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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