remains inexplicit. The second, much more serious, filled with logical structure and categories and definitions, underlines all the issues with heavy crayon. Both books have plenty of epigraphic quotations: the first runs to the Book of Job, Jean Giraudoux, Pasternak, and the *Gita*; the second, to Longfellow, John Haynes Holmes, Teilhard de Chardin, and Shelley. The first is illustrated with photos and line diagrams alone; the second has as well a set of air-brush paintings of remote fantastic planetary surfaces complete with strange ships and fierce beams. In the first book, we learn that the machined steel block kept in the Salzburg Museum as an artifact of the Carboniferous era is a fake. In the second, it is "Dr. Curlt's Cube" and described with quotes. Ordway and MacGowan are not credulous; they don't believe it either, but they don't say so because they have no clear basis in citation. The second book is somehow both indulgent and official. It quotes the Air Force at length, quite interestingly, upon saucers. It is tight in outline and structure, but wordy in text. It is rather diffident in comment, especially on the general foolishness of the Russian answer to the UFO, the Great Tunguska Meteor, seen by some over there as a space-ship crash. It comes out of a world of military intelligence, of big film studios, of Air Force translations, of astronautics, of position papers, library searches, programs and planning. If it suits your taste, it will be an equally useful source of the canon of speculation in this strange field.

No question exists in my mind that these books presage a future science. It isn't here yet. With last year's popular success *We Are Not Alone*, I hope the market will feel replete. Certainly there is a choice for readers of many tastes, romantic, cinematic, or journalistic. The science is yet to be born, but the literary genre is already mature. The books reflect our world, not "theirs." Will the critics remain far behind?

## Function and Structure in Physiological Psychology

The science of psychology may be classified in a variety of ways, for instance as social, behavioral, biological, mental, philosophical, or even humanistic (*1*). All but the biological approach, Joseph Altman insists, segregate psychology from its proper status as one of the life sciences. He strives to integrate psychology and biology in **Organic Foundations of Animal Behavior** (Holt, Rinehart, and Winston, New York, 1966. 544 pp., illus. $12.95).

To read the book is to marvel at the prerequisite Altman sets for himself and his peers. He states (p. 19):

> It is not our task to deal here in detail with the great wealth of biophysical, biochemical, and biological studies that are relevant to an understanding of organic structure and function, though familiarity with these findings is an absolute prerequisite to an understanding of the organic foundations of behavior.

Those familiar with the Darwinian influence in American psychology and with the systematizing tradition laid down by William James (*2*) in his *Principles of Psychology* will not find Altman's approach novel. Indeed, there are several striking parallels between the 1890 approach of James and the 1966 approach of Altman. Some of the more fundamental of these parallels will be considered later in this review. First, let us examine what Altman has accomplished in "over a decade" (p. ix) of self-education, writing, and rewriting.

Organisms, according to Altman, are complex, self-regulating, material systems. They are divisible into constituent elements on the one hand and organized subsystems on the other. In addition, they possess organizing properties not found in physical matter. The study of the organic foundations of behavior, Altman goes on to say, must be analytical (reductive to constituent elements and mechanisms), correlative (comparative within a particular level of organization), and teleological (functional within and between hierarchic levels of organization). Structures, processes, mechanisms, and functions of living matter are then described, beginning with the atomic elements found in organisms and including, in turn, inorganic and organic molecules; vegetative processes and animative activities; the senses, motor apparatus, neurons, glia, and neuronal organization; control by spinomedullary, paleocephalic, and neencephalic systems; organismic programming of transactions with the external environment; and, finally, four functional systems of behavior, self-preservative, species-preservative, group-forming and maintaining, and external-environment-mastering.

There is, however, unevenness in the treatment of particular topics. Altman is clearly on his home range when he discusses the structure of sensory apparatus and the structure of the nervous system. Insofar as he treats behavior in the context of such structural discussions, the text moves along in lively and comprehensive fashion. Perhaps the major omission is the lack of reference to Dethier's research (*3*) on motivation in the blowfly. By remarkably painstaking techniques, Dethier is rapidly closing in on both the internal factors and the external stimulus properties controlling the ingestive behavior of the blowfly. In view of Altman's biological orientation, the omission of such important work by an experimental zoologist and psychologist must be counted a fault. On the positive side, consideration is given in the book to the findings of E. Stellar, P. Teitelbaum, and A. N. Epstein, fellow faculty members of Dethier's at the University of Pennsylvania.

In contrast to his discussions of structures, Altman's teleological statements are jarring, despite the analogy of negative feedback. At best such statements call attention to problems requiring quantitative study. Presumably the thoroughgoing biological functionalist will approve of the teleology, and the thoroughgoing biological mechanist will dismiss it.

Although Altman does an acceptable job on motivation and learning in the context of organic structure, his treatment of learning as a subject matter in its own right (pp. 343–57) is technically erroneous and disappointing. Extinction, for example, is equated with inhibition (p. 350). Pavlov himself wrote (*4*, p. 49):

> This phenomenon of a rapid and more or less smoothly progressive weakening of the reflex to a conditioned stimulus which is repeated a number of times without reinforcement may appropriately be termed *extinction of conditioned reflexes*. Such a term has the advantage that it does not imply any hypothesis as to the exact mechanism by which the phenomenon is brought about.

To equate extinction with inhibition, as Altman does, misses the whole point of Pavlov's contribution to the measurement of behavior.

