BOOK REVIEWS

An Envisioning of Consciousness

The Astonishing Hypothesis. The Scientific Search for the Soul. FRANCIS CRICK. Scribner, New York, 1994. xiv, 319 pp., illus. $25.

When thinking about consciousness perhaps eight years ago, I took the opportunity to ask many people their views on the subject. Marvin Minsky described consciousness as relatively unimportant and perhaps only an epiphenomenon, since people are not conscious of how they do their most difficult "computations," such as recognizing objects in a visual scene. In addition, he noted that much progress had been made in getting digital machines to do such tasks without invoking the construct of consciousness. Richard Feynman, who throughout his life had spent considerable time pondering the question of how his brain worked, replied that consciousness was a fascinating subject that he had not been able to define in an operational sense. It was therefore not amenable to experiment or to mathematization and thus lay beyond the confines of science at present. Philip Anderson described why it should most likely be both collective and emergent. Francis Crick when queried commenced a long monologue on Gregor Mendel, peas, and the problem of conceptualizing the gene. The basic thrust of this discourse was that inheritance (and evolution) were the core of biology and had to be pursued regardless of the inadequacy of the definition of the problems. It took decades of fumbling to produce a clear concept of the gene, and decades more to explain that construct in molecular terms. Crick similarly argued that consciousness is so much the essence of humanity that it must be pursued as science however inadequate our current ability to make precise definitions.

The Astonishing Hypothesis is an attempt to make a science of consciousness and to interest others in pursuing this science. It purports to be a book for the general scientist, or even the lay person, with several chapters nominally written for such an audience. In fact, it is a call to the neurobiology and psychology communities, and to scientists at large, to accept consciousness as part of science.

For readers of *Science* the title and subtitle of the book are a little off-putting; "soul" is not a term commonly found in the scientific literature, and the hypothesis that consciousness is a correlate of neurobiology and will have an explanation that requires neither mind-body dualism nor understanding of elementary particle physics will not be amazing to most of the *Science* audience. Do not be put off by these considerations. The book is a heroic attempt to wrest consciousness from the minds of the philosophers and place it in the hands of scientists.

Crick's approach to consciousness is almost solely through our sense of vision. He roughly equates our visual awareness of objects with consciousness, or at least a form of consciousness. This approach has several advantages. Humans are highly visual, and our neocortex devotes large resources to visual processing. Thus there are immense amounts of neurobiology available to bring to bear on the subject. Visual psychophysics has been more intently studied than any other part of psychophysics, and thus there are more bridges available between neurobiology and psychology than in most other areas of perception. And finally, Crick has thought much more about vision than about any other aspect of neurobiology, and this makes him an excellent expositor of this subject.

The weaknesses of using visual awareness as the approach to consciousness are the complexity of the visual processing problem and the fact that we cannot be certain of "awareness" except via verbal communication with humans. A monkey can be trained to do a visual task, pressing a button when it sees (perceives) a particular object or percept. The fact that a monkey seems to behave as we would when we become conscious of a stimulus does not compel us to believe that the monkey is conscious of the stimulus. As Crick acknowledges, humans can react to stimuli they are unaware of (as in scratching a mosquito bite while absorbed in writing a review). When a primate neuron is found whose activity correlates with the monkey's ability to perform the task, it does not at all follow that the neuron is involved in "awareness," since awareness is not given an operational definition in non-humans. This problem becomes even more perplexing if you consider a computer program complex enough to allow a computer to examine visual scenes and answer questions asked about those scenes. If the program reliably gives the same answers as a human to the question "Are you now conscious of a visual pattern in the upper right corner of the visual field? If so, name the object," then does a computer running the program embody consciousness and awareness? We will certainly find within such a computer particular transistors whose activity correlates with the points at which the computer will answer "yes" or "no," so the mere existence of correlates is of no help.

The extreme complexity of visual processing leaves it totally unclear which of the activities and structures present in the human visual system are necessary to awareness or visual consciousness. Vision is too complex, and its complexities allow Crick to write voluminously about details that are peripheral to the essence of awareness. A person with one eye and one visual hemisphere and in dim light (only rods functioning, no color vision) still has visual awareness of objects. How far could the visual stimulus and the visual system be simplified yet still contain the essence of the problem? Other senses might be preferable to the visual system for examining the essence of consciousness. You can suddenly become aware of the odor of an (unseen) rose because a shift of the wind direction presents you with a strong odor dominated by that single source. For this olfactory stimulus, there is no problem of seeing three-dimensional objects from two two-dimensional retinas, no size or location invariance questions, and no "binding problem." We are much more forced to face in this example the fact that we have little to say about what awareness is, for there is no confusion with the difficult but peripheral computational complexities of vision.

The Astonishing Hypothesis is full of contradictions. Perhaps the most egregious is the discussion of consciousness in humans based chiefly on experiments in anesthetized cats. But on a subject as difficult and preliminary as this one, there will be no consistent unitary view, and Crick admits to presenting many possible viewpoints even though they may be contradictory.

In my view, until an operational definition can be given to "awareness" independent of the brain of humans, there is no way a science can be made out of consciousness. I side with Feynman in that regard, and Crick, in sidestepping this issue, in the long run defeats his own program. Like many acts of heroism, this one fails to reach its goal. The book should be read by scientists for its eloquent attempt to put consciousness, which we so much equate with the essence of our humanity, into the realm of science.

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