psychology. It need not be said that behaviorism polarizes, for the evidence is still abundant in the reactions to Watson's prime modern successor, B. F. Skinner.

This is a personal biography of Watson, not a scholarly analysis of his intellectual origins, his work, or his influence. It tells about the marital scandal and ensuing divorce in 1920 that cost him his chair at Hopkins and that kept him out of academic jobs for the remaining 38 years of his life. It also tells, at some length, about his second career, in advertising, which was no less successful than the first and a good deal more lucrative. Academic psychologists may know that Watson went to work for the J. Walter Thompson Company, but they do not usually know he became its highest-paying employee, its "chief show piece," according to a *New Yorker* profile of him in 1928. He directed inventive advertising campaigns for, among other items, Maxwell House Coffee, Ponds Cold Cream, and the Pennsylvania Railroad. He wrote and lectured to his advertising colleagues on the theory of selling more generally. In the popular press, though no longer in learned journals, he continued to be the spokesman for behaviorism, especially in relation to child-rearing. Few of today's psychologists in their 40's realize the extent to which American child-rearing in the 1930's, perhaps including their own, was shaped by popular articles Watson wrote on the subject in the 1920's, after he had shaken off the restraints of academic psychology. He had somehow derived from behaviorism an approach to parenthood that anyone today, even a fully committed behaviorist, would likely find forbiddingly unaffectionate.

This is a useful biography for filling in our knowledge about Watson after the departure from Hopkins. Unfortunately, Cohen's command of detail is occasionally shaky. For example, he underestimates the influence of Watson's teacher at the University of Chicago, the brilliant German biologist Jacques Loeb, and calls him a Frenchman besides. Watson is depicted working for the "Pentagon" in 1918, more than 20 years before it was built, or commenting on a psychologist called Raymond Cattell in about 1910, when *the* Raymond Cattell was about 5 years old. No doubt it was the unrelated James McKeen Cattell whom Cohen had in mind.

Other lapses are more serious. In sympathy with the subject of his biography, Cohen tries to make something out of Watson's work that cannot be found in it. There is no doubt that Watson was a potent catalyst in the formation of modern objective psychology, but he was truly just a catalyst. Next to nothing of scientific interest was left of Watson's own behavioral theories by 1924, when the *New York Times* reviewer of his book *Behaviorism* said it marked a "new epoch in the intellectual history of man." By then, the behavioral stream had moved on and branched in the work of K. S. Lashley, W. S. Hunter, E. R. Guthrie, Stevenson Smith, A. P. Weiss, and others. By 1945, behaviorism had consolidated around the fundamental issue of the nature of the learning process, to which Watson had contributed little beyond drawing attention to the work of the Russians, Bekhterev and Pavlov, on simple conditioned reflexes. The conditioned reflex has a place in modern behavior theory, but not nearly as central or as large a place as Watson, or for that matter Pavlov or Bekhterev, gave it. Like many journalists who write about the subject today, Cohen fails to realize that the subordination of behaviorism to the conditioned reflex was a brief diversion and has been out-of-date news for more than five decades.

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Aplysiology

Behavioral Biology of *Aplysia*. A Contribution to the Comparative Study of Opisthobranch Molluscs. ERIC R. KANDEL. Freeman, San Francisco, 1979. xvi, 464 pp., illus. Cloth, $40; paper, $20.

The gastropod mollusks, in particular the land snail *Helix* and the sea hare, *Aplysia*, were introduced into cellular neurophysiology primarily by the work of Angelique Arvanitaki in the 1940's and Ladislav Tauc starting in the '50's. The nerve cells of these animals lie at the surface of central ganglia, where they are readily visible and recognizable from individual to individual. The somata of these cells are commonly large and easy to impale with microelectrodes, and their electrical distance from their synapses is short enough that synaptic activities are readily recorded. It was thus inevitable that these animals would become popular targets for neurophysiological analysis. Their popularization has unquestionably been hastened and its form strongly influenced by the work of Eric Kandel and his associates on *Aplysia*. Work that has been done on *Aplysia* ranges from neurochemistry of parts of isolated nerve cells, to biophysics of nerve cell potential generation, to pharmacology of synaptic action, to the neuronal bases of behavior. Although Kandel and his collaborators have contributed importantly in all of these areas, their most distinctive contribution has been in establishing *Aplysia* as a model animal for investigating the relationship between nerve cells and behavior.

