

"normal science," in Kuhn's terminology), there are still matters which need to be understood for which we simply don't have the tools. At that juncture we will certainly not return to vitalism, and perhaps not even to organicism, but will turn to some more sophisticated way of labeling what we still need to know.

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Perceptual Development

Infant Perception. From Sensation to Cognition. LESLIE B. COHEN and PHILIP SALAPATEK, Eds. Academic Press, New York, 1975. Two volumes. Vol. 1, Basic Visual Processes. xvi, 426 pp., illus. \$22.50. Vol. 2, Perception of Space, Speech, and Sound. xvi, 246 pp., illus. \$17.50. Child Psychology Series.

The scope of this compendium on the development of perception in infants is broad, the topics it covers ranging from the characteristics of single neurons to perceptual-cognitive processes. The chapters vary in quality and should be read selectively.

Volume 1 focuses on fundamental visual processes, beginning with Daphne Maurer's introduction to the anatomy of the visual system, electrophysiological methods of assessing its activity, and the corneal reflection technique of determining where an infant is looking. These reviewers recommend concentration on the eye-movement monitoring techniques.

Bernard Karmel and Eileen Maisel proffer a neuronal activity model of infant visual attention. A lack of close acquaintance with the vast literature on neural and animal behavioral development is apparent in this chapter, and sections 2 and 3 in particular might be skipped. Instead of the details, the reader should concentrate on the fundamental points: that stimulus saliency is determined in part by the phylogenetically developed structural and functional organization of the nervous system; that visual fixation time follows an inverted-U function of the density of pattern contour at the retina; and that contour density is reflected in the late negative component (L-P) of the visual evoked potential curve in infants younger than 6 weeks but in the early positive component (P_2) at later ages. However, the tidiness of the concept of contour density is challenged in a later chapter by

Robert Fantz, Joseph Fagan, and Simón Miranda, who argue that many stimuli used to manipulate contour density (checkerboards, for example) actually incorporate two stimulus dimensions, the size as well as the number of elements in the pattern.

In the most ambitious chapter of volume 1, Philip Salapatek reviews the neurophysiological and behavioral literature on pattern perception in infants, including anatomy, saccadic localization, visual scanning strategies of geometric and social stimuli, and attention to differences in stimulus pattern. This chapter is a monumental contribution to our comprehension of perceptual development. Salapatek draws on the vast literature on the anatomical and neurophysiological development of humans and subhumans to explain and describe what must underlie much of early human perceptual development. In an intriguing epilogue, he conjectures that the earliest meaning attributed to distance or space cues beyond simple discriminability may be rooted in differences in eye movement patterns required to scan particular forms.

Whereas Karmel and Maisel and Salapatek are concerned with the neurophysiological basis of perception in the first 2 months of life, Fantz, Fagan, and Miranda survey the behavioral literature on visual capacity (discrimination), selectivity (attention), and recognition (memory) predominantly in midinfancy. There are substantive contributions here—the salience of curvilinear as compared to rectilinear patterns, the joint role of size and numerosity of elements in a stimulus pattern as determinants of fixation, the import of the postnatal age of the infant for a variety of perceptual dispositions, and the similarities and differences between Down's syndrome and normal infants in attentional behavior and recognition memory. But the review is convoluted, primarily because the field has relied on comparisons between isolated pairs of stimuli, rather than using independently scaled dimensions of stimuli with at least three levels and applying scaling techniques, especially multidimensional ones, to fixation preferences.

In the final chapter of volume 1, Leslie Cohen and Eric Gelber perform a valuable function in bringing together data, many of them generated in studies of other phenomena, bearing on memory in the infant. The study of memory has great potential importance, and the chapter raises issues of interest, such as the retention capability of young infants, transitions in memory ability that occur at 2

to 3 months of age, and sex differences in encoding and memory. But research in this field is difficult and complicated, and this chapter represents only one point of view. For example, Cohen and Gelber propose that the familiarization of an infant to a repeated visual stimulus can be understood better by plotting the infant's looking time backward from the trial on which the infant reaches a criterion of habituation based on proportional decline in looking time. The combination of such a habituation criterion and backward plots capitalizes on chance variations in looking time, however, and many of the attributes of the curves presented are artifacts of the approach. Several of the ideas suggested by these curves may be correct, but this method does not provide convincing support for them.

