BOOKS: NEUROSCIENCE

How We See Things

Gerald Westheimer

With his program to "establish an exact study of the functional relationship between the mental and the material worlds," the 19th-century physician, physicist, and polymath Gustav Theodor Fechner founded a new discipline he called psychophysics, a name accurately reflecting its agenda. He understood that any attempt to be "exact" when forging a functional relationship between two domains would founder unless both are capable of supporting rigorous measurements. Precision in defining and measuring physical variables has always been a viable proposition. In Fechner's time, physics seemed to give a complete and consistent picture of the world. The 20th-century reservations that have clouded that view still do not materially influence the determinism that the physical sciences provide in the study of perception.

Human Perception of Objects
Early Visual Processing of Spatial Form Defined by Luminance, Color, Texture, Motion, and Binocular Disparity
by David Regan

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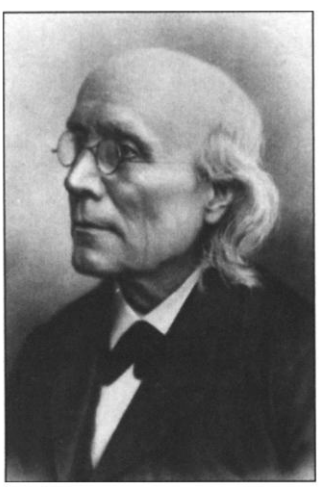
Whereas physicists have succeeded in downplaying the role of the human observer in securing empirical data, the situation is not quite so simple in the brain sciences. Certainly a huge knowledge base has been acquired through methods that investigate the brain in the manner of physical scientists, for example by using instruments to measure electric potentials, nerve pulse rates, changes in blood flow, or concentrations of neural transmitters. With such devices, the researcher's role in gathering data is not too different from that in the rest of science. Yet this is precisely what Fechner intended to transcend. He expressed what every 19th-century physiologist knew, but what has been gradually lost with the 20th-century's giant strides in exploring the nervous system, namely that there is a mental world. The question then and now is: how does one do science in such an arena? Helmholtz, the giant of 19th-century sensory physiology wisely decided to postpone such a quest, in the hope that it would become redundant as the physical sciences developed. Being nothing if not consequent, he resigned his chair of physiology in Heidelberg to become professor of physics in Berlin. But the problem, of course, has not gone away. It keeps on reappearing in all sorts of forms; whether the brain is a computer is just one of its reincarnations.



Psychophysics' founder. The polymath Fechner laid out a program to demonstrate empirically the unity of mind and body.

In the pursuit of Fechner's program there has been at least one route to success. True, the mental world is rich, varied, and complex, but rather than being ignored, it can be narrowed. Presented with a set of abstract stimuli, the human observer can be assigned a circumscribed role, for example merely to report which of two alternatives best describes the resulting experience. There will be scatter of data, but surprisingly it is often no different than in measurements elsewhere in science. This is Fechner's psychophysics at its most elementary. In the final analysis it has no substitute; no amount of probing of neuronal impulses, or any other brain signals, can stand in for the observer's report.

Human Perception of Objects is devoted to a wide range of visual phenomena that this approach has elucidated. David Regan, a professor of psychology at York University, Toronto, was trained as a physicist but has long been active in vision science. The book's subtitle, *Early Visual Processing of Spatial Form Defined by Luminance, Color, Texture, Motion, and Binocular Disparity*, provides an accurate guide of its content. Here, "early" refers to the beginning sequence of operations to which visual signals are subjected in the eye and the brain, where the analytical apparatus highlighted in the book is most appropriate. At that stage, processing is often nearly linear, and the categorizations of brightness, position, orientation, color and depth, with their strong roots in physics, are most effectively employed. Regan is particularly strong in confronting the issue of "channels," the concept that, even within a modality, processing occurs through a small number of independent submodalities. Channels are best exemplified by the three primary color mechanisms, but they have since been made part (though somewhat less incisively) of the analysis of form and orientation. Hovering in the background, as is appropriate for a contemporary book on vision, are the neurophysiological findings from other mammals, so spectacularly pioneered by the likes of Hartline, Kuffler, Hubel, and Wiesel. In Regan's hands, however, these aspects remain in perspective and do not become synonymous with human vision.

Sneaky spider. By merging into the three-dimensional organization of its surroundings, the crab spider defeats the camouflage-breaking capability of stereoscopic depth perception.

The book's sense of purpose and direction is nowhere lost, and from the start of the preface, the reader is immediately drawn into a close personal relationship with the author. Regan, it is clear throughout, is more comfortable with operationally definable and measurable concepts than with speculations about hypothetical perceptual notions. He rises above the traditional accounts of sinusoidal grating thresholds to cover, in particular, the visual detection of position, motion, and depth. But he stops short of such neighboring though less rigorously charted territory as Gestalt grouping or the response classifications that visual illusions imply.

Object recognition, however, is more demanding and challenging than mere form perception. Hence the book's title contains an unfulfilled promise; the more accurate subtitle describes what is delivered. Just as Fechner recognized that a science of perception is not complete without including the observer, so a book like Regan's makes us aware of the need to transcend the current trend of using the observer as a null measuring device. A treatment of the human perception of objects, one written with the precision with which Regan endows his account of the processing of spatial form, is still over the horizon.

The author is in the Division of Neurobiology, University of California, Berkeley, 565 Life Sciences Addition, Berkeley, CA 94720–3200, USA. E-mail: gwest@socrates.berkeley.edu