1-1-1982

Frisby: Seeing: Illusion, Brain and Mind

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It looks like a coffee-table book—large, glossy format, illustrations on almost every page. And do our eyes deceive us? Yes, they do. Straight lines appear distorted, regions of the same lightness and color look different, edges appear where there are none printed. Spectacles are provided, one lens a red filter, the other a green filter, and with the aid of these, patterns appear in depth. These include a marvelous three-dimensional spiral which rises up out of the page from what had been only a random texture of red and green dots. The book also includes reproductions of some of Escher’s impossible landscapes and the work of other artists who have explored the limits of ambiguity in pictorial representation. There are numerous diagrams of neural networks and photomicrographs of bits of the brains of various animals. All these figures, diagrams, photographs, and pictures have been conceived and laid out with great care, making a book which is thought provoking before we even read a word.

Frisby has a lot to add to the visual message. The illustrations and diagrams are organized to present a particular view of how seeing comes about. Perception is held to consist of a series of operations or “strategies” by which the incoming visual information is handled. Illusions are important because they are “misapplications of perceptual strategies”; they give us a glimpse through the phenomenologically immediate and smooth fabric of perception at the machinery which creates the fine surface. In other words, our visual systems perform so well and with so little effort that only by means of tricks and special effects can we believe that complex processes are involved.

Illusions are used to illustrate a series of lessons about vision. The first is a stern warning against the naive, simplistic notion that seeing is the creation of a picture of the world in the head. Frisby uses illusions to argue against this view; if what we see is so often distorted, then vision cannot be simply a direct copy. He uses the Escher waterfall as an example, arguing that since we perceive something that is impossible, our perceptual mechanisms must be capable of false descriptions, not merely incomplete ones. Of course, nobody really believes in pictures in the head, but Frisby is using the idea as part of a rhetorical device to set up, by contrast, his own conception of how perception works.

There is a long tradition in psychology for using elaborate metaphors to elucidate the human mind. Freud used a short hydrodynamic model based on the idea of libido as a fluid quantity. Donders treated us as telegraph wires. The Gestalt psychologists suggested that we have analogs of magnetic force fields in our heads. None of these devices has been as rich and fruitful as the comparison of the human mind to the structure of a computer or to the structure of a computer program. But Frisby does not take the computer as a metaphor for mind; rather he suggests that the human being is a form of computer, albeit one of great sophistication. The computer is fed with data in the form of symbols which it then manipulates in its electronics circuits to produce output, also in the form of symbols. The human visual mechanism is also thought of as receiving data, only it is in the form of the structure of light entering the eye. This light contains information about the environment. Once in the eye, this structured light is converted by receptors in the retina into symbols carried by electrical impulses through the nerve cells. The output is the percept.

Central to this view of the mind is a semiotic device. The human visual mechanism is understood to be building up a symbolic description of the environment. According to Frisby, the electrical impulses in the retina resulting from the transduction of the incoming light are symbols. These are not symbols of the kind used in communication, words, pictures, etc. Nor are they symbols in that they are labels for concepts. These are symbols in the sense that a certain neural activity correlates with certain physical stimulus. Insofar as the relationship is correlative and not denotational, many semioticians would call these “signs,” not “symbols.” However, as this was always a tricky distinction and the results of Frisby’s analysis are interesting, perhaps the point is not worth laboring. The important idea is that if a model of vision, or any other psychological activity, can be simulated on a computing machine, no one can accuse the model of not accounting for the phenomenon. The device forces the theorist to be explicit and precise.

Throughout the book, it is assumed that all human beings see in the same way. In many cases, it is assumed that most vertebrates see in the same way, and much of the evidence is derived from neurophysiological studies of animals such as cats and monkeys. One could not, therefore, use this work as a basis for an analysis of the way in which different cultures use visual symbols, or for any high-level analysis of what constitutes the content of perception. One might be able to use it to compare the wiring of different species. This is only to point out that the analysis is not aimed at revealing our higher faculties, but rather is intended to be a description of the basic grammar of seeing. As such, it is an insightful composite of much that is exciting in current vision research.

