting from the excitatory influence of a parallel but incompatible "functional system," a viewpoint shared by Konorski and others. As applied to alimentary conditioning in dogs, the inhibitory effect of nonreinforcement in the earliest stages of extinction or differentiation arises from the orienting reaction that inevitably accompanies "discordance" at the action acceptor. Discordance is essential for further development of a "secondary" or "indirect" inhibition brought about during the forma-

tion of a new action acceptor appropriate for nonreinforcement. Any procedure that minimizes discordance, such as Terrace's method of "errorless" discrimination learning, will yield little or no conditioned inhibition.

Anokhin's views on specific physiological mechanisms underlying conditioning and inhibition boil down to these essentials: Conditioning consists fundamentally of a molecular reorganization within the neurons that make up the functional system of the conditioned reflex. The energy expenditures necessary for discordance and conditioned inhibition involve a circuit from frontal cortex through hypothalamus to the reticular formation. Inhibitory influences might be of a hyperpolarizing nature when acting on effector units or of a depolarizing nature when high rates of synaptic input are involved. The latter mechanism is termed "pessimal" or Wedensky inhibition and is treated at some length by Anokhin in discussing dominant states of the nervous system.

As often as not, the train of logic from the experimental evidence presented to the particular conclusion it is meant to support becomes derailed in translation. It is the rich interplay with Russian neurophysiological traditions and schools of thought that lends force and urgency to Anokhin's arguments. This is not a reference work; to be fully appreciated or comprehended it must be read seriatim. It is a handsome volume, profusely illustrated with helpfully captioned figures. It includes good indices, a glossary, and an invaluable bibliography.

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Perceptual Psychophysics

Perception. Essays in Honor of James J. Gibson. ROBERT B. MACLEOD and HERBERT L. PICK, JR., Eds. Cornell University Press, Ithaca, N.Y., 1974. 318 pp., illus. \$14.50.

In the concluding section of his innovative text *The Senses Considered as Perceptual Systems*, J. J. Gibson wrote, "When the senses are considered as perceptual systems, all theories of perception become at one stroke unnecessary. It is no longer a question of how the mind operates on the deliverances of sense, or how past experience can organize the data, or even how the brain can process the inputs of the nerves, but simply how information is picked up. . . . The individual does not have

to construct an awareness of the world from bare intensities and frequencies of energy; he has to detect the world from invariant properties in the flux of energy" (p. 319). The study of visual space perception thus becomes equivalent to the task of specifying the information contained especially in the moving optic array and the kinds of information that in fact are usable by the organism—that is, a perceptual psychophysics relating invariants in the optic array to unique perceptual states.

This new psychophysics has inspired many creative contributions to the study of perception, a reasonable sample of which is contained in this festschrift in honor of Gibson. But it is doubtful that it, anymore than the old psychophysics, can escape the trend toward reduction, not necessarily in terms of physiology (for not enough is known about brain processes that might underlie information extraction), but rather in terms of a developing theory of cognitive processing. After all, the use of information by a computer is contingent not merely on the presence of information in the input channels, but on the state of the central processor as well. Only by modeling the central processor will we have the ability to explain the boundary conditions beyond which information pickup fails, and within which lies the range of usable information. Of course, once central processing is admitted a variant of Helmholtzian inference is inevitable, but in this case inference proceeds not from sensations but from information, a significant departure from classical theory.

The festschrift, a collection of 16 essays, touches on many aspects of Gibson's theorizing, historical, philosophical, and empirical. Notable instances of critical commentary are Mary Henle's dialog-discussion of the Gestalt notion of organization and her challenge of naive realism, as implied in Gibson's view of perception as direct and unmediated and the chapter by the art historian Gombrich on the possibilities for perception where there is little information to be extracted from the optic array. Most of the contributions are consonant with the Gibsonian view, and there is little effort aimed at establishing what it is that would constitute negative instances to the various propositions. Nevertheless, the papers presented are important ones for all students of perception. These range from an elegant treatment of transparency by Matelli to papers on visual coding of nonvisual spatial information by Pick and factors affecting brightness judgments of a surface by Beck and an ingenious analysis of the perceptual effects of the distribution of vanishing points in perspective representations by John Hay. The contribution by Hochberg deserves special mention. Here

one finds a concise and informative comparison of the empiricist theory of Helmholtz with the main premises of Gibson's psychophysical theory and a comparison of the latter with certain aspects of the probabilistic functionalism of Egon Brunswik.

