Book Reviews

Animal Learning

The Psychology of Animal Learning. N. J. MACKINTOSH. Academic Press, New York, 1974. xiv, 730 pp., illus. $18.50.

In physiological fields, there is seldom disagreement about the basic nature of a process and what is relevant to it. The study of animal respiration, for instance, deals with the anatomical and biochemical factors involved in oxygen intake and distribution. In principle, the study of animal learning ought to be similarly unified, since learning is the biological process by which animals adapt to causal relationships they encounter during their lifetimes. But in practice the factors that can supply coherence to learning are far more ephemeral than those that supply coherence to physiology and there is remarkably little agreement about the nature of the learning process.

The wide variety of tasks that investigators can invent and somehow induce animals to learn do not easily lend themselves to scientific organization. Consequently most students of learning structure their field by relatively artificial means; they tend to specialize in relatively narrow sets of problems, adhere to arbitrary theoretical positions, and define most of the rest of the field as irrelevant. The two leading schools of the last three decades, the Hullian and the Skinnerian, have been so far apart in their methods and ideologies that they seldom have interacted scientifically. Others are concerned with minitheories, theories so narrow that they hardly extend beyond the data on which they are based. Indeed, a growing number of scientists are beginning to feel that learning is not a process, like respiration or digestion, but a catchall term that refers to a large number of separate evolutionary adaptations to particular types of environmental situations.

In spite of all this, Mackintosh is an adherent of the traditional belief that learning is a general process that applies to many species in wide varieties of learning situations. In that spirit, he has written a critical review of the animal learning literature, selecting topics likely to interest those who share this belief: classical conditioning, instrumental learning, incentive, conditioned reinforcement, frustration, avoidance, punishment, contrast, extinction, generalization, and discrimination. He has avoided topics of interest to those concerned primarily with species differences in learning or with types of animal learning uniquely relevant to human behavior. A noteworthy omission is the exciting recent work on the learning of sign language by chimpanzees. Those, like this reviewer, who agree with Mackintosh's goals will regard his selection of topics as appropriate. Those who do not consider learning to be a general process or who believe that the traditional topics are unimportant will regard his book as a last hurrah.

Although Mackintosh's subject matter is traditional, he departs significantly from the behavioristic strategy that has been dominant among those who regard learning as a general process. Historically, the hallmark of behaviorism has been the belief that learning consists entirely of changes in muscular and glandular reactions. Because the ancient belief in a separate process of acquisiton of knowledge (or association) has been correlated with a mentalistic metaphysics for the last two millennia, it has been anathema to behaviorists. The definitive evidence summarized by Mackintosh that learning can occur in the absence of muscular or glandular reactions has usually resulted only in grudging minor revisions of most behavioristic positions. Mackintosh, however, supports the older theory that a common association process underlies all learning about sequences of events even when the resulting changes in behavior are as different as in the following sequences: a light cue followed by a sound, depression of a lever followed by food, a buzzer followed by painful electrical shock, a taste experience followed by sickness. Unlike traditional behaviorism, this approach prevents the similarities in different learning situations from being obscured through an overconcern with the details of how behavior changes. The differences in behaviors produced by a common association process can then be treated in detail, but as a logically separate issue. In this way, Mackintosh integrates a great deal of old and new material far more successfully than behaviorists do.

The style often is telegraphic and there are no major theoretical themes other than associationism. Therefore I found the many extremely sophisticated analyses of scientific papers and subdisciplines difficult to read and occasionally, when the material was new to me, I needed to consult the original sources. But this effort was well worthwhile. There is little nitpicking and hence the frequent severe criticisms of parts of the learning literature are very telling. However, I felt that the evaluation of operant schedules of reinforcement was so hypercritical as to be unfair and that the treatment of probability learning was superficial. Since there are no blatant errors, these feelings probably reflect my personal biases, and other readers may have different biases.

This book will become very influential if only because it has no competitor now and will probably not have one soon. Few have the breadth of knowledge and sophistication to survey the literature as Mackintosh has. The only likely alternative to his book would be a collection of chapters written by specialists in different aspects of learning. Although individual chapters in such a book might well be even more sophisticated than those in Mackintosh's, there also would be much less coherence. On a number of occasions, Mackintosh points up similarities in work done by investigators with different ideologies. For instance, Hullians and Skinnerians have both been concerned with causing animals to emit behaviors that produce painful electrical shock, but each group has seemed ignorant of the work of the other. This material, which probably would be in different chapters of a multiauthored survey, is in a single section of Mackintosh's book. Mackintosh also has carefully explained the similarity of the Hullian study of frustration and the Skinnerian study of contrast, two similar topics studied independently for over a decade. Such features ensure that any experienced investigator of animal learning will gain important new insights from reading this book.

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Iron as a Metabolite

Microbial Iron Metabolism. A Comprehensive Treatise. J. B. NEILANDS, Ed. Academic Press, New York, 1974. xviii, 598 pp., illus. $42.

