malian oculomotor system. After all, the behavioral laws governing eye movements were discovered during the middle of the last century; clinical neuro-ophthalmological syndromes have been delineated for even longer; psychophysiologists and cyberneticists have been cleverly manipulating stimuli ever since Dodge classified human eye movements in 1903; neurophysiologists elucidated the operation of the nerve cell and the synapse in the 1950's and 1960's; neuroanatomists are now making giant strides; and analysis of the visual sensory system has proceeded so well that it is common to encompass the behavior of single cells and the whole animal in a unitary description. So it is now clearly the turn of the visual motor apparatus, which, as Hering phrased it, "has to fit the sensory apparatus as the shell does an egg."

The three books here reviewed are all timely, and each in a different way makes an interesting contribution. Baker and Berthoz convened a satellite symposium of the 1977 International Congress of Physiology in Paris last July. The proceedings of the symposium, appearing within a remarkably short time, contain over 50 papers by more than a hundred participants. It was quite an achievement to have present in one place at one time a major proportion of the significant contributors in the field. As a consequence we have here what amounts to a progress report on the state of research on the oculomotor system.

Searching the book for a complete delineation of the brainstem apparatus for gaze control reveals that there is none as yet, though some partial characterizations are emerging. In particular, the signal sequence required for the generation of saccades and of vestibulo-ocular responses would seem close to being adequately characterized. But in the alert mammal, which is of course the ultimate preparation in this research, the colliculi, cerebellum, and cortex are all significant in even the most routine operation of motor sequences. In the oculomotor system one is dealing with a distributed network strongly modulated by, and interacting with, other pathways. So it is perhaps a little too optimistic to expect the kind of rigorous connectivity schema that has been constructed for, to cite an example, the retina.

Carpenter's book is almost exactly complementary to the Baker and Berthoz symposium volume. Here is a young English physiologist, obviously intelligent and analytical, displaying an attractively wide cultural vista that is unfortunately not open to most laboratory researchers struggling with the daily routines of single-cell recording in alert mammals. The result is an excellent overview of the field, including its behavioral aspects. The book deserves to be read widely since it provides the setting within which the popular single-cell neurophysiology is really meant to be understood. Because of the varying degrees of facility with which neurological researchers describe their findings, a synthesizer can be at a disadvantage when some consequential facets of a syndrome are incompletely reported. Carpenter thus occasionally runs into the difficulties inherent in the attempted encapsulation of widely diversified research findings. In sketching the contemporary scene of ocular motility research in historical perspective, Carpenter merits the gratitude of all workers in the field, whose bearings will be more secure as a result of his survey.

At first glance one may wonder why the trouble was taken to translate Shakhnovich's book from the Russian, but detailed perusal makes it apparent that there are several matters discussed in the book for which there is no overlapping treatment in English. It is of interest to note that, if Shakhnovich is representative, Russian workers have much the same view of the importance of current trends as we have. Shakhnovich himself seems driven by a wide-ranging curiosity to investigate topics as diverse as single units in the rabbit cortex, the trajectory of saccades, the accommodation-convergence synkinesis, and cerebral blood flow in various diseases. By current American standards he would be faulted for attempting too much and hence for failing to make his results fully convincing. The book incidentally contains a lesson about scientific attitudes common to East and West. One might have thought that the same scientific enterprise that sent space probes to look at the surface of Venus and Mars would have also prompted a look at the ocular tremor in humans as a possible diagnostic and prognostic tool. In the West, this approach is almost totally ignored. When Shakhnovich attempts it in Moscow, he seems to have to count cycles of ocular tremor by hand, four decades after Kolmogoroff (in the same city) developed elegant methods of harmonic analysis.

All three books can be recommended: Carpenter's monograph for providing a much-needed framework and overview, Baker and Berthoz's symposium volume for making available an up-to-date progress report from a large segment of the research community, and Shakhnovich's book for showing us the directions in which one person's interest can lead him.

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Bases of Motivation and Learning

Drives and Reinforcements. Behavioral Studies of Hypothalamic Functions. JAMES OLDS. Raven, New York, 1977. viii, 140 pp., illus. Paper, $8.75.

W. R. Hess earned the Nobel prize for discovering and studying the remarkable fact that electrical stimulation of localized regions deep within the brain can drive an animal to perform behavior that seems natural, for example, to eat as if hungry or to drink as if thirsty. Would James Olds, had he lived longer, have received the prize for discovering and studying electrical self-stimulation?

Olds was a prospector in physiological psychology. This book summarizes his search for the neural basis of motivation and learning. Starting out at McGill University to explore the reticular formation, he stumbled onto electrical self-stimulation of the forebrain. Anyone less astute or less energetic might have thrown out the strange rat that refused to run down the alley during brain stimulation. The rat kept coming back to the place where stimulation was turned on. Olds knew he had discovered a gold mine of information. The excitement spread when he trained a rat to press a switch 3000 times an hour to stimulate its own brain. Olds performed the basic experiments in every area of self-stimulation research. He and his colleagues mapped brain reward sites, studied the effects of major drugs, related self-stimulation to natural rewards, and started electrophysiological probing of the cellular basis of reward. Today self-stimulation is the major technique for studying the neural basis of the psychopathology of drive and reinforcement.

This simple and insightful book does three things. It demonstrates Olds's question-and-answer approach to brain research, it integrates the basic findings in neuroanatomy, neurochemistry, and electrophysiology that are related to brain reward systems, and it tries to point the way to a vein of research that would lead to a greater understanding of mental disease and drug abuse.

