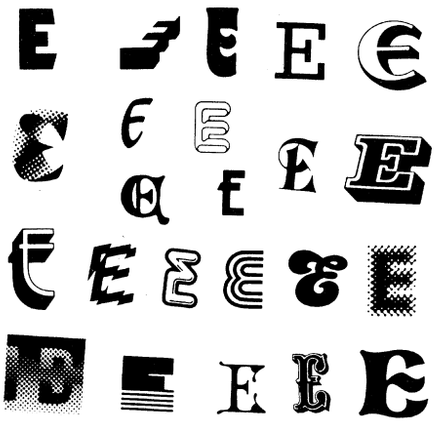
Pattern Recognition

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.

ROBERT FENDRICH
Department of Psychology, Quincy College, Quincy, Illinois 62301

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

whereas others think that a mask interrupts the processing of a target by means of inhibition.

As researchers have attempted to resolve these and other issues, masking has become one of visual science's most widely studied subjects. At the same time, it has been one of perceptual psychology's standard tools for investigating visual phenomena ranging from rod-cone interactions to subliminal perception. In view of the extensive research on masking, the time was ripe for the appearance of a book on the subject. It is gratifying that such a book has now been authored by Bruno Breitmeyer. During the last decade Breitmeyer has made many experimental contributions on this subject, and his 1976 theoretical paper with Leo Ganz is the most ambitious attempt to date at a comprehensive model of visual masking.

In his opening chapter Breitmeyer does a marvelous job of placing the study of visual masking in a historical context. He has unearthed quotations from published papers that show that most of the salient features of masking were recognized by the latter half of the 19th century. We discover, for instance, that Sherrington appreciated the distinction between forward and backward masking, and we also learn that the seeds for the two major categories of contemporary masking theories (integration and interruption theories) were planted by Stigler around the turn of the century. The next several chapters review the voluminous literature on masking, with particular emphasis on metacontrast masking (backward masking in which a target and a mask do not overlap spatially). In these chapters Breitmeyer introduces two major themes that run throughout the rest of the book: that temporal transients play a crucial role in masking and that masking results from interactions at multiple levels of stimulus processing. Next comes a chapter that critically reviews contemporary theories of masking. The chapter is intended to set the stage for Breitmeyer's own theory, and as a result some other theories are covered perfunctorily or not at all.

Breitmeyer's theory of visual masking, which is the focus of the rest of the book, is an unabashedly neuropsychological one. Expanding on the model presented in his 1976 paper, Breitmeyer voring some form of it. Breitmeyer, however, endorses a rather extreme, and therefore controversial, version of the distinction. For one thing, he equates sustained and transient channels with X and Y cells. This is a mistake, for both cell types can exhibit either sustained or transient responses, depending on stimulus factors. The mistake is compounded when Breitmeyer overemphasizes the differences between the receptive-field properties of X and Y cells. He erroneously concludes, for instance, that transient (Y) cells behave like low-pass spatial filters whereas sustained (X) cells resemble band-pass spatial filters. In fact, both cell types typically exhibit band-pass selectivity. Breitmeyer also concludes that transient cells respond faster than do sustained cells, when in fact there is solid evidence to the contrary.

Breitmeyer could avoid these difficulties by abandoning the physiological underpinnings of sustained and transient channels and relying entirely on psychophysics. Even neurophysiologists acknowledge that the story of the X and Y cells remains too muddled to be useful dation, Breitmeyer's theory would bother those who demand logically tight, neuroreductionistic reasoning. From the outset Breitmeyer candidly admits that his theory is built on "fuzzy" categories, as he calls them, and he argues that the fuzziness is a necessary consequence of his integrative approach. Breitmeyer's approach *is* bold; it offers an account of perceptual and neural findings in which coherence is provided by functional parallels between these two classes of phenomena. Moreover, in the last few chapters Breitmeyer tackles the issue of ecological significance by arguing that visual masking plays important roles in normal visual behavior, including the elimination of "double-exposures" from different, successively fixated scenes.

Whether Breitmeyer's integrative approach is successful remains debatable, but it is surely interesting and significant. Breitmeyer has given us a well-written, provocative book that is the definitive source on visual masking.

RANDOLPH BLAKE
Cresap Neuroscience Laboratory, Northwestern University, Evanston, Illinois 60201

Issues of Gene Regulation

DNA Methylation. Biochemistry and Biological Significance. AHARON RAZIN, HOWARD CEDAR, and ARTHUR D. RIGGS, Eds. Springer-Verlag, New York, 1984. xiv, 392 pp., illus. $59.50. Springer Series in Molecular Biology.

The level of interest and research activity focused on the biochemical mechanisms and biological functions of DNA methylation has grown exponentially in recent years, as is evidenced by a cursory review of the number of scientific journal articles addressing this subject. Despite the intense study there remain many unanswered questions, and any discussion of DNA methylation is likely to evoke strong opinions from serious followers of the subject. Given this state of affairs it seems a propitious time to summarize the existing experimental data about DNA methylation in a manner more comprehensive than would be possible in a single journal review article. To provide such a summary is the expressed intention of the editors of *DNA Methylation*. They have set out to provide an in-depth introduction for students, as well as a reference guide for investigators working in the field. The book contains 16 chapters, beginning with a general introduction and continuing with a series of mini-reviews, each of which is focused on a particular aspect of DNA methylation. The result shows that a well-written and well-organized collection of contributions by different authors can provide an authoritative, readable,