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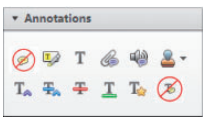

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Wagemans, J. (Ed.). The Oxford Handbook of Perceptual Organization
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Book Review

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Reviewed by: Bruce Bridgeman, *University of California, Santa Cruz, CA, USA*

It will take a large dose of perceptual organization to digest this book, more than a thousand pages and half a million words, small type, and 51 contributions. But the contributions from leading experts in the study of perception are sweeping and authoritative. This will be the standard reference work for a generation to come. It isn't intended to be read cover to cover, but as a series of authoritative reviews essential for the library of everyone interested in perception.

The volume is not for the casually interested. When a chapter brings up Panum's fusional area for example, there is no definition and no explanation. You just have to know what it is and why it is important. The chapters are aimed at professionals.

That said, the volume is not without mistakes. For example, Schwarzkopf and Rees in their chapter on perceptual organization and consciousness note Richard Gregory's interpretation of the Müller–Lyer illusion as involving perceived three-dimensional distance. But the illusion does not require inward- and outward-facing arrows. It works with circles, squares, or just about any scribble, evidence that it is the low-spatial-frequency components in the arrows, not their detailed geometry, that are responsible for the illusion. Faced with such evidence, Gregory freely admitted that his interpretation was wrong. In the same chapter is an illustration of that illusion, but with a twist—the line with outward-extending arrows really is longer than the one with inward-extending arrows, as though the editors didn't really believe in the illusion. The same problem infects beginning psychology textbooks: Favreau (1977) renamed it the Müller–Lyer illusion.

In a volume of this size, some lapses or misinterpretations inevitably arise. In the otherwise excellent and informative chapter by Goodale and Ganel on two visual systems, one for perception and the other for action, the impression is given that the distinction was introduced by Goodale and Milner in 1992. But the first wide-ranging analysis of vision in these terms came in a special issue of *Psychologische Forschung* in 1968. The first demonstration of the distinction in normal human behavior came from Bridgeman, Lewis, Heit, and Nagle (1979), and many more studies defining the systems and their interactions appeared before 1992. The perception–action distinction is an important one for understanding sensory systems, though, for at base the senses have two distinct jobs, first to acquire information about the world for use in planning future behavior and second to guide immediate action in real time. The chapter remains an intellectual tour de force, reviewing a wealth of methods to address the what–how distinction, most relating to vision.

Of particular interest, and unusual for an archival volume of this sort, is a section on applications. It includes a chapter on camouflage in animals (Osorio and Cuthill), influenced

by Gestalt psychology and more recently by pattern recognition data and theories. The chapter includes arresting illustrations of effective camouflage, though the defeat of camouflage by stereoscopic vision is of course not available in the images. Applications of Gestalt ideas also figure in a chapter on Bauhaus architecture and design, and even Japanese gardens (van Tonder and Vishwanath). More general perceptual organization in art is handled in the final chapter of this section (Koenderink).

With so many authors, there is inevitably some overlap and redundancy in the chapters. Mary Peterson's chapter on psychophysics of figure–ground organization overlaps with Self and Roelfsema's "The neural mechanisms of figure–ground segregation" as well as Kogo and van Ee's "Neural mechanisms of figure–ground organization: Border-ownership, competition and perceptual switching." It is sometimes useful, though, to get varying theoretical perspectives on similar problems. Reviewing these chapters, it became clear that in nature every edge, every contrast has a three-dimensional interpretation—a surface roughness, a dihedral angle, or an occlusion. As a result, our evolved visual systems struggle to provide three-dimensional interpretations of every brightness gradient, often resulting in illusions in our artificial world where many edges printed on planes provide information. Reading (missing from the volume) is an example, where alphabets around the world scrupulously avoid letters with patterns that might have a three-dimensional interpretation.

Despite the handbook's more general title, almost all of the articles concern vision. This is partially justified because that sense looms large in human perception and correspondingly more is known about it. There is a section on "Other Modalities," but even that section is partly about vision, including the Goodale and Ganel chapter and another on sensory substitution (Stiles and Shimojo).

The chapter on tactile and haptic perceptual organization (Kappers and Bergmann Tiest), however, contains some real surprises for those accustomed to considering the perceptual properties of vision. The spatial relations section of the chapter includes a historical context going back to Helmholtz, pointing out non-veridical aspects of perception. (It takes about two weeks to beat naive realism out of our beginning psychology undergraduates at the University of California). Tactile perception involves reference to the body in ways that vision does not. Asking blindfolded observers to adjust two threads on a table to be parallel resulted in the threads diverging if the distance between the threads was smaller than the observer's shoulder width, and converging if the distance between them was larger. Setting aluminum bars on a table to be parallel while blindfolded also elicits huge errors, up to 90°, depending on the orientation of the observer's hands. The errors might be due to the realization that proprioception of position is startlingly poor, something we also knew from vision, but here it has unexpected real-world consequences. The errors decline after a delay, suggesting a shift from an egocentric to a more allocentric reference frame, something also seen in vision but apparently not so exclusively visual as we had thought. So comparing chapters in this comprehensive volume can teach us a lot that our piecemeal experiments and papers cannot.

Especially welcome is a pair of chapters (van Leeuwen) that go beyond descriptive theory and phenomenology to attack the brain mechanisms of perception. The chapters are tantalizing because after nearly a century of modern neurophysiology, we still don't know the actual processing that underlies any complex perceptual process. The chapters show us when and roughly where to look for such mechanisms, by EEG and other tools, and they show us that, whatever the mechanisms are, they must be distributed over billions of neurons
1 and support cells. A single-cell recording gives us a sample of perhaps one billionth of the system of which a neuron is a part. We have recordings of a myriad of types of clever neurons, but in most cases we still don't know how those neurons do what they do.

What are their inputs, what algorithms are being instantiated? David Marr pointed to the importance of the algorithm level that sits between neural receptive fields on one hand and behavior on the other, but knowledge of neural algorithms remains the weak link in understanding how the brain works. Current models are limited—perhaps there will never be adequate models of how a billion neurons cooperate to allow pattern recognition and visually guided behavior because an adequate model would be too complex for us to understand. But we won't know until we try.

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