Looking Backward

**Why We See What We Do: An Empirical Theory of Vision**

by Dale Purves and Beau Lotto

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Reviewed by Alan Gilchrist

To the surprise of most people, vision has not yet been explained scientifically. There is no agreement on how we see the size of an object (at various distances), its color, and whether it is moving or not, simply by looking at it. How does the rich, three-dimensional world of visual experience arise from the ambiguous, seemingly impoverished two-dimensional image projected onto the retina? Imagine that a retinal image contains a trapezoidal region of a given intensity. Its shape could come from a rectangle lying down or a trapezoid standing up. Its intensity could come from a white surface in dim light or a black surface in bright light. How does the visual system compute an answer (that is, generate a percept)?

Purves and Lotto must be applauded for defining this "pervasive ambiguity of retinal stimuli" as the central problem. In the finest tradition of giving science away, they bring this problem to life using a series of computer-generated illustrations that delight the eye and edify the mind. The coverage is reasonable, with chapters on lightness, color, three-dimensional space and motion. Sensory physiology is thoroughly addressed, which is not surprising given the status of the senior author as a leading neuroscientist. More surprising is the authors’ bold critique of sensory physiology. Dismissing current research trends (such as channels) as fads, they argue that neuroscience has failed to address the ambiguity problem. They assign a vital role to phenomenology and suggest that rapid progress in neuroscience requires an understanding of the "overarching strategy of vision."

The authors argue at great length that the ambiguity of the retinal image is solved by the human visual system in a "wholly empirical" fashion. Whereas other theories invoke inferential processes, contextual patterns or maximum simplicity, Purves and Lotto speak of probabilities extracted from past visual experience. Consulting my stored memories of similar trapezoidal images, I discover that in most cases, the object turned out to be a rectangle. Thus I see a rectangle.

Past-experience theories have historically moved in and out of fashion. Although not mentioned by Purves and Lotto, Adelbert Ames and his colleagues promoted the same theory, called transactionalism, in the mid-20th century, illustrating it with such engaging demonstra-

Alan Gilchrist is in the Psychology Department, Rutgers University, Newark, New Jersey 07102, USA. e-mail: alan@psychology.rutgers.edu

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