Behavioral Biology of Aplysia and Kandel's earlier book, *The Cellular Basis of Behavior* (1976), together constitute a major effort to bring both knowledge of the nervous system and behavior of *Aplysia* and an approach to the study thereof to the widest possible audience.

The purpose of *The Cellular Basis of Behavior* was to provide budding neurobiologists with the rather considerable neurophysiological background needed for understanding work on cellular bases of behavior in invertebrates and to summarize the work on *Aplysia* itself. Both from my own classroom experience and from comments of students at a variety of levels, I believe the book to have been a masterly success. *Behavioral Biology of Aplysia* will reach a smaller but I believe no less enthusiastic audience. Its goal is to reintroduce *Aplysia* from a broader point of view; that is, to draw attention to questions of adaptation, evolution, and comparison between closely related forms. It is intended as a handbook of the biology of *Aplysia* for serious students of the animal's behavior and nervous system.

To this end the book brings together a wealth of facts on classification, distribution, system physiology, nutrition, natural history, experimental psychology, experimental biology, and central nervous system physiology of the opisthobranch mollusks, the subclass of the gastropods to which the genus *Aplysia* belongs. There are a variety of ways in which students of *Aplysia*'s behavior and nervous system can benefit from the book.

First, the knowledge the book provides will aid in such practical matters as maintenance of laboratory cultures and physiological preparations. Beyond this, the book is a compendium of useful information on natural history and ecology. Comparative psychologists wanting to design experiments to test the ability of *Aplysia* to learn for food reward and interested in minimizing delays of reinforcement will learn here that even when food is quite close it takes *Aplysia californica* about half an hour to find it; those interested in learned food aversions and specific predispositions to learn should find it useful to be told that

in nature different species of *Aplysia* generally select food types that are most nutritious for them, whereas in the laboratory this selectivity breaks down. It is important that both classes of investigators know that *Aplysia* completes its life cycle in only one year, a fact that must have important implications for the role of learning in its life, for the rapidity of learning, and for the longevity of memory. Students of the well-studied circadian rhythmicities in *Aplysia* will learn here that, whereas *Aplysia californica* are active during the day, several tropical species that are normally active at night become diurnal in the laboratory. All students of molluskan nervous systems should be aided by the explanations of the often confusing twists and turns of the nerve cord and ganglionic fusions that occur in gastropods during evolution and again in modified ways during ontogeny.

Another major value of the book's breadth of information stems from the fact that many "aplysiologists" are specialists who use these animals simply because of the ease with which their nervous systems can be studied. Such investigators must in the course of their work observe phenomena or characteristics that would be of value to understanding some other aspect of the animal's biology. The investigator who is biologically knowledgeable is in a position to recognize the significance of incidental observations. For example, Hughes and Tauc might have dismissed their discovery that there was a homolog of the right giant cell of the abdominal ganglion in the left pleural ganglion as merely one more example of the oddities and complications produced by torsion and detorsion rather than correctly recognizing it as evidence that the ancestral left pallial ganglion had become part of the left pleural rather than the left abdominal ganglion, as older theories had supposed; this sort of revision can alter views of phylogenetic relationships.

