sizes of collections when the information was available. The brief description of climate and soil is very useful but also shows how little we know. One chapter shows the geographical affinities of the flora, which, not surprisingly, demonstrates the close relationship with the vegetation of the east and west facing slopes of the Andes further north. Of special phytogeographical interest is that 7 percent of the Fuegian taxa show affinities with the flora of the islands surrounding Antarctica, including New Zealand and Southern Australia. The short summary of the principal vegetation zones, the base for a systematic study of the plant communities, is helpful, and the index of Indian names and uses of plants is an interesting feature not frequently found in a flora. Still another important asset is the comprehensive bibliography. The difficulties that have been overcome by the author in compiling this bibliography can be appreciated only by someone who has tried to find bibliographic information in poorly funded university, government, and private libraries of South America.

The systematic account includes all the 545 recognized species in Tierra del Fuego; of these 128 species have been introduced, accidentally or deliberately, from Europe. The keys are workable, and the numerous illustrations are superb. The many distribution maps and habitat indications make this flora a tool that can be used by any person with a simple dissection microscope and some biological training, although the inclusion of a detailed map of Tierra del Fuego would have been desirable. Too many of the habitat indications are difficult to localize.

The book has only one shortcoming that should be mentioned. This is the lack of any Spanish translation. Many persons in Argentina and Chile who might be interested in using this flora are not in full command of the English language. A translation of the description of the vegetation zones and the principal plant communities would have been a valuable addition, as would a Spanish version of the glossary to the systematic account, since many of the terms are not easily found in general dictionaries.

As it is, Moore's *Flora of Tierra del Fuego* is a beautiful and important work that will play a major role in the further exploration of the ecosystems of the southern tip of South America.

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The Psychology of Learning

Conditioning and Associative Learning. N. J. MACKINTOSH. Clarendon (Oxford University Press), New York, 1983. viii, 316 pp., illus. $29.95. Oxford Psychology Series, No. 3.

Concern with conditioning and learning in infrahuman animals has a long and rich heritage. One can trace its origins in the associationism of British philosophy and in the reflex view of Russian physiology. For many years it was the dominant strand of American psychology. All of these traditions have sensed the importance of adaptation of the individual organism by learning from its experiences. They have shared the view that understanding the way in which learning occurs is a first task in understanding behavior and experience. And they have shared the view that a major example of such learning is conditioning and the formation of associations.

During the middle of this century this view was so prevalent that laboratory experimental psychology was almost coextensive with the study of learning. Great promises were made, grand schemes were constructed, and hopes ran high that all of behavior could be understood in terms of conditioning. Every psychology student knew well the names of Hull, Guthrie, and Tolman, not to mention Skinner and Pavlov. Yet today much of that is changed. Animal learning is not the "hot" area of experimental psychology, and the names of workers in the field hardly roll off the tongues of students. It is still not entirely clear what happened. Partly graduate students were attracted by competing fields that seemed to offer promise: cognitive psychology and neurobiology. Partly, the study of conditioning did not make good on its overzealous promises of application to all of behavior. Partly, the field was perceived as continuing to grapple with old problems without making much progress. The result is that conditioning and learning now represent a relatively small field in psychology, populated by specialists who are disappointingly uncommunicative with their colleagues in allied fields.

This state is all the more lamentable because in fact the last 20 years have seen remarkable changes in the field. We now have available important and cohesive bodies of knowledge about certain elementary learning processes. Moreover, although there is by no means unanimity within the field there are quite useful quantitative theories of associative learning processes that have remarkable predictive and explanatory power. These theories hold considerable promise for detailed guiding of the neurobiological investigation of learning. They also have potential as providing a basis for some of the more complex performances that currently hold the attention of cognitive psychology.

In good part this progress has been made by concentrating on one particular form of learning, Pavlovian conditioning, and returning to the insights of surprisingly unread authors such as Pavlov and Konorski. But it also reflects a change in the attitude of students of learning. They are increasingly willing to attribute to the organism quite sophisticated knowledge, but they continue to seek simple ways in which that sophistication can be achieved. Truly impressive gains have been made in accounting for learning in terms of reconceptualized notions such as excitation, inhibition, and contiguity.

It is the current state of knowledge of this field that Mackintosh attempts to capture in this book. The goal is to describe at high level current thinking about conditioning as it is studied in infrahuman organisms. As the author points out, this is in some sense a theoretical book. But it presents a consensus of the field rather than the author's own theoretical stance. The introductory chapter emphasizes that exciting changes have taken place in the field. Several of the subsequent chapters discuss these changes under rather standard headings, such as "Classical and instrumental conditioning." But other aspects of the book's organization reflect these changes more directly, such as the chapters on contiguity and contingency and on the "laws of association." The result is a book that indeed captures much of the field.

