hear" calls forth the filtering process, and the instruction "Listen to this medley of voices and repeat any digits you hear" emphasizes the capacity for pigeonholing. Here again decision analysis is shown to be useful. In commenting on theories of the speed of decision or reaction time Broadbent argues that adjustment to produce more efficient reaction to more probable signals is predominantly one of pigeonholing or decision-criterion adjustment, but that some filtering may also be operative.

The contribution of these concepts and of the attempt to broaden applications of decision theory to human performance is not so much one of new explanatory power; many investigators have made the same or corresponding distinctions in their own specific domains of interest. Rather their importance lies in the introduction of the *same* concepts across the whole range of human performance from sensory detection and response choice to reactions to environmental stressors.

The author argues for the research strategy of defining large classes of theories and systematically eliminating alternative classes on the basis of experimental evidence. There is some of this in his book, but he is also willing to extrapolate his inferences into regions where the evidence is fragmentary. He is usually careful to label these forays into the unknown for what they are, and they frequently provide the most stimulating passages of the book. In spite of his predisposition toward systematic hypothesis elimination, one gets the feeling that he does not find that nearly so much fun as the complementary process of formulating his own explanations of puzzling data.

Broadbent does not shirk his responsibility to take a position on virtually all the standard issues concerning human information processing. On the paradox of selective attention—how is it possible to select for processing certain aspects of a stimulus event and reject others without having already analyzed the stimulus to identify the aspects to be selected?—he supports Anne Triesman's arguments that attenuation or filtering takes place and that the category states can be biased to be excited more easily for highly probable signals. Thus, in his terms, the paradox is explained by a combination of filtering and pigeonholing. The fact that in tachistoscopic experiments words occurring frequently in the language are more easily perceived than less common words he attributes entirely to response bias or pigeonholing; but concerning the reduced probability of seeing emotionally charged words—the phenomenon of perceptual defense—he remains equivocal, except to argue that it is different from the word-frequency effect. He tends to support a statistical decision model of evidence accumulation as an explanation of variations of speed of decision or reaction time, and adheres to the robust version of Alan Welford's limited-channel-capacity theory as an explanation of the psychological refractory period, the tendency for the response to the second of two closely spaced stimuli to be delayed.

In his discussion of the issues surrounding the distinction between long- and short-term memory he introduces the concept of an address register that provides storage of the access points for information in either the long- or the short-term stores much like indirect or associative addressing in a computer. This notion provides a mechanism for introducing some of the subtle ways of employing selective address-coding cues or tags to enhance or inhibit the recall of certain items or classes of items. It is responsive to the current interest in forgetting as a failure of retrieval and makes the concept of pigeonholing meaningful in the analysis of memory.

For a book by an information-processing specialist, particularly one with interests in practical applications, Broadbent's earlier book, *Perception and Communication*, was notably challenging to any reader's information-processing talents. In *Decision and Stress* he has provided a glossary, has worked hard to achieve clearer explanation of the fundamental ideas, and has been generous with homely analogies. Nevertheless, the material is densely packed, and concepts such as pigeonholing may remain elusive for all but the most dedicated reader who devotes all of his processing capacity to the task.

One might reflect on the question of whether it is ever wholly feasible to survey and structure an area of research that is as broad as the one Broadbent has tackled. That it is a difficult task is evidenced in the fact that, except for occasional footnoted references to later work, it is apparently material available to him in 1967 that formed the basis for this book. Some conspicuous gaps result; for example, the work on memory search by Saul Sternberg and by many subsequent investigators is not mentioned. For an author of Broadbent's capabilities one must conclude that it is the complexity and breadth of the material as well as the strong theoretical treatment that account for the long lag between collection of the data base and publication. Greater timeliness certainly would be desirable, but I found myself sufficiently challenged by the data and theory he reports to want to examine how he *would* assimilate the new facts, and repeatedly that sent me off on yet another of those entertaining chains of digression that characterize one's interaction with a stimulating book.

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The Unfolding Nervous System

Developmental Neurobiology. MARCUS JACOBSON. Holt, Rinehart and Winston, New York, 1971. xiv, 466 pp., illus. $12.95. Holt, Rinehart and Winston Developmental Biology Series.

Question: when is a brain not a brain? Answer: during development. Through an incredible orderly progression of morphogenetic steps, the primordial cells, which start out as a simple flat plate of neuroectoderm, evolve into a stupendously complicated system of interacting neurons. The search for the underlying cellular and molecular signals that control this biological spectacle has tantalized the best minds in the brain business for the last century. Yet, the mysteries of the developing nervous system remain largely unsolved and developmental neurobiology must still rank as an "endless horizon" open for exploration.

The apparent lack of progress does not stem from a lack of serious experimental effort, for some of the most ingenious and sophisticated of biologic manipulations have been brought to bear on this problem. To the technical and conceptual achievements of Ramón y Cajal, Harrison, Detwiler, Weiss, and Hamburger, the last generation has added thymidine autoradiography, cellular electrophysiology, and genetic pathology. In fact, through combinations of these latter approaches the processes by which the cerebellum, the olfactory bulb, and the hippocampus attain their adult forms have been very fully described.