Another major benefit to be derived from *Behavioral Biology of Aplysia* is a wealth of ideas for further work. The leads given are many and often fascinating, and answers to many stimulating questions seem within reach. For example, in this as in the earlier book is described a large amount of physiological work on cell R15 of the abdominal ganglion, which displays circadian rhythmicity and a whole range of plastic phenomena; we learn here that when the cell fires it secretes a substance that promotes water retention, which should provide the key to understanding the functional implications of the plasticity and rhythmicity. In the chapter on development of the nervous system, observations are described that suggest that the formation of axosomatic synapses on undifferentiated neuron somata triggers the outgrowth of primary unipolar processes and secondary branches, whereas subsequent growth and differentiation are dependent upon a readily isolatable substance that is secreted into the ganglia by surrounding non-neural support cells. Such information will suggest all sorts of experiments to the developmental neurobiologist. Later in the chapter, we find that searching for adult food in the environment occurs some days before the ability to consume the food develops, and an incomplete version of eating behavior emerges about a day before functionally competent feeding patterns are seen. Given that the neural circuitry of feeding behavior is well on its way to being unraveled, the possibility of elucidating the significance of these precursors to the development of full feeding behavior is obvious.

A central set of questions revolves around the circuitry controlling comparable behaviors in related species. A number of behaviors such as feeding, escape locomotion, withdrawal, and simple forms of learning are now being successfully analyzed at the cellular level in a variety of opisthobranchs. The kinds of questions raised by the cell-by-cell comparisons that are becoming possible are well illustrated by the analysis of feeding behavior. Among the opisthobranchs are forms that get food by scraping seaweed, that bite and swallow it, and that are carnivorous and seize their prey by extending their radulas. How is circuitry modified to produce the variations in behavior? Is a constant set of homologous nerve cells involved? Do their connections change, or are more subtle quantitative variations responsible for changes in the behavior pattern? Do features that are phylogenetically plastic also tend to be plastic in the face of experience? When nonhomologous cells are involved, do similar circuits for similar behavior patterns nevertheless evolve? Although definitive answers are not yet at hand, interesting pieces of information are becoming available. For example, one neuron, the metacerebral giant cell, has already been found to be common to pulmonate mollusks and the opisthobranchs and to have roughly similar but not identical effects on circuitry for feeding behavior in several animals from both subclasses. Analyses at this level should help us to see how natural selection modifies nervous systems to produce new behavior patterns.

Although the book as a whole, which consists largely of strings of facts that cannot yet be assembled into a coherent picture, will be most valuable to investigators of opisthobranch nervous systems and behavior and to systematists looking for new clues to help unravel the somewhat unsettled phylogeny of the mollusks, the chapter on learning, arousal, and motivation should be of great interest to the more general reader. It reviews experiments on learning that go beyond what were discussed in *The Cellular Basis of Behavior* and, I believe more important, discusses a variety of observations on interactions between different kinds of behaviors and behavioral states (for example, what effect do the presence of food and "food arousal" have on defensive behaviors?). The investigation of interactions between well-defined behavioral systems with known circuitry is one of the most exciting challenges of the near future, and this chapter provides an enticing introduction. Kandel engages here in some intentionally simplistic discussion of such concepts as drive, motivation, arousal, and sensitization that may not sit well with some readers. But the result is bound to be critical appraisal that will clarify our thinking and promote cellular analysis.

In sum, *Behavioral Biology of Aplysia* will fill a vital role for serious students of *Aplysia*'s nervous system and behavior. It also contains a great deal of material that will intrigue general neurobiologists willing to take the time to immerse themselves in some 400 pages of "aplysiology."

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Surgeons Observed

Forgive and Remember. Managing Medical Failure. CHARLES L. BOSK. University of Chicago Press, Chicago, 1979. x, 236 pp. $15.

This account of surgical education is a model of careful field research and sociological analysis. Bosk set out to discover how the quality of performance in a social role is monitored and evaluated in the setting of a small group. He selected surgical training as a setting where performance is tangible, radically "open" to inspection, and routinely subject to strict surveillance. Surgical work, clearly, is among the most visible of tasks, far less vexed by intangibles of inter-