DISCUSSION

JAMES GIBSON'S PASSIVE THEORY OF PERCEPTION: A REJECTION OF THE DOCTRINE OF SPECIFIC NERVE ENERGIES*

James Gibson has developed an initially persausive and highly influential theory of perception, whose features are molded against the contours of the doctrine of specific nerve energies. In this paper I would like first to portray briefly the doctrine of specific nerve energies as expressed by Johannes Müller, and then to investigate more finely Gibson's opposing image of perception. I believe that this examination will reveal Gibson's passive theory of perception to be unwarranted by the evidence and in its particular assertions to be logically defective.

Müller's doctrine of specific nerve energies. Though the doctrine of specific nerve energies was not original with Müller—he acknowledged the views of Sir Charles Bell and the central elements of the doctrine can be traced through Kant, Locke, Descartes, Galileo back to Plato and Democritus—nonetheless he gave the conception form and currency in psychology. In Book V of volume II of his celebrated *Handbuch der Physiologie des Menschen* (1833 to 1840), Müller propounds and elaborates the doctrine in a series of ten laws.[1] But the basic tenets of the thesis are simply expressed:

> That which comes to consciousness by way of the senses are immediately only the properties and conditions of our nerves; but imagination and judgment are ready to interpret the events produced in our nerves as properties and changes of the external body . . . [Further] the mind not only receives the content of sensation and interprets it imaginatively, but it also has an influence on the very content of sense. . . .[2]

The doctrine of specific nerve energies thus articulated attributes to perception two characteristics to which Gibson and other passive theorists take especial exception: first, that in perception we are immediately aware only of the activity of our own nervous system; and second, that the perception of objects is mediated by cognitive

*This is a somewhat revised version of a paper read at a conference of philosophers and psychologists at M.I.T., October 25, 1974.

[1] J. Müller, *Handbuch der Physiologie des Menschen,* vol. 2, part 1. Coblenz: Hölscher, 1837. Pp. 249-75.

[2] *Ibid.,* pp. 249 and 272.

processing of the data of the senses—i.e., that in some way the data are acted upon by the mind or brain so as to provide elements of structure that are not antecedently present.

Gibson's Passive Theory of Perception

Perception as a function of stimulation. Gibson's is an active theory in one sense. He sees the perceptual mechanism as a seeker of stimulation. The mechanism is a *system,* an apparatus which explores available stimuli and adjusts the sense organs in order to achieve optimum reception.[3] But unlike Müller, Gibson does not believe the perceptual system organizes the input or processes it in any way; nor does it decode signals or interpret messages. Rather, it simply *extracts* information from stimulation.[4]

The stimuli, according to Gibson, which give rise to any perception are always energy states and fluctuations. Stimuli should not be confused with the physical object, which along with the medium is their source.[5] Gibson does sometimes speak of distal stimuli (properties of the object) and proximal stimuli (energy at the receptors), but his usual meaning for *stimuli* is energy patterns and transformations at the surface of the sense organs.[6]

Gibson defines *perception* as "the process by which an individual maintains contact with his environment."[7] But since this also defines breathing, it is not very helpful. His thesis that perceptual learning takes place when the phenomenal world and phenomenal objects come into closer agreement with either proximal stimuli or physical objects (he is not always clear which) suggests that we are to identify perception with being aware of phenomenal objects and events, and that perception becomes better when they become more like phy-

---

[3] J. Gibson and E. Gibson, "The Senses as Information-Seeking Systems," *Times Literary Supplement,* June 23, 1972, 711.

[4] J. Gibson, *The Senses Considered as Perceptual Systems.* (Boston: Houghton Mifflin Co., 1966. P. 5.

[5] J. Gibson, "Perception as a Function of Stimulation," in S. Koch (ed.) *Psychology: a Study of a Science,* vol. 1. New York: McGraw-Hill, 1959. P. 471.

[6] J. Gibson and E. Gibson, "Perceptual Learning: Differentiation or Enrichment?", *Psychologcial Review,* 62 (1955), 35.

[7] Gibson, "Perception as a Function of Stimulation," p. 457.

sical stimuli.[8] Yet if this is the implication, it certainly will not lead to the conclusions he wishes to draw, as we will see shortly. Too, he frequently speaks of perception as "detecting information about the world. . . ."[9] And, as we will also more thoroughly investigate, it is this wider notion of information seeking and detection which he wishes to generally identify with the process of perception.

