Molecules and the Mind

Information in the Brain. A Molecular Perspective. IRA B. BLACK. MIT Press, Cambridge, MA, 1991. xxii, 225 pp., illus. $30. A Bradford Book.

The culmination in the 1950s of many years' effort to discover the basis of heredity will long be regarded as a watershed in biological research. On a more immediate time scale, however, the molecular biological revolution has also had some less fortunate consequences. Preeminent among these is the common belief that explanations of biological phenomena not offered at the molecular level are of little value. Nowhere is this problem more evident than in neurobiology. The issues outstanding in this complex field range from unequivocally molecular questions—the genetics of neuronal differentiation or the mechanism of ion selectivity in membrane channels, for example—to quasi-philosophical concerns, such as the basis of consciousness and the nature of perception. Despite this diversity, there is a widespread conviction that neurobiological problems—from membranes to mind—must be solved primarily in molecular terms. This book is important because it requires the reader to confront squarely the question of whether the present enthusiasm for molecular explanations of the brain—in all its manifestations—is well founded.

Black's aim is an ambitious one, motivated by a perceived "crisis" arising from the absence of a "mechanistic vocabulary" that might animate a general theory relating "mind, brain, and behavior." The stated goal of the book is "to utilize a series of new and radical insights derived from neuroscience to develop a novel formulation of the physical basis of brain function and mind" (p. xii). An excellent expositor, Black is at his best when describing the neurotransmitters associated with particular brain systems and the functional roles such molecules are known to play. The middle chapters, which form about one-third of the book, are largely built upon information now available about catecholaminergic subsystems, the mechanism of catecholamine action, and the regulation of these transmitter molecules and their synthesizing enzymes. This work, to which Black has made important contributions, provides a compelling argument for the proposition that a great deal of useful knowledge about signaling molecules has been gleaned that can sometimes be correlated with behavioral effects. Lucid reviews of trophic factors, opiate peptides, and various molecular dysfunctions that lead to neurological disease are also presented.

Less successful is Black's attempt to place these often fascinating phenomena in a general framework in which molecules serve as "symbols" that link the nuts and bolts of brain function to such fashionable issues as cognition, self, and mind. The central idea he proposes is that neurotransmitters and other signaling molecules in the nervous system have multiple functions. From this generally accepted fact (which applies to hormones and other molecules that convey biological signals), Black extracts a "principle of polyfunction" that is meant to endow neural signaling molecules with special significance. The symbolic role that Black attributes to neurotransmitters derives from their ability to provide an internal representation of external circumstances. The internal symbols arising from the actions of transmitters and other neural signaling molecules constitute a "representational structure that participates in the ongoing operation of the system itself." Summarizing the relation between symbol, self, and subjectivity, Black concludes that "the continuous cycle, the continuous interaction of multiple levels, continually changes the self and its cognitive and emotional underpinnings. . . . Levels within levels and cycles within cycles interact to form and mold the self. . . . It may be concluded that multidirectional interactions among levels are fundamental to brain function and that higher-level regulation of lower-level symbols is widespread throughout the neuraxis. . . . The self, then, is a vast aggregate of functions distributed throughout the brain and even the entire neuraxis" (p. 179). The meaning of all this may be a good deal less clear to readers than his exposition of the conventional roles of transmitters and other molecules that affect neural signaling.

The difficulties Black encounters are largely the result of his persistent attempt to subsume a diversity of poorly understood brain functions under a general theory about molecular signaling. This single-mindedness, while admirable, leads to forced and sometimes inchoate arguments. Understanding any complex phenomenon—a work of art, for instance—demands a variety of intellectual (and technical) schemes. Most art enthusiasts would seek to fathom a painting in terms of form, content, esthetic canons, the social setting of the artist, and so on. Few would wish to limit themselves to analyzing the composition and chemistry of the paint or to elaborate a theory of art on such a limited basis. The molecular framework that Black chooses for this book *does* beautifully illuminate a number of the neurobiological issues he raises. Others such as the nature of subjectivity, self, cognition, and mentation are not much informed by this line of attack.

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Visual Systems

Development of the Visual System. DOMINIC MAN-KIT LAM and CARLA J. SCHATZ, Eds. MIT Press, Cambridge, MA, 1991. xii, 299 pp., illus. $65. Proceedings of the Retina Research Foundation Symposia, vol. 3. A Bradford Book. From a symposium, Woodlands, TX, May 1990.

The highlight of this book is its first chapter: a sparkling account of retinal development in *Drosophila* by Seymour Benzer. Throwing a formidable battery of genetic, molecular-biological, and neuroanatomical techniques at the problem, Benzer and other workers have demonstrated the importance of intercellular communication and regulation, as opposed to cell-autonomous development, in bringing the fly's photoreceptor cells into their crystalline arrays. They have also defined a set of genes that are expressed in a hierarchical sequence during retinal development and whose role, in some cases at least, is understood at a biochemical level. Benzer stresses the potential for application of these findings to an understanding of the development and maldevelopment of the human eye and brain; the radical differences in structure conceal, in his view, a vast shared genetic heritage that current technology makes ripe for analysis. Only at one point does his enthusiasm carry him away,