Seeing is considered to be a series of mathematical transformations of incoming data. These transformations are described on three levels. First, there is a description
of the mathematics itself. Frisby explains how it is possible for features consisting of bars, edges, and corners to be extracted from two-dimensional patterns. Second, there is a description of "the visual machinery of the brain." This consists mostly of evidence gained from studies of cats and monkeys who had tiny electrodes inserted into their brains while patterns were flashed in front of their eyes. These studies revealed that in certain areas of the brain, nerve cells seem to be behaving like feature detectors, responding selectively to bars, edges, and the like. The third strand of the argument comes from studies with humans. These usually involve having people stare at patterns for long periods of time after which other patterns look different. For example, wider stripes will appear to be even wider to a subject after he or she has stared at narrow stripes. Such effects are usually interpreted as being due to fatigue of cells in the human brain similar to those found in the cat or monkey brains. This completes the link between the computer, the cat and monkey, and the human.

With this three-pronged approach Frisby often achieves a fine synthesis of current ideas in psychology, computer artificial intelligence, and neurophysiology. It is not unusual to blend ideas from these separate disciplines: indeed the disciplines themselves are constantly borrowing from one another, and they have a pool of ideas in common. However, it is certainly an achievement to have made the blend so readable.

Unfortunately, in the chapter on lightness and brightness the approach fails. There is a problem that puzzles vision researchers which can be stated in the form of the following question: "Why does soot look black even in sunlight, when it may be reflecting more light to the eye than snow in an adjacent shadow?" Frisby claims to have the solution. He suggests that the edges, where the light distribution changes gradually, are interpreted as changes in illumination, and this can then be discounted when we calculate the lightness of a surface. He gives shadow as an example of light changing gradually. Abrupt changes in the light entering the eye are to be interpreted as changes in surface lightness. According to this formula all the brain has to do to judge the relative lightness of a surface is to discount diffuse edges and take sharp edges into account.

There are numerous situations for which the theory does not work. Consider the corner of a concrete building, one wall of which has the sun shining on it. At this corner there is an abrupt change in illumination, yet there is no change in surface lightness. According to Frisby's view we should see one wall as black and one as white. Of course, we do not; we see both walls as the same gray, and we see that one wall is illuminated by bright sunlight. With respect to shadows, even though they have fuzzy edges, their images on the retina may be sharp, if they are viewed from a distance. Thus, the shadow of a large object, say a tree trunk, will project a sharp edge to the back of the eye when viewed from a distance of a few yards. Clearly, in order to distinguish illumination from surface lightness, we need to do more than just sort out the sharp and fuzzy edges. We have to know about the spatial arrangements of things before we can figure out what parts of the environment are better illuminated; only then can we discount the illumination in arriving at a judgment of surface lightness.

Overall, the book works much better at explaining the illusions which illustrate its pages than in explaining the appearance of objects in the environment, or in saying anything that would be relevant to the student of human culture. Frisby does not use his levels-of-description approach to attempt analysis at high levels. There is little here to tell us how we recognize a friend or appreciate a dance. This narrowness of scope is due to the reliance on neurophysiology and computer models for explanations. These models tell us about organization into visual features, but beyond that neurophysiology tells us nothing; and the computer models, for the most part, rely on findings two generations old by the Gestalt psychologists.

Of course, it is not fair to criticize Frisby for the fact that scientists have not solved all the mysteries of perception, and there is enough current excitement in the areas of neurophysiology and artificial intelligence to warrant a number of books of this kind. Frisby has written a lively, entertaining introduction to these areas. However, the grand scope of the semiotic design which he lays before us at the beginning of the book leads us to expect more. There is a lot known about aspects of perception such as form perception, visual symbols (as they are used in communication), composition in the graphic arts, and space in architecture. The levels-of-description idea would be well suited to dealing with these areas; while it is unnecessarily powerful to deal with feature detectors. It is as though, in his enthusiasm about the area of computer artificial intelligence, Frisby had decided to limit his understanding of human vision to what can be programmed into a computer. Indeed, it often comes across as though he is more interested in how computers can see than in how people can see, and at the end, while pushing the point that man is a machine, he flips it around and argues that machines can be sentient creatures. The following words are drawn from his concluding paragraph:

... as the pursuit of artificial intelligence proceeds, I am sure we will have to adjust our notions about the nature of man, just as the Victorians had to adjust theirs in the fact of Darwin's theory of evolution. "Man is an animal? Rubbish!" was the irrational, all too common, but also very understandable, reaction to Darwin's ideas. Today the parallel response is: "Man is a machine? Ridiculous!" quickly followed by remarks revealing some sadly ignorant myths— "Machines can't think," "Computers are no more than large, electronic arithmetic calculators." "Machines do only what they are told to do," and so on. Machines are simply not necessarily like that, certainly not present-day sophisticated computers, but this fact is not widely recognized.
Either one is left gasping and horrified by this vision of a new conceptual revolution brought about by computers, in which case the conceptual framework of the book will also be unacceptable; it would be best to leave it on the coffee table to glance through and look at the pictures; or one may be excited and exhilarated by the technological revolution, in which case one may enjoy looking at human vision through the eyes, as it were, of a computer.


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Several years ago, Susan Sontag wrote that "a widely agreed-on" attitude argues that a society can be considered "modern" when "one of its chief activities is producing and consuming images." She went on to assert that within this modern society "the images that have virtually unlimited authority are...mainly photographic images" and that "the concept of the authority stems from the properties peculiar to images taken by the camera." (Sontag 1977:153). She recognized that a modern society communicates largely through visual means, and that an understanding of the properties peculiar to images taken by the camera is essential for the understanding of the means of communication within the contemporary world.

It is for this reason that we should welcome two books recently published by David Godine of Boston, both of which represent an attempt to analyze precisely these properties peculiar to images taken by the camera. Janet Malcolm's Diana and Nikon approaches the issue from the tradition of formalist art criticism; Gisèle Freund's Photography and Society approaches the issue from the tradition of Marxist critical theory. The two books are in a sense complementary, at least to the extent that they represent two of the major approaches to photographic criticism. Both propose certain questions, but Freund's book certainly provides more answers. Perhaps this is because she is not trapped by the dichotomy indicated by the books' titles; that, somehow, the aesthetic aspects of photography should be distinct from the social aspects.

Janet Malcolm's Diana and Nikon is a collection of 11 essays which, with one exception, originally were written for The New Yorker at various times during the past few years. Malcolm is one of the few serious photographic critics working for a major magazine, and as such she has had to make her way into relatively uncharted territory. In these essays, she is certainly searching for the properties peculiar to art photography; she is searching for the identity of the photographic critic as well. It is, however, a very self-conscious quest, and she is candid enough in her preface to admit that in "rereading these essays" she is reminded of "someone trying to cut down a tree who has never done it before, isn't strong, has a dull axe, but is very stubborn" (p. ix). She certainly makes a brave attempt, but unfortunately this particular tree is very large, and one suspects that she is inadvertently using the wrong end of the axe.

Malcolm, like most critics involved with the discussion of the aesthetics of photography, is concerned about the position of the photograph in the world of art vis-à-vis the painting. She distinguishes herself from many less successful writers, however, by the ruthlessness with which she is willing to expose the dependence of certain photographers upon this older and better-established medium. In discussing the work of Alfred Stieglitz and the Photo Secession group at the turn of the century, for example, she unequivocally states that "the most advanced photographers were modelling their work on Symbolist, Impressionist, and Pre-Raphaelite painting" and creating, as a result, "portentous, misty landscapes" and "blurred, symbolic portraits...of sad, gloomy women and marmoreal, naked children" (pp. 2-3). And in discussing the work of Edward Weston, Paul Strand, and Man Ray, major figures in the medium 20 years later, she argues that their achievement was largely "to replace the Impressionist, Symbolist, and Pre-Raphaelite models of the Photo Secession with those of the Cubist, Futurist, Dadaist, Purist, and Surrealist art" (p. 21). Few writers are so willing to devastate the sacred images of any medium.

But the analysis of the relationship between photography and painting that represents one of the strong points of her approach to photographic history paradoxically contributes to her downfall as well. As a historian, she is refreshingly willing to revise the accepted manner of looking at the "classics" of photographic history: many professionals in the field have suspected the strong connection between avant-garde photography and avant-garde painting, but few have been so forthright in their analysis of it. As a critic, however, she has placed herself in an entirely untenable position, as the method of criticism that has most influenced her is one that is inextricably associated with painting. Moreover, it is a method of criticism that developed, at least