Perception as information detection. When Gibson speaks of sensations it is usually only to dismiss them as the products of a rarified kind of experience and as being unnecessary for perception.[10] The bold hypothesis he proffers is that perception can occur without "phenomenal accompaniment."[11] He cautions us that sensationless perception does not mean that no effectors have been impinged upon; rather it means that "organs of perception are sometimes stimulated in such a way that they are not specified in consciousness."[12] Information, not qualitata, is received. An example of information detection without sensory specification in consciousness is provided by the case of the blind man's 'obstacle sense.' To the blind man this is felt as facial vision, but actually the source of the information is auditory echo detection. He senses the wall without realizing what sense has been stimulated.[13] Articular kinesthesis for the body framework and vestibular kinesthesis for the movements of the head are yet other examples of perception in which the "sensory quality arising from the receptor type is difficult to detect, but the information is perfectly clear."[14]

In arguing for sensationless perception Gibson is really putting

---

8 Perception, according to Gibson, is exclusively a function of stimulation. His theory postulates a psychological correspondence between stimulation and perception, such that "for every aspect or property of the phenomenal world of an individual in contact with his environment, however subtle, there is a variable of the energy flux at his receptors, however complex, with which the phenomenal property would correspond if a psychological experiment could be performed." (*Ibid.*, p. 465). Perceptual learning takes place, not through better cognitive organization of sensory data, nor through the elaboration of richer connections among sensations; rather, learning occurs by finer discrimination of stimuli already present. Whenever learning is successful "the phenomenal properties and the phenomenal objects correspond to physical properties and physical objects in the environment . . ." (Gibson and Gibson, "Perceptual Learning: Differentiation or Enrichment?" 34).

9 Gibson, *The Senses Considered as Perceptual Systems*, p. 2.

10 J. Gibson, "A Theory of Direct Visual Perception," in J. Royce and W. Rozeboom (eds.), *The Psychology of Knowing*. New York: Gordon and Breach, 1972. P. 215.

11 Gibson, "Perception as a Function of Stimulation," p. 463.

12 Gibson, *The Senses Considered as Perceptual Systems*, p. 2.

13 *Ibid.*

14 *Ibid.*, p. 111.

forward two general theses, which are not disentangled in his discussion. The first is that perception, conceived as information detection, "is direct in that it is not mediated by . . . sensations or sense data."[15] This thesis, in turn, can be understood in two possible ways: information detection can occur without any connection with conscious sensible qualities or it always occurs in tandem with such qualities but does not depend upon them.

The first alternative is not supported by any of Gibson's examples. The blind man 'feels' the presence of the wall through 'facial vision.' One 'feels' the movement of one's legs and the motion of the car in which one is riding.[16] But perhaps the thesis should be interpreted to mean that while conscious sensory experience does always accompany perception, perception does not depend on it. However, given constant accompaniment, empirically demonstrative independence would be methodologically Herculean. Further, such observations as "it is surely a fact that *detecting* something can sometimes occur without the accompaniment of sense-impressions"[17] and Gibson's denial of a processing component to perception do not lend this interpretation much support and too, it would certainly have the effect of moderating the boldness of his general conception of perception. On neither interpretation, therefore, does the first thesis appear warranted.

The second thesis which is knotted up in Gibson's hypothesis of sensationless perception is that perceptual qualities frequently cannot be attributed to a specific organ of sense. But this I think can be conceded without supporting any talk of sensationless perception. It does seem natural to attribute sensations of hot and cold, rough and smooth to the organ of reception, the skin. And taste does seem to be on the tongue and smell in the nose. But sound is not always at the ear, rather at the object emitting it; and the color of objects is on

[15] Gibson, "A Theory of Direct Visual Perception," p. 215.

[16] One example which Gibson does not mention but which appears to come close to sustaining the thesis that information can be detected without any phenomenal accompaniment is that of movement detection by receptors at the very periphery of the retina. When these receptors are stimulated by movment (e.g., by objects moving at the edge of the field of vision) we experience nothing; but a *reflex* is initiated which rotates the eye so as to bring the foveal region around to pick up the moving object. To use Gibson's terms, "this is not a reaction paralleled by experience." But whether we should call it "perceptual information detection" is something else again. Discrimination and specificity of this sort are also characteristic of nonexperienced enzyme secretion in the pancreas; yet even Gibson would, I think, be loathe to describe that process as perception.