The amazing versatility of iron as a metabolite can be best appreciated through a consideration of its various roles in the life support systems of prokaryotes. The need for a treatment of microbial iron metabolism that can facilitate such consideration

while providing a readable general introduction to what has happened in the recent past in various areas of research on iron metabolism seems to be well satisfied by this treatise. Established authorities provide 20 chapters on all pertinent and currently active aspects of microbial iron metabolism studies, ably organized by the editor, who has contributed the introductory chapter on the general nature of biological iron and its participation in microbial physiology. A casual inspection of the chapters that follow, grouped under the headings of transport, biosynthesis and storage, iron enzymes and proteins, reactions of inorganic substrates, and medicine and chemotherapy, makes it clear that no one reviewer can comment authoritatively on how well the various contributors serve their particular fields. This reviewer, however, has received a generally favorable impression of the sections of the book that cover ground with which he is familiar and has derived considerable enlightenment from portions devoted to unfamiliar aspects. In general, each contributor—in addition to offering adequate factual coverage—has attempted to evaluate the status of his subject. Thus the statement on the jacket that this "is certainly a volume that points the way to future research" is accurate.

Whatever criticism there may be of this effort to present a complete picture of current and past research on iron in living systems must have more general than specific bases. Research on many relevant subjects—one may mention transport, biosynthesis, the iron-sulfur enzymes (such as ferredoxins, "HIPIP," nitrogenase, hydrogenase, and glutamate synthase), the prokaryotic cytochromes, and oxygenases—is in a state of rapid flux and development, and reviewers of such subjects can at best present progress reports with limited opportunity for systematic organization of material. Here and there one may also point to omissions or ask for further clarification. For example, in the introductory chapter, which contains a very brief presentation of inorganic iron chemistry, one might suggest that there be mention of phosphorus-containing ligands as iron chelates to go along with the excellent summary of ligand chemistry involving oxygen, nitrogen, and sulfur ligands. In the following treatment of iron-limited growth, no mention is made of studies on the interesting situations that arise in dealing with nutrition of photosynthetic bacteria wherein iron limitation places a unique stress on microorganisms faced with the necessity of reaction-center biosynthesis.

Sections that are particularly informative on topics of current interest are those on the genetics of nitrogen fixation, nonheme iron in respiratory chains, cytochromes, nitrogenase, and hydrogenase (all research areas of rapid growth and change).

The text is readable, and typographical errors are less frequent than is usual in a first edition. It is likely that the sections concerned with very active researches will experience rapid obsolescence, but there are major portions that probably will not require drastic updating for a reasonable time. This treatise should be a helpful source of information on all aspects of iron metabolism, not only for investigators interested in prokaryotic iron metabolism, but also for researchers looking for clues to the solution of problems involving the physiology of iron in eukaryotic systems.

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Studying Free Radicals

Microwave Spectroscopy of Free Radicals. ALAN CARRINGTON. Academic Press, New York, 1974. xii, 264 pp., illus. $12.50.

The author of this book successfully draws together the threads of a diverse subject. Microwave spectroscopy of stable gaseous molecules has been pursued actively by spectroscopists since the end of World War II (which gave birth to the klystron oscillator, the microwave spectroscopists' first practical energy source). Spectral transitions between angular momentum states of overall molecular rotation are interpreted to give precise information on molecular geometry. Similar studies on free radicals are of more recent vintage. With two exceptions (CF_2 and SiF_2), the free radicals discussed in this book are diatomic or triatomic open-shell molecules. The coupling of the electronic angular momentum contributed by the open shell structure with that due to nuclear rotation, vibration, and nuclear spin produces a molecule of delightful spectroscopic complexity. Only a few of the myriad of microwave transitions have been studied in any of the free radicals, yet a wealth of structural and dynamic information has been deduced. The spectroscopic investigation of free radicals in the laboratory should receive a major impetus from radioastronomers who have detected microwave emissions from radicals such as OH and CN, as well as from some as yet unidentified species, contained in interstellar gas clouds. Microwave spectroscopy of free radicals (which are nearly always unstable, transient species) in the laboratory is not trivial from the experimental point of view, and there is a distinct possibility that a large proportion of such measurements will be made in the near future with radiotelescopes.

After an introductory chapter in which the theoretical principles underlying microwave spectroscopy are reviewed briefly, the second chapter deals with experimental aspects of the various approaches to gas-phase free-radical microwave spectroscopy. An experimental approach that depends upon the molecular paramagnetism that arises from the open shell structure (developed largely in the author's laboratory) is particularly suitable for short-lived species. Magnetic tuning of the energy levels allows fixed microwave frequency operation in a compact resonant cavity. Also described are the recent uses of far-infrared lasers as energy sources, as well as microwave/optical double resonance methods. The theory of molecular energy levels is outlined in chapter 3, which includes a brief discussion of the various Hund coupling cases that is important for the later interpretation of free radical spectra. The final chapters of the book, 4 and 5, are devoted to the presentation and analysis of the spectra of diatomic and triatomic radicals, respectively.

This is not a heavily theoretical book; rather, it provides a good overview of the status of work in the field, as well as an introductory guide to gas-phase free-radical spectroscopy.

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Effects of Power Plants

Thermal Ecology. Proceedings of a symposium, Augusta, Ga., May 1973. J. WHITFIELD GIBBONS and REBECCA R. SHARITZ, Eds. U.S. Atomic Energy Commission, Oak Ridge, Tenn., 1974 (available as CONF-730505 from National Technical Information Service, Springfield, Va.). xvi, 672 pp., illus. Paper, $13.60. AEC Symposium Series, 32.

The rapidly expanding electric power industry, with its large steam generating stations that emit about two-thirds of the fuel energy into the environment as waste heat, has prompted concern for the thermal integrity of natural waters used for cooling. There has been an unprecedented rush to study power station effluents throughout North America, encouraged and often required by regulatory agencies. Largely