Even more erroneous is Altman's misreading of B. F. Skinner (*5*). Skinner's singular contribution to the measurement of learning and behavior, rate of response, goes unmentioned, but "Skinner box" (p. 353) and "schedules of reinforcement" (p. 354) are mentioned. Admittedly, Pavlov and Skinner themselves have contributed to the kind of confusion reflected in this book, Pavlov by physiologizing and Skinner by emptying the organism and misdirecting his criticisms at the apparatus and procedures of others. Nevertheless, a comprehensive survey of the sort attempted by Altman should do more than perpetuate confusion.

The parallelism in the concluding paragraphs in James's *Principles* (*2*, vol. 2, pp. 688–9) and Altman's text (p. 469) is startling. Both give empirical and logical priority to structure ("nervous system," "neurology"). Both are at great pains to point out how little we know about mental function ("psychogenesis," the "psychic"). Both end on a note of despair ("'utter night'," and "cannot be resolved"). In view of the despair of both James and Altman, it is my opinion (*6*) that physiological psychologists, indeed all scientists, should consider assigning the same reality status to function as they do to structure.

The feeling one has as one reads the book is that it is a solid (structural) book, solid to heft and solid to own. It contains separate author and subject indices, a 36-page bibliography, lists of suggested general readings, many illustrations, and much information. It should prove useful for teaching and for the researcher who wants to know what has been happening recently in physiological and comparative psychology.

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2. W. James, *The Principles of Psychology* (Holt, New York, 1890; 2 vols.).
3. V. G. Dethier, *Science* **143**, 1138 (1964).
4. I. P. Pavlov, *Conditioned Reflexes* (Oxford Univ. Press, London, 1927).
5. B. F. Skinner, *The Behavior of Organisms* (Appleton-Century, New York, 1938).
6. W. C. Stanley, "A Mathematical Analysis of the Function-Structure (Wave-Quantum) Problem in Science," in preparation. Compare Dethier's statement that ". . . there is more to the behavior of insects than systems analyses and unit neurological analyses reveal" (*3*, p. 1145).

## Mathematical Activity in England

E. G. R. Taylor's **The Mathematical Practitioners of Hanoverian England, 1714–1840** (Cambridge University Press, New York, 1966. 519 pp., illus. $16.50), a sequel to her *Mathematical Practitioners of Tudor and Stuart England* (Cambridge University Press, 1954; shortly to be reissued) is the swan song of a remarkable woman who did much to create the modern science of geography in the early years of this century and subsequently developed a consuming historical interest in cartography and navigation. Her *Haven-Finding Art* (1957) will be familiar to many, and indeed it was as an offshoot of her researches into navigational techniques, maps, instruments, and teaching methods in post-medieval England that her interest in the lower echelons of practicing mathematicians developed.

Taylor's earlier volume on mathematical practitioners struck a rich vein in chronicling en masse the many mathematics teachers, textbook writers, map- and instrument-makers, and engineers who during the 16th and 17th centuries, it could be argued, laid the foundation for England's maritime supremacy and scientific prominence by 1714. Skillfully filling in the background of a period she knew so well, Taylor unearthed a great deal of informatory detail relating to the life and work of the humble practitioners to whom she was determined to accord due recognition. The pattern she there established, in which a set of prefatory general essays introduce a series of lists of potted biographies and a calendar of books and pamphlets published, is now (with some modification) repeated in this continuance of the story up to 1840. Over the preceding century and a quarter the careers of some 2270 who, for want of a better phrase, "practiced" mathematics are traced. Taylor, it would be fair to say, does not refute the accepted view that 18th-century England was a mathematical backwood, but at least she reveals that the wood was alive with activity, not usually well directed, of all kinds.

The two volumes share a basic weakness. The mathematical practitioners they study were never more, at any time, than an ill-assorted, motley group with no real unifying bonds of education, social class, political influence, or intellectual parity: indeed, they achieved true identity only about the beginning of the 19th century when they splintered into the autonomous professions of surveyor, architect, engineer, actuary, draftsman, and others. The net which seeks to trap discordant elements must perforce be both wide and full of holes. Taylor has inevitably, in her determination to miss not a one, caught some surprises in hers, from Isaac Newton and Benjamin Franklin down to William Herschel and the infamous Captain Bligh of the *Bounty*, but has lost, for example, the émigré Huguenot Abraham de Moivre, who trod the streets of London many long years between the houses of his pupils. In the more conventional entries, too, a certain incompleteness of information and false emphasis are apparent. (We are not told that John Harris in 1702 wrote the first vernacular tract on fluxions or that Edmund Stone's greatest gift to his contemporaries was his English version of L'Hôpital's *Analyse*.) On the whole the fine, flowing prose of the more general essays hides their tendency to be mere scrappy running commentary on particular events or situations (the activities of the Admiralty's Board of Navigation, typically, or particular refinements in contemporary instrumentation). No profound assessment is made of the dampening effect of the lack of systematic mathematical education in either school or university, or of the cumulative influence of the writers of popular textbooks in bowdlerizing mathematical taste. Like its predecessor, the newer book will find its main use as a directory but is not adequate to do more.

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## Statistical Mechanics

During the last few years the literature on general statistical physics has been enriched by various contributions. It is, however, only in relatively few of the monographs that one finds a serious attempt towards a synthesis of the macroscopic concepts of nonequilibrium thermodynamics and the concepts of statistical mechanics based on the ensemble theory. Wolfgang Yougrau, Alwyn van der Merwe, and Gough Raw's **Treatise on Irreversible and Statistical Thermophysics** (Macmillan, New York, 1966. 288 pp., illus. $9.95) constitutes a valuable attempt in this direction. At the same