[17] Gibson, *The Senses Considered as Perceptual Systems*, p. 2.

their surfaces, not experienced in the eye. Indeed, undoubtedly we learn that our eyes have to do with color and form because these disappear when we close them. Thus, simply because we cannot through immediate conscious experience attribute the proprioceptive sensation of body motion to any definite organ of sense is not by its peculiarity of example reason to sustain the argument for sensationless perception. For the same can be said of color perception, whose sensory qualities are obvious. Is the perceiver, particularly when untutored, immediately conscious of the activity of the retina of the eye, the optic tracts, the lateral geniculate body and the striate cortex, which together constitute the organ of visual perception? Gibson's rendering of the hypothesis of sensationless perception and its constituent theses simply does not stand up to close anlysis. Nonetheless, his theory that the senses are primarily information detection systems does not collapse with his notion of sensationless perception. It has a vitality independent of that notion.

Gibson does allow a measure of truth to the doctrine of specific nerve energies. When the senses are considered as channels of sensation and when we experimentally isolate single receptors, then information about the source of arousal may not get into the nervous system. But when we consider the senses as information detection systems and treat those systems as integral units searching out patterns of stimulus fluctuation, then the measure of truth is exhausted and the Müllerian doctrine becomes misleading.[18] In a sloshing metaphor Gibson portrays the observer with his detection systems as awash in a "sea of stimulus energy," immersed in a flowing array of stimulation. And it is this sea having relational properties of its own, rather than the individual elements composing it, which he regards as essential for conveying information.

> The stimuli as such, the pin-pricks of light or sound or touch, do not carry information. . . . Note that they are not in any sense pictures or images of objects and of layouts as so many psychologists have been tempted to think. Nor are they signals from the objects and surfaces of the environment like dots and dashes in a code. They are mathematical relations in a flowing array; nothing less.[19]

Indispensable, therefore, to Gibson's theory of the senses as information detection systems is the conception of the environment as a plenum of energy fluctuations carrying information. To illustrate his conception he considers stimuli appropriate for visual perception as the paradigm case. Objects illuminated by a light source reflect that light into the environment, and at every point in the environing

[18] *Ibid.*, p. 38.

[19] Gibson and Gibson, "The Senses as Information-Seeking Systems," p. 711.

medium there will be what he calls "sheafs or pencils of rays"—or, more recently, "bundles of visual solid angles"[20]—converging from all directions. These pencil rays, or visual solid angles, of light are borders created in the ambient medium by light energy reflected from the structural features of the illuminated objects. For stationary objects the ambient array is structured, that is, caused to have borders within it, by: (1) the various inclinations of surface facets; (2) the different reflectance properties of substances; and (3) the chromatic reflectance of substances.[21] The borders thus created carry information to the surface of the retina. Gibson argues that it is this information, existing independently of the perceiver,[22] which is really the stimulus for visual perception:

> The angular pyramids of the ambient light carry energy of course, but the *borders* of the adjacent pyramids are merely relations of contrast. A relation, I think, cannot be said to carry energy. A boundary, margin, border, contour or transition is nevertheless justly considered a stimulus for the eye, or more exactly, stimulus information for an eye. . . .[23]

The fluctuations of energy patterns which surround the organs of sense permit the percipient subject to detect both changes and permanence. Observer movement is detected when the whole visual field begins streaming past; object movement when there are changing ratios and gradients within the field. Objective sameness and identity of things and events are assured by pickup of invariants within the ambient array. Changing ratios and constancies are immediately available as stimulus information for the receptive systems of sense. This is why Gibson asserts his interest in "the energy that excites a mosaic of cells, not that which excites a single cell—variables of adjacent and successive order, not variables of unchanging amount and frequency at a fixed point on the receptive surface."[24]

There is no doubt that Gibson's conception of the ambient array has a good deal of theoretical merit, and as a practical device for dealing with those problems of perception with which airplane pilots are troubled—the source of many of his experimental conclusions—it is surely very useful. But as an essential component in a comprehensive and logically adequate theory of perception it has several liabilities, three of which may be touched on here.