Volume 2 includes chapters on the infant's perception of space, objects, social beings, and speech and sound. Albert Yonas and Herbert Pick provide an epistemological inquiry into the perception of spatial representation, suggesting that generalization be withheld until results converge on a common interpretation across a variety of stimuli and responses, an admonition reminiscent of Garner, Hake, and Eriksen's strategy of "converging operations." It is still a cogent recommendation.

Then T. G. R. Bower, in the volume's most intriguing piece, argues that an infant cannot perceive the third dimension unless it knows that objects that have gone out of sight still exist—that is, unless the infant has a grasp of object permanence. Bower believes that even very young infants possess this knowledge, despite the conventional literature that places its appearance late in the first year. He argues that the typical procedure's used to assess an infant's knowledge of object permanence (for example, determining if the infant attempts to retrieve an attractive object it has seen being covered with a cloth) are tests not of knowledge of object permanence but of knowledge that an object has not changed when it is placed inside another object.

Those fond of criticizing Bower will find much ammunition with which to attack this position. For example, the argument rests prominently on two studies by Bower and Wishart (*Cognition*, 1972). In Bower's chapter he claims that infants are as unlikely to reach for an object placed under a transparent cup as for one hidden under an occluder and that this demonstrates that the object is transformed by being inside the transparent cup. But according to Bower and Wishart's original data four times as many infants (albeit

only half the sample) retrieved an object hidden under a transparent cup as retrieved one hidden under an occluder. Bower also presents in support of his contention that infants have a grasp of object permanence the fact that they will reach for a once-visible object that experimenters put out of sight by plunging the test chamber into darkness. However, his and Wishart's study failed to determine if infants would under similar conditions "find" an object they had not seen before. Intriguing, but not proved.

In a chapter that should have preceded, not followed, Bower's, Gerald Gratch reviews the literature on Piaget's concept of the object with respect to its theoretical implications and psychometric assessment. He contributes the hypothesis that in traditional experiments designed to assess knowledge of object permanence young infants fail to solve the problem because they misinterpret the hiding of the original object (does the infant perceive the object as being transformed in Bower's sense?) and that older infants fail because they forget the hiding place. But, like Yonas and Pick, Gratch shuns pulling the data toward an integrated conclusion concerning this aspect of the infant's perceptual world.

Michael Lewis and Jeanne Brooks chart the course of social perception, specifically the development of the ability to discriminate between pictures of human and other objects, infants and adults, and themselves and strangers. Although it contains more conceptual perambulation than the quantity and quality of the data merit, the chapter is provocative.

In the final section, Kurt Hecox sketches the anatomy and neurophysiology of the auditory system and summarizes the development of the auditory evoked response, and Peter Eimas presents data on the infant's perception of certain speech sounds. These are solid contributions, but because of the density of material and the technical vocabulary they will appeal only to readers already conversant with speech audiology and sensory neurophysiology.

These volumes have several liabilities: certain topics are omitted (for example, the orienting response to auditory stimuli, sense modalities other than vision and audition, substantial topics in perceptual-cognitive development); some authors rely disproportionately on their own data; several chapters are rather technical for newcomers and are written in a plodding style; and the material is not well integrated. Moreover, most of the contributors are trained in the behav-

ioral sciences, and neurophysiologists will occasionally find naive, outdated information, and misinterpretation in the accounts of research related to their disciplines. Nevertheless, most of the contributors are leading authorities in their own fields, the amount of literature surveyed is considerable, and the volumes bring together data from a variety of perspectives. Undoubtedly, some of the papers in these volumes will become major references and points of departure for future research in this growing field.

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