All in all the festschrift provides an excellent account of the influence of J. J. Gibson's perceptual psychophysics in contemporary perception research.

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The Family Canidae

The Wild Canids. Their Systematics, Behavioral Ecology and Evolution. M. W. Fox, Ed. Van Nostrand Reinhold, New York, 1975. xviii, 508 pp., illus. \$19.95. Behavioral Science Series.

Members of the family Canidae inhabit every major continent, including Australia, where dingos and foxes were introduced by man. Except for the domestic dog, "man's best friend," the majority of species have a poor reputation in folklore and mythology, being credited with possessing most undesirable human traits, such as cunning, deceptiveness, viciousness, and unpredictability. Paradoxically, recent research on behavioral ecology of canids has emphasized the evolution of sociality and cooperative behavior in this group, since the modal breeding system is monogamy and both parents and older juveniles contribute to the rearing of young. In addition to having this advanced social organization, the canids, of course, are primarily carnivorous, a fact that has provoked some authors to suggest that in order to understand human behavior it is as important to analyze the social behavior and ecology of a wolf pack as those of a gorilla group. Thus the Canidae are an interesting group for study by ethologists, ecologists, and sociobiologists and the publication of a volume devoted to this family is welcome.

The strength of this book lies in its diversity. Canid physiology, systematics, evolution, ecology, and social behavior are all covered by authors whose areas of expertise and approach vary widely. Some chapters are reviews and others are reports of original research.

The chapters on the ecology of particular species form the core of the book; the reviews of the different foxes stand out for their thoroughness (Ables, Chesemore, and Trapp), including material on denning habits, home range size, feeding habits,

and reproduction. There are also four chapters devoted to feral dog ecology and behavior; these research efforts on dingos in Australia (Corbett and Newsome) and feral dog populations in the United States (Beck and Nesbitt) suggest that dogs do not exhibit a social organization similar to that of wolves, thus raising again the eternal question whether the domestic dog is descended from the wolf or another, now-extinct canid.

Social behavior, as such, is not well represented in this volume, but a chapter on golden jackals (Golani) and one on a captive wolf pack (Zimen) are valuable because of their emphasis on individual variability and social dynamics. Ethologists like to generalize about species-specific behavior; both these chapters, but especially Golani's, remind us that individuals differ from each other and thus social relationships will always be somewhat unpredictable. Two chapters on foxes emphasize behavioral differences as well (Keeler, and Belyaev and Trut), but relate these to physiological differences resulting from selection by man.

Canid systematics is best represented by several chapters on anatomical differences within the genus *Canis*. Unfortunately none of the other taxonomic papers adequately discuss the relationship between the Asiatic dhole, the African hunting dog, and the South American bush dog. These three forms were originally lumped into a single subfamily, but anatomical, behavioral, and chromosomal evidence increasingly indicates that they are unrelated. This fact is mentioned by Langguth when reviewing the South American canids, but in the chapter on taxonomy by Stains and that on chromosomes by Chiarelli the outdated classification is used. Moreover, Fox presents a tree of evolutionary relationships of canids in his chapter on canid social evolution that is different yet again from those of the other authors. For the reader unfamiliar with the family, these differences may prove confusing.

Although this book includes much useful information on canids, it has some drawbacks. The editor did not attempt to integrate the various chapters, and the volume lacks cohesion. Also, there are an inordinate number of typographical errors and misspellings in the book. This is worth mentioning only because the misspelling of Latin names (for example *Otocyon megalotis*, *Dusticyon*, and *Atelocynus microtis*) and even authors' names, in a volume that will be used as a reference work, creates errors that will be perpetuated.

The foreword is by Konrad Lorenz.

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