---

20 Gibson, "A Theory of Direct Visual Perception," p. 219.
21 Gibson, *The Senses Considered as Perceptual Systems*, p. 194.
22 Gibson, "A Theory of Direct Visual Perception," p. 217.
23 Gibson, *The Senses Considered as Perceptual Systems*, p. 193.
24 Gibson, "Perception as a Function of Stimulation," pp. 471-72.

First, the case of visual perception seems to dominate Gibson's discussion of the general characteristis of perception. Retinal stimulation may depend upon a pattern and order for perception, but for the perceptions of taste and odor they are not as significant, though quantity is. Second, though patterns of energy transformations are important for visual, auditory, and haptic perception, so also are the patterns of receptor connections and interactions. The information detected also echoes these latter. It is a mosaic of excited cells as much as a mosaic of energy fluctuations which gives rise to perception.

The third problem concerns Gibson's notion that higher-order variables—the "mathematical relations in a flowing array"[25]—are the proper stimuli for perception:

> The important ones for perception and behavior are variables of the adjacent and successive order of frequencies and intensities, that is, variables of the stimulus *array* and of the stimulus *flow*. There are gradients, derivatives, ratios, and rates in this flowing array of energy, and these are the higher-order variables of stimulation which the theory postulates.[26]

It is this conclusion along with his proposition that cognitive processing is in no way involved in perception that cause the difficulty. Indeed, Gibson so concludes in order to avoid the assumption of a cognitive reworking of input; that assumption conjures up for him the malign shade of Bishop Berkeley.[27] But in what sense can gradients, derivatives, ratios, and rates be said to exist in physical energy states at the surface of the sense organs? As Attneave[28] remarks, when a page of numbers is presented to an observer, the numbers necessarily have a mean, standard deviation, and other higher-order mathematical properties; but these can exist as stimuli, after a fashion, only if they have been calculated. All we have in immediate sensory stimulation is one receptor or a group of receptors firing in a certain sequence, a sequence as much determined by the anatomy and physiology of the nervous system as by the physical characteristics of the energy. Relations, at least those to which Gibson here refers, are not real features of the physical world. To use the older jargon, they are *entia rationis cum fundamento in re;* that is, they demand a mentating observer as well as certain physical situations in order to exist. What is a border of light? In the natural world, if

---

[25] Gibson and Gibson, "The Senses as Information-Seeking Systems," 711.

[26] Gibson, "Perception as a Function of Stimulation," p. 464.

[27] J. Gibson, "On the Proper Meaning of the Term 'Stimulus,'" *Psychological Review*, 74 (1967), 533.

[28] F. Attneave, "Perception and Related Areas," in S. Koch (ed.), *Psychology: a Study of Science*, vol. 4. New York: McGraw-Hill, 1962. Pp. 629-30.

we accept the account of contemporary physics, there are only discrete photon units. These strike adjacent retinal receptors; and after the perceptual system damps some of the receptor signals and augments others, we see boundaries and borders. Borders are relations which exist only for cognating perceivers.

Information theory. A theory of perception which postulates that information exists in the patterned flow of physical energy, so that no processing is needed for the subject immediately to perceive a world, requires that some little be said about the character of this information. Unfortunately Gibson does say but little. At one point he identifies his notion of information with that developed in information theory, and mentions that the new possible quantitative measures of uncertainty provided by information theory permit the psychologist to study perception "without having to worry about the puzzles of epistemology."[29] But in another passing reference to the concept of information he notes that "*information about something* means only *specificity* to something."[30] From this latter he infers that the information conveyed by light, or sound, or odor, etc., does not require that the medium contain a copy or replica of the stimulus source, but only that the patterned energy be specific to the source:

> . . . a property of the stimulus is univocally related to a property of the object by virtue of physical laws. This is what I mean by conveying of environmental information.[31]

In declaring that the surrounding energy flow contains information Gibson is asserting three things: that the stimulus energy is structured; that the structure reduces prior uncertainty; and that the structure is 'univocally' related to properties of object sources. Let us consider these seriatim. The contention that physical energy flow has structure is reasonable for almost any theory of perception. But to go further and say that it has the kind of structure that Gibson suggests—i.e., pencil rays, solid visual angles, borders, ratios, etc.—is, as we have seen, somewhat misleading. To indicate, in accord with information theory, that stimulus patterns reduce prior 'uncertainty' seems to push him closer to admitting a cognitive or processing component to perception. At any rate, the concept of information as found in information theory does not demand that the carrier of the information be specific to any originating object or event—the relationship of uncertainty obtains only between stimulus event and perceiver. Hence, appealing to information theory to buttress the concept of information operative in his theory of perception is of little avail.

