courage other investigators to undertake to answer the questions it raises before all the evidence is gone forever.

I would be remiss as a reviewer should I fail to mention that both the author and the publisher have been unforgivably careless in the production of this volume. There appears to have been no editing and no proofreading, at least in the first part, where proper names especially suffer. One should not have to pay the high price charged to read raw field notes with greatly reduced freehand sketches presented as "site plans."

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Correlates of Movement

Neurophysiological Approaches to Higher Brain Functions. EDWARD V. EVARTS, YOSHIKAZU SHINODA, and STEVEN P. WISE. Wiley, New York, 1984. x, 198 pp., illus. $39.95. The Neurosciences Institute Publications Series.

This book arises from discussions held during two conferences at the Neurosciences Institute. The book takes the well-established point of view that all behavior requires movement for its expression and its communication and that therefore "higher brain functions" may be examined by studying the neural correlates of movement execution. The proposition is that the output neurons in the primary motor area of the cerebral cortex, which Evarts has studied so fruitfully, are closely linked with motor behavior in advanced animals. On the other hand, sensory signals that trigger behavior are not tightly coupled to that behavior, and an identical stimulus can trigger a variety of different behaviors under different circumstances. To study how the brain controls these different behavioral responses in a flexible manner is to study the foundation of higher brain functions.

The work makes no attempt to be exhaustive in its coverage of the background of or the experimental observations that relate to this general proposition. Nevertheless, the views of the authors themselves and their interpretations of the contributions that their own studies have made to the understanding of "preparatory set" (to make a movement) and motor output are described in some detail. Hammond's 1956 demonstration that prior instruction of a subject could dramatically modify an apparently involuntary (automatic or reflex) neuromuscular response is at the basis of many of the investigations that are described. It is made clear that many motor actions that would appear to be completely automatic are, in fact, greatly influenced by changes in central excitatory state that are "set dependent." The flexibility of the response is attributed to functional changes in the cerebral cortex.

This is not a work to be consulted for detailed information about the cellular or regional organization of the cerebral cortex, although these are reviewed in a summary manner, as are the connectional relationships of the sensorimotor regions of the cerebral cortex. Most pertinent to the topic under review are the physiological observations made in monkeys and in humans under conditions of flexible motor responsiveness and from regions of cerebral cortex not closely linked to the motor output itself, for example from frontal regions of the forebrain. Yet the section of the book that discusses these observations provides little information. It presents very selective observations and describes them rather uncritically.

The penultimate section of the book has the attractive title Behavioral Correlates of Identified Cell Types in Cerebral Cortex. It reviews methods that might be employed to give more precision to the understanding of the meaningfulness of physiological responses recorded from the cerebral cortex or its connections. The review is a most unsatisfactory one that does less than justice to a number of the methods it explores. For example, it is concluded that the spike-triggered averaging method for revealing the functional significance of cell-to-cell connections is unlikely to find substantial application beyond the search for connections to motoneurons. Such a conclusion fails to acknowledge the wealth of detailed functional and connectional information that has already been obtained in many other neural systems using such approaches.

One can have little disagreement with the final conclusion of the book, that, by monitoring the function of cortical neurons with identified relationships to motor output, it should be possible to observe the influences on the neurons of the continuously changing activity in many other brain regions and circuits, some local and some remote, as an animal modifies its behavior in relation to changing situations. Sherrington, in concluding his Silliman Lectures, *The Integrative Action of the Nervous System* (1906), saw the cerebral cortex "as the organ of, and for, the adaptation of nervous reactions." But the connections of the sampled cerebral neurons will have to be known, and inputs and outputs will need to be specified precisely in terms of their quantitative contributions of excitatory or inhibitory influences to the local neuronal state, if any sensible interpretation is to be provided of their observed responses. This book does not help to define the need for this detailed knowledge to be evaluated for the individual connections of each of the identified neurons whose contributions to behavior are being evaluated.

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Gerontology in the U.S.S.R.

Physiology of Cell Aging. VLADIMIR V. FROLKIS, Ed. Karger, Basel, 1984. viii, 206 pp., illus. $89.25. Interdisciplinary Topics in Gerontology, vol. 18. Translated from the Russian by Alexander Lipinsky.

This book reviews some of the extensive studies done during the past decade at the Institute of Gerontology in Kiev, U.S.S.R. The Institute, perennially directed by D. F. Chebotarev, is the major Soviet group for gerontology and geriatric research and is a unit of the prestigious Academy of Medical Sciences of the U.S.S.R. (Department of Clinical Medicine). Like the National Institute on Aging, it runs a broad extramural program and also has its own experimental and clinical research groups; the groups comprise about 100 full-time scientists. (After more than ten obvious sources in the United States could not supply current information about the Institute, I tried to telephone two English-speaking colleagues at the Institute. After a minute's hubbub in Russian, the Institute's switchboard unexpectedly deflected me to the director's office and Chebotarev himself came on the line to graciously answer my questions.) Vladimir Frolkis, the editor of the book, is head of the Laboratory of Physiology, one of eight in the Section of Experimental Medicine. Frolkis's name is familiar to experimental gerontologists for his physiological and biochemical studies of the nervous systems of aging laboratory animals. He is first author of seven of the ten chapters.

The volume represents many Soviet scientists who are little known in the

international literature and who can only rarely attend meetings in the West, though some of the Kiev group often report their work in English-language gerontological publications. The extensive bibliography contains sources that are not widely known, including special publications of the Institute of Gerontology. Russian titles are helpfully translated into English. The bibliography shows an energetic attention to the English and Romance-language gerontological literature that is far more conscientious than most of us give to the Slavic scientific literature.