The first section lists the questions that were asked about the psychology of self-stimulation. How rewarding is self-stimulation in terms of work expended or pain endured? Is self-stimulation related to normal feeding or reproductive behavior? Is the drive effect Hess discovered the same as the "priming effect" in which a little stimulation causes a rat to search for more? The brief answers to 35 questions form a historical review. This section adds clarity and style, which make the book particularly good for classroom use. The author is a good teacher; he asks some questions that have not been, but could be, answered. For example, he presents evidence that leads him to ask if rats would self-inject morphine into the brain. (A report of success has come from his laboratory since the book was written.)

The next section sketches attempts to localize anatomical substrates of drive and reward. It begins with lesion studies and leads into recent catecholamine studies. Olds is intrigued with the general theory that facilitation of catecholamine activity promotes both the rewarding aspects of self-stimulation and relief from depression. Amphetamine's action is the prime example. It facilitates the activity of all three catecholamines (norepinephrine, epinephrine, and dopamine) and does so in three ways (by transmitter release, reuptake block, and direct postsynaptic action). It increases self-stimulation in rats and is an antidepressant in humans. Unfortunately, at high doses amphetamine can cause reverse effects on self-stimulation and can induce psychotic symptoms. Perhaps an overdose causes postsynaptic depolarization block or any of the several types of feedback inhibition that have been proposed in various catecholamine systems. Perhaps it causes excessive "drive" in relation to "reward" or flooding that blurs the response-reinforcement contingency necessary for learning. Clearly the theory is simplified and vague with regard to specific transmitters, pathways, drug levels, response measurements, and behavioral definitions. Olds recognizes this and does not overemphasize any particular postulated mechanism, such as "dopamine reward," "dopamine drive," or "norepinephrine reward." Instead he tentatively supports a combined theory proposed by T. J. Crow. Olds says mesolimbic and nigrostriatal dopamine pathways might be involved in "those rewards that come at the beginning of the consummatory process" and that are "involved in a positive feedback way" with initiating events, whereas the dorsal noradrenergic bundle "might be more involved in those rewards that come toward the end of a consummatory process and which carry the seeds of satiety and the demise of the drive system."

This old-fashioned psychological terminology combined with colorful language is sure to distress some readers. However, there is a large and growing population of scientists who do not pale at the use of "reward" when it refers to self-stimulation, or of "drive" when it refers to the induction of eating. Physiological psychologists are no longer talking to themselves when they use these terms, they are talking with neuroanatomists, neurochemists, and neuroscientists of all kinds.

Electrophysiologists probably are the last major holdouts, and with good reason; it has been terribly difficult to show that the firing of any single cell is causally related to the performance of a learned behavior, much less to "drive" or "reward." Olds tried. He did find neurons that fired in anticipation of food reward as a function of food deprivation. The book discusses the problems of interpreting such findings and gives examples of other attempts to identify "reward neurons."

Last, and most speculative of all, Olds suggests that chemical codes in the form of peptides, such as adrenocorticotropic hormone, might bias neuronal processes and thereby determine various drive states, such as fear or hunger. He then asks how a peptide code for drive could spread within the brain. His answer: the peptides could be packaged in their own vesicles and transported in catecholamine neurons.

Olds the psychologist turned neuroanatomist, turned neuropharmacologist, turned electrophysiologist, has in this section of the book turned neuroendocrinologist. Every neuroscience student should be exposed to this book, not to learn any of these fields but to learn how to study the brain on its own terms, by the integration of many kinds of information.

The book ends with the most twinkly-eyed, far-out idea for the neural basis of learning Olds ever proposed. He suggests, as a working hypothesis, that catecholamine neurons pick up peptide hormones in the hypothalamus and carry them through the brain to produce drive states. The *same* neurons might release amines to produce reward. The pattern of neural activity would determine whether the drive peptide or the reward amine would be released. "In this case the problem of how a reward connects a drive to a set of behaviors or objects would be resolved in an easily conceptualized way. Connecting a reward fiber would consist in connecting a drive fiber." If the past is any guide, this idea is at least partially correct. James Olds was a prospector with a knack for getting there first.

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Dissociationism Revived

Divided Consciousness. Multiple Controls in Human Thought and Action. ERNEST R. HILGARD. Wiley-Interscience, New York, 1977. xviii, 300 pp., illus. $16.95. Wiley Series in Behavior.

For the past two decades Ernest Hilgard has been pursuing research on a family of topics that experimental ("scientific") psychology has assiduously avoided. These are the great topics of 19th-century dynamic psychiatry—for example, hysteria, hypnosis, unconscious mentation—which because of their methodological intractability have by and large been relegated to the subfield of abnormal psychology. It has been Hilgard's goal to "domesticate" these unruly topics and to assimilate them into the body of experimental psychology, where many of them logically belong.

In the present work Hilgard seeks to integrate his research and thinking on these subjects. The book is a potpourri of the "fascinating" topics which tend to draw students to the field of academic psychology but which, as they soon discover to their consternation, are not usually dealt with within it. Among the topics included are possession states, multiple personality, hypnotic age regression, amnesia and repression, dreams, hallucinations, imagination, automatic writing, the hypnotic experience, and even spiritualism and the ouija board.

The theme unifying this sprawl of topics is the doctrine of dissociationism, the view that the "unity of consciousness is illusory" and that every individual is made up of and controlled by a multiplicity of subsystems which may be more or less dissociated, that is, separated by an amnesic barrier. This is by no means a