---

29 Gibson, *The Senses Considered as Perceptual Systems*, p. 245.
30 *Ibid.*, p. 187.
31 *Ibid.*..

Gibson's use of the word "univocal" to describe the relation between physical energy patterns and their sources is strange. "Univocal" is a semantic and, therefore, a cognitive term; it is used to refer to words or phrases which have only one *meaning*. But Gibson's intention in employing the term is clear: he means to maintain that a given stimulus pattern can be produced by only one definite kind of object or event. This assumption is a principal strut in his passive theory of perception. Another comes with the postulation of the rule: "The same stimulus coming to the eye will always afford the same experience."[32] With these two supports Gibson can confidently sustain the essential theorem of the passive theory of perception, namely that *through perception we come to be acquainted with things as they really are.*[33]

This theorem, however, is in danger of being undermined by the phenomenon of reversibility of perception with constant stimuli, for instance, in the reversals of the Necker cube or the goblet-faces display. In these cases we have the same stimuli but alternating perceptual experiences. A judicious study of these illusions and the myriad of studies on the effects of motivation level and prior experience on perception[34] might lead to the conclusion that the informational structure of perception also depends on the characteristics of the observer—an implication Gibson wishes to avoid[35] and must if he is to preserve a pure passive theory. He attempts to save the principle of 'same stimulus, same perception' by the expedient of arguing that in perceptual reversals the physical stimuli may be the same but the information contained in them is equivocal: "The perception is equivocal because what comes to the eye is equivocal."[36] Note that "equivocal" is another semantic term.

It is time to make sense of this. Our perception of Gibson's strategy should by now be clear. The passive theory of perception relies on two principles; and these principles depend on two semantic concepts, univocity and equivocity. What Gibson has done is to patch his two principles with cognitive concepts in order to discover in stimulus energy what the active theorist can find only in the cog-

32 *Ibid.*, p. 246.

33 Gibson, "A Theory of Direct Visual Perception," p. 227: "The availability of of information in ambient light and the possibility that it can be picked up directly have implications for epistemology. They lend sophisticated support to the naive belief that we have direct knowledge of the world around us. They support direct realism."

34 For a pertinent and provocative example of this literature, see M. Segall, D. Campbell, and M. Herskovits, *The Influence of Culture on Visual Perception*. Indianapolis, Ind.: Bobbs-Merrill, 1966.

35 Gibson, *The Senses Considered as Perceptual Systems*, pp. 246-47.

36 *Ibid.*, p. 247.

nitively processing observer. Clearly these concepts cannot be applied to physical events as construed by natural science. To say that stimulus patterns are univocally related to their object sources would be to say that they *mean* only specific object sources. But independently of an interpreting observer two physical events can bear no relation of meaning between them. Nor can it even be said that only one kind of stimulus event is producible by one kind of object source; as Gibson himself admits, using light and filters in the proper way illusory surfaces and distances can be created for perception.[37] It is just as improper to speak of stimulus characteristics as themselves being equivocal. Words and other signs are equivocal when they can be *understood* in two or more senses. But a physical event *in se* cannot have the property of equivocity. That is simply not one of the concepts one finds in contemporary physical theory.

Gibson's ideas about stimulus information simply will not stand on their own; they require the covert support of cognitive concepts. Yet he has expressly denied that such concepts are necessary for perceptual theory. Why he thinks them superfluous we must now consider.