With this book Jacobson has attempted to review selected portions of a great number of experiments on the

major issues of developmental neurobiology and has grouped them according to several rather large subcategories of problems: morphogenesis, histogenesis, neuronal and glial differentiation, and the establishment of interneuronal connections. The success or failure of his efforts will vary depending upon the knowledge the reader brings to this book. It is not easy to read. The author's habit of defining specialized terms only after he has used them two or three times may frustrate novices, and the habit of describing the same experiments several times in different chapters could well create in the reader a "déjà vu" feeling and the erroneous impression that he has gained some familiarity with the literature of a very involved subject. Despite the obviously erudite and scholarly approach, the internal organization of the chapters and subsections often seems to be randomly determined and may well confuse those readers who expect their introductory reading to present material as an organized procession of hard data and softer interpretations. The chapters could probably be read in almost any order, as with Cortazar's Hopscotch. I found the last chapter, which contains Jacobson's own theory of neuronal specificity and a subtle statement of his motivations for studying development, to be a stimulating introduction to the analysis of this book.

These are stylistic points, however, and they will thwart the reader only momentarily. Perhaps more troublesome in potential damage to inexperienced neuroscientists are the author's assertions that the controversies over neurofilament-microtubule interconversions or the reality of axonal protein synthesis are now settled issues. They are not.

Nevertheless, anyone interested in the general problems of cellular differentiation and recognition will find both source material and theory relevant to the nervous system in this very useful book. Read with a dictionary close at hand, this book can be a rewarding and educational reading experience. One minor but noteworthy example (a possible warning for unwary reviewers?) is Jacobson's correct use of the name *Ambystoma* rather than the commonly used and erroneous "*Amblystoma*"; the latter term translates from its Greek roots as "stupid-mouth."

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Translocation

Phloem Transport in Plants. ALDEN S. CRAFTS and CARL E. CRISP. Freeman, San Francisco, 1971. xxii, 482 pp., illus. $12.50. A Series of Books in Biology.

The subject of translocation in plants is an old and difficult one. Both the tissues through which it occurs and the forces responsible for movement have been contested. The controversies have been lively.

Crafts's early conviction of the merits of the mass or pressure flow mechanism has shaped his scientific career. This book is best viewed as a monograph of his and his associates' work.

In justification, one should point out that the pressure flow mechanism is the only one for which a reasonably sound scheme of operation is readily evident. Its simplicity is beguiling, however, in view of the difficulties and uncertainties others have found in fitting it to all of the accumulated data.

The subject of phloem exudation, a phenomenon that could not be handled critically prior to the aphid-stylet technique, is belabored by the authors, in this reviewer's opinion. Also the importance to physiology of previous evidence for closed pores in the sieve plate is overemphasized. Physiological data have always indicated free movement through sieve tubes, and most physiologists have placed the burden of proof as to the open or closed status of the pores on the anatomists, who, although they originally believed the pores to be closed, now, on reexamination with the electron microscope, find them to be open. The consequences of this development are fully incorporated into the book.

If one approaches the book with these things in mind, together with a consciousness that the authors' aim was "to collect *and interpret* [italics mine] the experimental information available," one will find a useful compilation of literature and opinions dealing with each of the subtopics of translocation.

The strength of the book rests in the zest with which the authors have searched for and compiled most of the literature even remotely oriented toward a discussion of mechanisms. Some papers whose intent was data gathering, or merely a careful description of the phenomenon of translocation per se, are omitted; there is some carelessness in citing of authors.

A weakness of the book resides in the apparent urge to reinterpret data in a way foreign to the intent of the original author. Reinterpretation is perhaps justified in some cases in the light of recent findings on sieve plate pores and is generally acknowledged by the authors, but it nevertheless does present a problem as to whose interpretation is best.

The authors have managed to encompass, judge, and classify most of the available data bearing on translocation mechanisms. The study of translocation benefits from such a book. Prior knowledge of the literature is necessary for the reader, since frequently the arguments require familiarity with papers and often even figures and plates of specific papers. As to its place among books about translocation, this one has no competitors in breadth and depth of coverage.

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Nematode Worms

Plant Parasitic Nematodes. B. M. ZUCKERMAN, W. F. MAI, and R. A. ROHDE, Eds. Vol. 1, Morphology, Anatomy, Taxonomy, and Ecology. xiv, 346 pp., illus. Vol. 2, Cytogenetics, Host-Parasite Interactions, and Physiology. xviii, 348 pp., illus. Academic Press, New York, 1971. $22 each volume; $38 the set.

The Structure of Nematodes. ALAN F. BIRD. Academic Press, New York, 1971. xiv, 318 pp., illus. $16.50.

Some of the most fundamental biological principles were established by the study of nematodes, but on the whole these animals are rather neglected by zoologists. With so much emphasis in zoological teaching on evolutionary theory and phylogenetic relationships, the fact that nobody really has much idea as to where they fit in has not exactly helped nematodes to get the attention they deserve. As parasites of man and domesticated animals they have, of course, been treated in courses on parasitology; and the growing realization of their importance as agricultural pests has led to their recognition in courses in plant pathology and, to underline the point, "entomology." But they continue to be neglected as animals in their own right; in my view, the development of the more applied fields of biology will be greatly impeded until this is remedied.

The recent demonstration that some nematodes are vectors of plant viruses has increased interest in them. The zo-