Several of the many topics covered in the book are notable. Chapter 1 briefly mentions the effects of age on the electrical activities of snail neurons; this work was subsequently reported more fully by Frolkis in *Mechanisms of Ageing and Development* **25**, 191 (1984). Age changes in the control of aldosterone and in hypothalamic influences on the adrenal cortex have been studied by L. V. Magdich and are discussed by Frolkis and E. N. Gorban (chapter 2). Solid work on immunological changes with age is described by G. M. Butenko (chapter 3), who studied parabiosis and the grafting of spleen cells between animals of different ages in a strain of CBA mice. Butenko's studies are particularly appealing because they go beyond the descriptive observation of many of the geronotological studies in the U.S.S.R. in their attempt to establish mechanisms by manipulating specific aspects of aging. In the interest of corroborating results it is helpful that a relative of the widely used CBA mouse is available in the U.S.S.R.

A recurrent theoretical motif is Frolkis's general interpretation of age-related changes as resulting from two opposing processes, destructive aspects of aging that are countered by *vitauct*, or life-prolonging processes, such as axoplasmic flow, cell division, or detoxification. The attention given to such general concepts here and occasionally elsewhere in the Russian literature suggests a propensity to formulate general theories that may not be testable in detail. Most scientists prefer to focus on specific hypotheses, since it is so difficult to make robustly generalizable biological theories.

In addition to the group in Kiev, other experimentalists who study biological and medical aspects of aging are cited in the book. V. M. Dilman and V. N. Anisimov at the Petrov Institute for Oncology (Leningrad) have made many important contributions, including detailed predictive hypotheses about neuroendocrine mechanisms in aging and in oncogenesis. No reference is made in the book to Zh. Medvedev's pioneering contributions, especially the error theory of aging, which, in 1961, first focused attention on the potential importance of altered information flow from the genome.

In sum, the present volume can be regarded as a valuable entry to a literature that is often neglected. The volume furthers the long-range maintenance of international scientific contact by increasing our awareness of Soviet colleagues with kindred scientific pursuits.

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Spinor Calculus

Spinors and Space-Time. Vol. 1, Two-Spinor Calculus and Relativistic Fields. ROGER PENROSE and WOLFGANG RINDLER. Cambridge University Press, New York, 1984. x, 458 pp., illus. $89.50. Cambridge Monographs on Mathematical Physics.

Most discussions of special or general relativity use the mathematical machinery provided by tensor calculus. However, over the past 25 years it has become increasingly clear that there is an alternative to tensor calculus that often simplifies calculations and is, in a certain sense, more fundamental. This is the calculus of two-component spinors. Until now, a student wishing to learn spinor calculus had to turn to dozens of original papers and struggle with incomplete results and different conventions. *Spinors and Space-Time*, to be published in two volumes, provides for the first time a systematic and complete discussion of the properties and applications of two-component spinors. It is a long-awaited and much-needed work.

Volume 1 makes it clear that the work is not just for the beginning student. In addition to its excellent presentation of established material, it is filled with new insights, simple arguments, and general formulas that will benefit even the expert in the field.

The volume begins by introducing spinors geometrically in terms of "null flags." The three basic spinor operations—addition, scalar multiplication, and inner product—are all given explicit geometric interpretations. The introduction discusses many interesting properties of the Lorentz group such as that (as was first pointed out by Penrose) a uniformly moving sphere will appear rotated and not flattened, as a naïve application of the Lorentz contraction might suggest. Of particular note are the figures, which beautifully illustrate the text and help the reader to visualize the various geometric constructions.

The authors then move on to a more abstract algebraic approach to spinors that forms the basis for the rest of the book. That the space of spinors is a complex two-dimensional vector space leads to a number of special properties, which are discussed in detail. In keeping with the algebraic approach, traditional differential geometry is presented in a slightly untraditional way, for example by defining a manifold in terms of its ring of smooth functions. Derivatives of spinors and spinor curvature are discussed from both a basis-independent and a basis-dependent point of view—the latter approach leading to the Newman-Penrose spin coefficient formalism. One of the less familiar topics discussed in the book is a method for translating an arbitrary spinor equation into tensor language. For example, it is shown that the linear Weyl neutrino equation is equivalent to a nonlinear equation on an antisymmetric second-rank tensor.

The main application of spinors that is discussed in volume 1 is to relativistic fields. Spinors provide a simple unified treatment of massless fields of arbitrary spin. The conformal properties and consistency conditions (which arise in curved space) for these fields is examined. Of particular importance are the discussion of initial data on null surfaces and the explicit formulas for the field in terms of integrals over its initial data. An approach to interacting fields that is based on these results is also discussed. Further applications of spinors, including their use in asymptotically flat spacetimes to prove the peeling theorem for radiation and the positive energy theorem, will be given in volume 2.

Volume 1 develops and uses extensively the abstract index notation that was introduced by Penrose to provide a basis-independent notation that would facilitate calculations. Although abstract indices are certainly quite useful, they are perhaps overemphasized in this book. There are over a dozen different symbols used for indices, and a great deal of time is spent explaining the notation. This emphasis on notation tends to detract from the subject matter and make the otherwise clear exposition somewhat difficult to read. Unfortunately, the situation is complicated by the fact that the printing does not enable one to easily distinguish certain types of indices. One hopes that this last problem will be cor-