Intellectual perception. In order to account for the structure of our perceptions and the part experience plays in contributing to that structure, Müller found it necessary to employ the explanatory concept of an actively constructing mind, which frequently operates without explicit self-awareness. Gibson believes that perception can be explained perfectly well without appeal to any intellectual processes, conscious or unconscious:

> It will here be suggested that the senses can obtain information about objects in the world without the intervention of an intellectual process—or at least that they can do so when they operate as perceptual systems.[38]

Under the rubric of 'intellectual process,' and thus among those activities of the perceiving subject Gibson wishes to exclude as requisite for normal perception, are: interpreting of neural messages,[39] processing of information,[40] learning the sensory code,[41] storage of information,[42] memory,[43] retrieval of stored image,[44] com-

---

37 Gibson, "Perception as a Function of Stimulation," p. 477.
38 Gibson, *The Senses Considered as Perceptual Systems*, p. 2.
39 Gibson and Gibson, "The Senses as Information-Seeking Systems," 712.
40 Gibson, "A Theory of Direct Visual Perception," p. 216.
41 Gibson and Gibson, "The Senses as Information-Seeking Systems," 712.
42 Gibson, "Perception as a Function of Stimulation," p. 486.
43 Gibson and Gibson, "Perceptual Learning: Differentiation or Enrichment?", p. 40.
44 Gibson, *The Senses Considered as Perceptual Systems*, pp. 277-78.

parison of sensation with stored image,[45] and constructing of information from the input of sensory nerves.[46] In fine, Gibson wishes to deny that the nervous system in any way organizes, structures, or changes the information which is available at the surface of the receptors. This is a passive theory in a nearly perfect form. If we allow him to further argue that properties of objects are 'univocally' related to stimuli, then we have the perfect passive theory. The senses are merely conduits conveying unsullied information to mind about the real properties of the world.

There would seem, nonetheless, to be some elementary perceptual experiences which demand reference to intellectual processes for their explanation. For instance, there are times when one cannot recall the face of a person or position of an object, but can immediately perceive that the face or position is the 'same' as that experienced before. More conventional perceptual theories have minimally postulated processes of memory storage, retrieval, and comparison. But even for these experiences Gibson asserts that such processes or anything similar to them are not required: for ". . . the judgment of 'same' reflects the tuning of a perceptual system to the invariants of stimulus information that specify the same real place, the same real object, or the same real person."[47] Nor need we invoke higher nervous centers, as the active theorists do, to explain any organizational or structural characteristics of perception: "Instead of postulating that the brain constructs information from the input of a sensory nerve, we can suppose that the centers of the nervous system, including the brain, resonate to information."[48]

Now even the most sympathetic reader of Gibson must pause at these assertions, for they square with neither the conceptual nor the experimental evidence. Can the perception of sameness really be explained by "the tuning of a perceptual system to the invariants of stimulus information that specify the same real place, the same real object, or the same real person"? I think not. For the question now becomes: How do we recognize the present invariancies as the same as those of the past experience? And surely the phrase "the tuning of a perceptual system" is devoid of empirical meaning; it only sounds as if it ought to explain something. "Resonating to informa-

[45] *Ibid.*
[46] *Ibid.*, p. 267.
[47] *Ibid.*, p. 278.
[48] *Ibid.*, p. 267.

tion" is little better. Presumably this simply means that the brain is passively affected by information. But then what? Alas, Gibson tells us no more.

In recent years there has been a good deal of investigation of the functions of various features of the neural receptor system. The evidence gives strong support to the hypothesis that neural input is processed at several levels in the nervous system. Ratliff's work on the eye of *Limulus* (*the horseshoe crab*) is instructive in this regard; for it shows that "neural mechanisms of the retina are more than mere devices for the passive transmission of information about the temporal and spatial pattern of illumination on the receptor mosaic."[49] Using microelectrodes which were able to record impulses from a single receptor and precisely directed light intensities, Ratliff demonstrated that the discharge of nerve impulses from a stimulated receptor is reduced by illuminating other receptor units nearby, the degree of inhibition depending on frequency of discharge of neighboring receptors, the number activated, and their distance from the unit inhibited. A fair conclusion that one may draw from Ratliff's work and one he himself draws,is that the inhibitory properties of the retinal system of *Limulus* sharpen boundary perception beyond what a simple passive theory would allow.[50]

Even more sophisicated mechanisms are at work in the vertebrate eye. Kuffler's studies on the eye of the cat reveal that its retinal system has both inhibitory and facilitory features, such that absolute intensities of light are not detected; rather, intensity gradients are distorted in order to produce contrasts more beneficial to feline survival.[51]

In human perception there is convincing evidence that similar stimulus damping and augmenting occur. For example, the phenomenon of Mach bands indicates that the actual physical stimulus array which reaches the retina is not perceived; on the contrary, the infor-

---

[49] F. Ratliff, "Some Interrelations among Physics, Physiology, and Psychology in the Study of Vision," in S. Koch (ed.), *Psychology: a Study of a Science*, vol. 4. New York: McGraw-Hill, 1962. P. 446.

