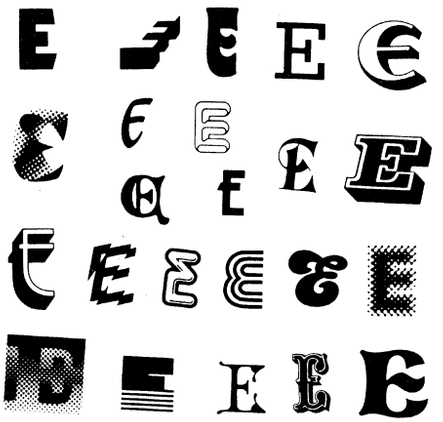
Pattern Recognition

Figural Synthesis. PETER C. DODWELL and TERRY CAELLI, Eds. Erlbaum, Hillsdale, N.J., 1984. x, 310 pp., illus. $34.95.

In the early 1960's, it was found that the area of the mammalian visual cortex onto which the retina first projects contains a multitude of cells responsive to such image characteristics as the orientation, position, and direction of motion of local contour segments. The cortical processing of image information thus appears to begin with an analysis of the image into a collection of local contour attributes. We do not perceive the world as a collection of local attributes, however: we perceive global figures and coherent configurations. Whether one chooses to regard the initial stage of analysis as one in which features or one in which spatial frequencies are being extracted, it is evident that the extracted attributes must be recombined at some later stage in a process of figural synthesis. The manner in which this synthesis occurs has been the subject of substantial speculation.

The issue of how local information is recombined to form global figure percepts is necessarily intertwined with the issue of the visual constancies. The images of objects formed on the retina alter their size, shape, and orientation as an observer changes position. These instabilities are largely absent from our internal representations. We therefore do not see a simple reconstruction of the image; we see a model of the world that manifests considerable invariance despite a variety of image transformations. Any account of the process of figural synthesis must account for this invariance.

Figural Synthesis is a collection of nine papers that address various aspects of these intertwined issues. The level of inquiry of the first two papers is that of perceptual phenomena. In the opening paper, Julian Hochberg critically reviews the two general classes of explanation that have been offered to account for the perceptual constancies, explanations that invoke inference-like processes and those that invoke direct neural responses to image attributes, and argues that the integration of sensory information must be mediated by mental structures. He reviews recent findings concerning the perception of figures in aperture viewing situations (situations in which figures are presented piecemeal across time). In the second paper, Walter Gogel considers some of the ways in which perceptions can determine other perceptions. Two classes of phenomena are considered in substantial detail: the relation of perceived size and perceived distance and the induction of motion in stationary objects by a moving surround.



"Variations on the letter E. Most of these examples can be identified in isolation by human observers. A simple encoding of lines and angles would, however, be highly misleading in several of these examples due to the addition of depth information and extraneous, stylistic contours. Some preprocessing such as blurring might be useful in order to ignore irrelevant details." [From P. Cavanagh's paper in *Figural Synthesis*]

The remaining seven papers are primarily concerned with modeling some of the possible neurophysiological mechanisms by which the contour characteristics extracted in the initial stage of analysis might subsequently be integrated. The prevalent level of analysis is what Peter Dodwell terms "level two," the level at which the "organization and transformation of sensory attributes" occur, prior to the actual comprehension and naming of figures. David Foster reports on experimental attempts to assess the nature of the codes used to specify high-order spatial relations and pattern attributes. Michael Cohen and Steven Grossberg address the question of how a neural system apparently designed specifically to process contours goes about computing and filling in regions of uniform luminance and propose neural standing waves as the basis for a solution. Terry Caelli attempts to model a theory of image coding that is couched in terms of the properties of "perceptive fields," spatial codes that are determined psychophysically and that "exhibit tuning characteristics and geometric and processing determinants." Patrick Cavanagh argues for the potential value of a neural log polar frequency transform in the extraction of invariant pattern information. Dodwell, who has worked within the context of the model of neurophysiological vectorfields developed by William Hoffman, reports research directed at demonstrating the salience of certain Lie group transformations in the processing of visual information. Hoffman reviews and extends his model of cortical vectorfields. Steven Zucker discusses computational strategies for the analysis of two types of dot pattern; patterns he terms "type I," which give rise to the impression of well-defined contours or edges, and patterns he terms "type II," which give rise to the impression of a directional flow.

The book is, to a significant extent, one in which specialists are speaking to specialists. Certain papers should be of interest to all researchers concerned with the topic of shape perception. Hochberg's paper addresses a number of provocative issues regarding the nature of perceptual processes. Dodwell presents data on the McCollough effect that have implications that extend beyond the theoretical model he is testing. The emphasis of the book, however, is on mathematical models, and the papers by Cohen and Grossberg, Caelli, and Hoffman are likely to be in large part accessible only to visual psychologists who are also mathematical modelers. This stress on mathematical models is to some extent at the expense of a wider representation of more cognitive approaches to the subject of figure perception. Within the context of this limitation, *Figural Synthesis* is a valuable review of some current approaches to a difficult subject that is of fundamental importance to an understanding of the nature of vision.

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Vision

Visual Masking. An Integrative Approach. BRUNO G. BREITMEYER. Clarendon (Oxford University Press), New York, 1984. x, 454 pp., illus. $34.95. Oxford Psychology Series no. 4.

Visual masking is intuitively easy to understand: the visibility of one stimulus (called a "target") is impaired when that stimulus occurs closely in space and in time with another (called a "mask"). Despite its intuitive simplicity, however, masking is one of visual science's most confusing and controversial subjects. To give just one example, for years investigators have quarreled over whether maximum masking (that is, the most pronounced impairment of target visibility by a mask) occurs when target and mask are presented simultaneously or when