Many of the questions about memory that seem puzzling to Popper and Eccles have been asked (and some answered); many of the questions about the growth of knowledge and the structure and function of language have been explored, as have many of the mechanisms of the self-conscious mind that Popper and Eccles assign to the homunculus. These assignments occur usually when the authors fail to find a physiological mechanism that will serve the purpose. However, alternative mechanisms are alive and well in psychology, linguistics, and the cognitive sciences in general. It is embarrassing that a philosopher of the mind and a physiologist of the brain can be functional illiterates in the disciplines about whose subject they speculate.

It is not the case, as Eccles asserts in a particularly painful bit of nonsense, that recognition memory consists of the retrieval by the brain of candidate events, which are then accepted or rejected as "correct" or "incorrect" by the mind (which, if it had the knowledge, would not need the brain). It is certainly not the case both that the "first product of the human mind is human language" (p. 11) and that "language, once created, exerted the selection pressure under which emerged the human brain and the consciousness of the self" (p. 13). It is not the case that computer models cannot simulate the brain "whose function is not primarily to compute but to guide and balance an organism and help it to stay alive." It is not the case, as Popper asserts, that the only possible theoretical comprehension of mental events would have to come from a theory of the mind that he properly rejects, associationism.

Modern conceptions of the mind include those theoretical processes and mechanisms that are ascribed to human beings in order that their behavior, actions, and experiences may be understood. In contrast to traditional mentalism, and the authors' frequent implication, these mechanisms are largely unconscious and not available as "contents of consciousness." As Karl Lashley noted many years ago, consciousness primarily contains the products, not the processes, of thought. Current mental theories, which can accommodate problems of human memory much better than Popper's and Eccles's conjectures, have long abandoned associationism. Others inquire about the structure and origins of language, giving us knowledge far beyond that obtainable from brain preparations. Most practitioners of the fledgling science of artificial intelligence would consider the simulation of guiding, balancing, and raw survival relatively simple compared to the problems about the structure of knowledge that they are currently tackling.

I have selected some very few examples of the authors' innocence of current work; the book is strewn with many more. The references to psychological work are either out of date or obtained by hearsay (or even, in one case, by hearsay of hearsay of hearsay). Both authors directly or indirectly admit their ignorance or avoidance of modern psychological literature. What a fine book this might have been if they had done their homework.

Finally, if we admit the construction of mental theories, and if we accept Popper's dictum against reductionism, where is the problem? Theories of mind and theories of the brain can coexist; eventually we will be ready to make statements coordinating the two. In the meantime the world is full of theories and experiments bearing on attention, memory, consciousness, the self-concept, the bases of intelligent behavior, and knowledge. Once we know that the "body" and the "mind" are constructed human products, we can reject both Descartes's artificial dualism and the Popper-Eccles vague, backward-looking nostalgia for the human soul. Read the book and find what fascinating problems are still left, but remember that many of them are well on their way to some temporary solutions.

GEORGE MANDLER
Center for Human Information Processing, University of California at San Diego, La Jolla 92093

Brain Structure and Function

Architectonics of the Cerebral Cortex. Papers from a symposium, Vienna, Austria. MARY A. B. BRAZIER and HELLMUTH PETSCHE, Eds. Raven, New York, 1977. xvi, 486 pp., illus. $37.50. International Brain Research Organization Monograph Series, vol. 3.

The International Brain Research Organization has over the past few years mounted a series of symposia on different aspects of basic and clinical neuroscience. These in turn are generating a series of volumes, of rather mixed quality. The present volume is the third in the series and to date probably the most generally useful. The symposium on which it is based was held in Vienna in 1976 to mark the 100th anniversary of the birth of the Rumanian-born neuropathologist Constantin von Economo, who received his early training and did most of his work at the University of Vienna. Von Economo's contributions to neuropathology and cortical cytoarchitecture, including his widely cited monograph (with G. Koskinas) *The Cytoarchitectonics of the Human Cerebral Cortex*, are briefly reviewed by Lesky, of the Institute of the History of Medicine in Vienna, and are set in a more general historical context by Brazier.

These historical chapters are followed by a number of chapters dealing with the morphology of specific cortical cell types. As is often the case with symposium volumes, much of the work discussed in these chapters has appeared in original form elsewhere. This is true also of Szentágothai's excellent discussion of specificity and randomness in cortical connectivity, in which he elaborates on his concept of the modular construction of the cortex. The remaining chapters on morphology are in general less substantial and are concerned with less basic issues. A great deal of effort has obviously gone into the studies dealing with the distribution of lipofuchsin in cortical neurons, the grouping of cortical dendrites in bundles, and the changing distributions of certain enzymes during cortical maturation, but it is difficult at this stage to relate them meaningfully to most other aspects of cortical structure or function.

Rather more than half the book deals with different aspects of electrocortical activity during normal behavior and during pathological or experimentally induced seizures. Again, little of the material is new, and one suspects that much of the phenomenology that is reported is not likely to stand the test of time. However, it is convenient to have some of it brought together and presented within reasonable compass; this is especially true of the contributions from Eastern Europe, some of which are otherwise difficult to obtain. Although some of these later chapters are likely to be of interest to clinical electroencephalographers, they will probably not arouse much interest among neurophysiologists. This is disappointing in view of the exciting recent developments in cortical physiology. It is rather surprising that in a volume concerned with cortical function there is so little reference to the recent electrophysiological studies of columnar organization in the cortex, or to the work on the response characteristics of neurons in conscious, behaving animals, or to that on the striking effects of selective sensory deprivation. But it is

perhaps inevitable in a volume of this sort that much good work will be omitted and that some work of inferior quality, or of less general interest, will be included. As with most Raven publications the printing is excellent; however, the price the reader has to pay for this is considerable.