[50] *Ibid.*, pp. 447-51.

[51] S. Kuffler, "Discharge Patterns and Functional Organization of Mammalian Retina," *Journal of Neurophysiology*, 16 (1953), 37-68.

mation supplied by the array is distorted by neural processing.[52] Brightness and color contrast phenomena provide other instances in which the information available in the physical stimulus array is distorted by neural processing, presumably occurring at the very level of the retina.[53]

Active construction and reorganization of perception by higher nerve centers have been postulated by many investigators to account for phenomena little heeded by Gibson. Perhaps he ignores these perceptual curiosities because they are induced in 'artificial' ways, thus rendering inaccessible relevant information in the ambient array —something his own ecological optics aims to avoid. Prototypes for these studies can be found in the work of Helmholtz, an active theorist and pupil of Müller. For instance, Helmholtz reports of a subject whose ocular muscles were anesthetized.[54] The subject was commanded to turn his eyes to the right. Since the eye muscles were paralyzed the visual array on the retinae did not change, yet the subject reported a movement of the environment to the right. Helmholtz argues that efferent impulses (*Willensimpulse*) were internally registered and so reorganized perception as to effect the experience of a compensating movement of the environment. This would appear to be a singular instance of 'same stimuli' but different perceptions.

Perceptual learning. Infants and young children cannot make the the kinds of perceptual judgments of which adults are capable. They simply do not see everything that might be seen in a situation. This fact has always been a challenge to passive theorists. For the passive theorist does not wish to admit that children must learn to associate sensations, to construct and organize the bits and pieces they receive from the environment into a coherent picture. Gibson is no different.

52 The phenomenon of Mach bands can be observed in the following way. If one paints a white four pointed star on a black cardboard disc and mounts this on a wheel so that it can be rotated rapidly, when it is rotated the light energy given off should have these characteristics: the amount of light reflected by the central white field uniformly bright in the center, then decreasing smoothly through shades of gray to the uniform black of the surround. However, what one actually sees are Mach bands: a band at the edge of the center field which is brighter than any other part of the central white area; and at the inner edge of the dark surround, a very black band, blacker than the outer part of the surround.

53 An experiment to try: stare for 30 seconds at a light through a colored bit of cellophane; then look away on to a white wall or piece of paper. You will see a patch of color on the wall which is the complement of the colored cellophane. Here is a case of perceptual experience which is without appropriate stimulus accompaniment. For a variety of other simple perceptual experiments with similar morals, see R. Gregory's *The Intelligent Eye.* New York: McGraw-Hill, 1970.

54 H. von Helmholtz, *Handbuch der Physiologischen Optik.* Hamburg: Leopold Voss, 2nd ed., 1896. Pp. 744-45 (part 3, section 29).

He condemns the view that sensations and perception are related as building materials to finished product, a notion that implies there is more in the product than in the received materials.[55] In this lamented view perceptual construction and stored information furnish the extra that is required. The view assumes, Gibson affirms, that "perception is in decreasing correspondence with stimulation."[56] Enrichment theories of perceptual learning—those that prescribe the adhesive of stored experience to stick together the elements of sensation—thus violate the cardinal passive principle that there is a one-to-one correspondence between stimulation and perception.

Enrichment theorists suppose that some kind of associative process is necessary for the existence of consistent and integral perceptions. They believe that one sense needs to be validated by another, that visual perception, for example, could not provide adequate distance information except that certain sensations of sight have become associated with the tactile sensations of extension. Gibson, of course, does not think that such sensory associations are necessary: because the "different stimulus energies—acoustical, chemical, and radiant—can all carry the same stimulus information."[57] If the perception, say, of fire were a compound of separate sensations of smoky odor, crackling, warmth, and yellow-orange color, then he agrees that there would had to have been some associations of past experience to explain how any one of them could evoke memories of all the others. "But if the perception of fire is simply the pickup of information the *perception* will be the same whatever system is activated, although, of course, the conscious sensations will not be the same."[58] The theory of perceptual learning which Gibson espouses, then, postulates that there are redundant invariancies in the different energy emanations from perceptual objects. Hence, the different sensory modalities are privy to the same sensory information. Association is not needed.