This is not a book one would casually recommend to a novice. The writing style is excellent by any standard. And Mackintosh is a scientist of unusual acumen who has the ability to summarize issues and alternatives with a flare. But the book appears to have been written for those who already have considerable background. For such readers the book provides a valuable, scholarly, and balanced summary. But for those less acquainted with the field it may often seem impenetrable. This is a field that prides itself on elegance of design and precision in the selection among alternative hypotheses. Mackintosh's discussion superbly captures that sytle. But to the uninitiated it may sometimes seem like endless nit-picking over procedures and needless elaboration of implausible explanatory alternatives. The very discussion that makes this book valuable for

the expert may reduce its impact on scientists outside of the field.

It is natural to compare this book with two others, Mackintosh's own *The Psychology of Animal Learning* (1974) and Dickinson's *Contemporary Animal Learning Theory* (1980). Mackintosh's earlier book has been for 10 years the standard summary of the field. The present volume is less encyclopedic, is less historical, and concentrates more on theories as distinct from data summaries. In that sense it is much more accessible. Dickinson's book is more frankly an attempt to make available to a broad audience essentially the same material as that covered in the present volume. For most readers, I recommend initially reading Dickinson's book and then the present volume. The truly dedicated should then read Mackintosh's 1974 book.

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Developmental Neuroscience

Development of Auditory and Vestibular Systems. R. ROMAND, Ed. Academic Press, New York, 1983. xvi, 576 pp., illus. $59.50.

The study of the anatomy and physiology of the acoustico-vestibular systems has long been popular. In contrast, the particular aspect of development of the auditory and vestibular systems has largely been ignored until recently, perhaps because of the difficulties of adequately preserving embryonic nervous tissues and recording from embryonic neurons. This book is intended to provide an account of this evolving subject and directions for future work. The book is a collection of 16 well-written chapters by authors who recapitulate many of their own data in addition to providing critical reviews of their specialties. Although the book could make an excellent starting point for a student unfamiliar with most of the topics covered, some of the discussion, particularly that of the physiological aspects, seems more directed to specialists.

The book addresses both basic research and clinical advances, with an emphasis on the former. The chapters concentrate on the auditory system more than on the vestibular system, on function more than on structure, and on receptors and brainstem nuclei more than on higher brain centers. Normal development is emphasized, although the abnormal is discussed in chapters on ototoxic drugs and noise (by Henry) and mutant mice (by Deol). Though Romand intends to limit the book to mammalian studies, with the exception of one chapter on spacecraft studies (by Vinnikov *et al.*) that deals with fish and amphibians, most contributors refer to relevant avian studies.

The overall quality of the chapters is quite high. Problems are clearly set forth. For example, Saunders, Kaltenbach, and Relkin, in their excellent review of the development of the outer and middle ear, express a concern that the timing of embryological events is not fully known for any one species because of the multiplicity of species that have been studied. In a chapter on the functional development of the cochlea, Romand states that a more quantitative investigation of all structures of the cochlea is needed in order to understand more precisely what happens at each stage of maturation. He notes that virtually nothing is established about the numbers of efferent and afferent contacts on hair cells or the numbers of efferents contacting afferents. Anniko notes that the importance of nerve-fiber contact for the development of hair cells in the vestibular sensory organs is still highly controversial. In a critical review of the ontogeny of the inferior colliculus, Moore concludes that the combined use of physiological recording and anatomical tracers has greatly enhanced our understanding of the mature central nervous system and should be applied to developing systems. It seems apparent, as is suggested by Mysliveček in a review of evoked responses in auditory cortex, that the productivity of future studies will depend on how well morphological, functional, biochemical, and behavioral indices can be combined to define intermediate stages of development. In a chapter on the development of the cochlear nuclei and the superior olivary complex, Brugge points out that the auditory system contains some of the largest synaptic endings in the vertebrate brain—namely, the end bulbs of Held in the cochlear nucleus and the calyces of Held in the trapezoid body. These endings, comprising homogenous populations of endings that contact particular neuron types, are exceptionally well designed to address basic developmental questions, such as what guides axons to grow toward their appropriate target cells and to form specific types of synaptic endings. In fact, the auditory and vestibular systems offer two of the very best model systems to exploit the relationship between peripheral development and the ontogeny of first- and second-order sensory neurons.

In summary, this book is a readable synthesis of literature on the subject. In addition to offering substantial bibliographies, it should encourage new interest in the development of the auditory and vestibular systems.

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