W. M. COWAN
Department of Anatomy, Washington University School of Medicine, St. Louis, Missouri 63101

Isotopic Variations in Space

CNO Isotopes in Astrophysics. Proceedings of a meeting, Grenoble, Aug. 1976. JEAN AUDOUZE, Ed. Reidel, Boston, 1977. xiv, 198 pp., illus. $22. Astrophysics and Space Science Library, vol. 67.

Carbon, nitrogen, and oxygen are essential products of the generation of nuclear energy in stars. Primeval nucleosynthesis formed helium and hydrogen. During stellar evolution, carbon and heavier elements form. Thus, a universe of stars beginning with hydrogen, deuterium, and helium could, by orderly processes now understood, produce all the elements and isotopes with which we are familiar. In the carbon-nitrogen-oxygen group are contained the elements essential for life; ^{13}C, ^{15}N, and ^{14}N are ash from the carbon cycle, ^{12}C is ash from helium burning. Instabilities somehow move synthesized nuclei to the surface of stars and eventually into interstellar space.

The present volume consists of 21 papers discussing work on these processes carried out with the use of a variety of astrophysical techniques. Anomalous carbon isotope ratios have long been recognized in stars; molecules containing rare CNOS isotopes provide radio astronomers with details of isotopic composition in space. The book discusses the surprising finding of an apparently high concentration of deuterated compounds in space and whether chemical fractionation alone explains the isotope variations detected. Anomalies in meteorites, the solar wind, and the lunar surface all give rise to puzzling questions.

The book gives rich detail on elemental and isotopic variations in red giants. Abundance variations are found within a single globular cluster even though such old stars were formed with the same initial composition. The increased carbon content of their atmospheres suggests both unexpected helium burning and instabilities that transfer material from stellar cores to surfaces. A quantitative exploration of reaction rates in the energy-producing cycles is given by G. R. Caughlan, who has recomputed the equilibria in slow and fast CNO cycles as laboratory cross sections have been improved.

The large number of interstellar molecular species with isotopic variants also provide a set of new problems. Astrophysicists are now faced with understanding the complicated low-temperature, low-density chemistry of free radicals and carbon compounds. Some reactions possibly occur on small solids. This subject is particularly well explored in introductory and résumé papers.

Changes of composition inside stars are ultimately reflected in the global composition and spectrum of a galaxy; the secular increases in carbon and, especially, nitrogen are reviewed by the editor, with collaborators, and by B. M. Tinsley. The $^{12}C/^{13}C$ ratio in the earth is not typical of the stars or of interstellar clouds. The N/O ratio at the center of galaxies differs from that at the edges. We see in our neighborhood, and in other galaxies, the result of nuclear furnaces slowly accumulating synthesized nuclei over eons and recycling them to the interstellar medium, from which new stars are born.

The book is an excellent introduction to the subject. It can be recommended to physicists and astrophysicists and to those interested in free radicals and low-temperature chemistry.

JESSE L. GREENSTEIN
Hale Observatory, California Institute of Technology, Pasadena 91125

Foraging in Primates

Primate Ecology. Studies of Feeding and Ranging Behaviour in Lemurs, Monkeys and Apes. T. H. CLUTTON-BROCK, Ed. Academic Press, New York, 1977. xxii, 632 pp., illus. $41.

Primates, with the exception of a number of specialized, insectivorous prosimians, mostly small and nocturnal, are primarily vegetarian. Vegetarian primates are far from uniform in their eating habits, however. Some, such as the colobines, are primarily leaf-eaters, and others are primarily fruit-eaters. Among primates, geladas are the only true grazers: more than 90 percent of their diet is grass. One primate species, *Lemur mongoz*, feeds mostly on flowers and nectar. Another, *Galago elegantulus*, specializes in plant gums. Many basically vegetarian primates eat considerable amounts of animal material, including various invertebrates and small vertebrates. Even the fruits that they eat often contain insect larvae. Baboons may be the only nonhuman primates that prey on mammals of their own size range. From this animal food, primates obtain their essential vitamin B_{12}.

Systematic studies of primate feeding ecology began to proliferate about ten years ago. This volume is the first book devoted to the topic. Its 20 contributors present basic data on feeding behavior, diet, ranging patterns, and related aspects of primate ecology. Detailed treatment is given to 17 primate species, including various prosimians, monkeys, and apes. Two final chapters survey variations within and between species, including correlations between several components of primate life histories. Three appendixes provide useful information on research methods.

The material in the volume is largely descriptive, often quantitative. Most of the authors used point samples, which provide estimates of the time spent on each food but not of the amounts eaten. The few hypotheses that are tested are primarily of the no-pattern type. Several of the authors suggest relations of primate foraging to behavior and social organization. Surprisingly, they are almost uniformly silent about the possibility that primate populations are food-limited (although there is evidence that several are), and they scarcely mention recent ecological research on optimal foraging. Clearly primate field research has been largely independent of related developments in other areas of ecology.

This well-written volume, along with results of the recent Cambridge symposium on primate feeding behavior, the proceedings of which are to be published by Academic Press, provide us with a new perspective on primate foraging. The next step will be to relate foraging patterns in primates to other aspects of their ecology and behavior by testing hypotheses about differential habitat utilization, competition, optimal diet and foraging strategies, social and spatial relations, demographic parameters, and other components of primate life histories.

STUART ALTMANN
Biology Department, University of Chicago, Chicago, Illinois 60637