But how then are we to account for the differences in perceptual abilities that seem to come with experience? For Gibson perceptual learning is a process of increasing discrimination of variables in the stimulus flux. No constructive achievement is required. This discriminational theory of learning is powerful enough, he avers, to explain even the perceptual recognition of words and sentences, that is, the learning of language. For example, arrangements of ink on paper

55 Gibson and Gibson, "Perceptual Learning: Differentiation or Enrichment?", p. 34.
56 *Ibid.*, p. 34.
57 Gibson, *The Senses Considered as Perceptual Systems*, p. 55.
58 *Ibid.*, p. 54.

reflect differentially patterns of light, so that within the array at the retina the invariables constituting letter forms, syllable forms, and word forms are specified for discrimination. To learn these shapes is to be able to discriminate and identify them. Thus, "the process of learning to read can legitimately be conceived as one of discriminating and abstracting the variables of stimulation in a pyramiding order."[59] Learning to understand written language, on the passive theorist's account, does not demand the association of words and phrases with any mental images or concepts, and certainly does not require the complex cognitive machinery of the psycholinguists.

But can it be that simple? A child can be taught to discriminate the different letters of Greek, even to perceive that given word shapes are different from others. In fact, he might be able to read off sentences, using the sounds he has been taught to 'associate' with the words. All this could, of course, occur without the child being able to *read*, that is, understand Greek. Learning to use symbols, as Postman has insisted contrary to Gibson, supposes that an object—a dash of ink, a sound, a color—acquires sign properties "by virtue of sequential dependencies among environmental events."[60] Associations of some kind must take place among sign, object, circumstances, and other signs; for surely signs cannot be said of themselves to bear information isomorphic with the perception of that to which they refer. The same must be said of our sensations of objects. While it may be the case that there is some redundancy among sensory modalities, this cannot be the full story of perceptual learning.[61]

---

59 Gibson, "Perception as a Function of Stimulation," p. 487.

60 L. Postman, "Perception and Learning," in S. Koch (ed.), *Psychology: a Study of a Science*, vol. 5. New York: McGraw-Hill, 1962. Pp. 65-6.

61 The case for some cross-modal transfer of information is brought by an active theorist, Richard Gregory. In a classic study of a man who, being functionally blind for all but 10 months of his fifty years, had his sight restored through advanced operational techniques, Gregory and J. Wallace ("Recovery from Early Blindness: a Case Study," reprinted in P. Tibbetts (ed.), *Perception* (Chicago: Quadrangle Books, 1969), pp. 359-88) report that their subject did recognize, for instance, upper case letters which he saw for the first time. While blind he learned to touch-read raised upper case letters, though not lower case; and these letters he could not visually recognize. There was other evidence for cross-modal transfer. However, there was additionally convincing evidence that the subject's ability to perceive distance was very weak, that is, until he was able to tactilely and proprioceptively work out the correct distance. Most interesting was the finding that the subject was virtually unaffected by standard visual illusions, Müller-Lyer lines, Zöllner lines, the Herring illusion, and the Necker cube. Other illusions involving figure-ground reversals he was unable to describe at all. It should be noted that all of these illusions are based on conflicting cues for depth and distance perception. Though it is difficult to generalize about cases of restored sight—there is always danger of retinal degeneration or neural maldevelopment—this case suggests both: that active association of information from different modes of sensation plays a role in normal perception; and that there is redundancy of information supplied by the various sensory modalities.

Though Gibson's passive theory in several of its particular features is of value for its practical effect—e.g., the analysis and correction of perceptual anomalies in airplane navigation—his utter disavowal of enrichment theories weakens even more the internal logical structure of his theory, perhaps disastrously so. Enrichment views, he says, assume a decreasing correspondence between perception and the stimulus array. His view asserts a univocal relationship. Yet, by his own account we immediately perceive objects, not pencil rays of light; we observe distances, not density gradients of stimulation; we see objects move, not fluctuating patterns of energy. Surely perception of this kind involves little correspondence between the percept and the stimulus. It appears we are offered, after all, an enrichment theory disguised in threadbare concepts.

ROBERT J. RICHARDS.

UNIVERSITY OF CHICAGO.