Book Reviews

Perception: A New Functionalism

The Senses Considered as Perceptual Systems. JAMES J. GIBSON. Houghton, Mifflin, Boston, 1966. 351 pp., illus. $7.50.

This book is an interesting and thought-provoking treatment of sensory psychology. Though the subject matter is old, the approach is quite new. Gibson has managed to take seemingly commonplace observations and creatively transform them into a critique of some basic assumptions in this broad field.

One of the assumptions found wanting by Gibson is the notion that perception is based upon having conscious sensations. Examples of this assumption include the idea that the brain is a computer that processes sense data prior to the occurrence of perception. Also, there is the still widely accepted doctrine of unconscious inference. An example of the use of this Helmholtzian idea may be found in current treatments of size constancy. Here it is held that sensations of distance are registered and processed by the organism in some way that permits an object to appear to be of the same size regardless of how far away it may happen to be. Gibson objects to all of this. He holds that sensations, if they exist, are mere byproducts of perception and are not basic to its occurrence. The senses are employed to detect objects, not to permit an observer to have sensations. The study of sensation is therefore irrelevant to the study of perception. It may shock some readers to find that Gibson would thereby dismiss the study of receptor sensitivity, that is, psychophysics and sensory physiology, as being irrelevant to the problems of perception.

The classification of senses according to the kinds of stimuli which excite receptors in various organs is also eschewed by Gibson. He argues that this kind of classificatory scheme stems from the old idea that sense qualities differ because of differences in the specific energies of nerves. Gibson's alternative is to classify sensitivity along functional lines. His whole approach might be considered to be that of a new functionalism. In addition to an entirely novel and interesting treatment of proprioception, major emphasis is given to obtained perception. This is mediated by the perceptual systems, which are described at length. They include the basic orienting system, the auditory system, the haptic system, the taste-smell system, and the visual system. The classification is made not in terms of specific energies of nerves but in terms of modes of attention. The auditory system is for listening, the haptic for touching, and so forth. All the systems are partially redundant in the information they enable the organism to extract from its environment. The greater part of the book gives descriptions of these perceptual systems in terms that reflect a common approach to all of them.

In my opinion the best parts of the book are those concerned with the capabilities of the haptic system and the portions dealing with visual perception. In the section on the haptic system Gibson describes a lovely experiment in which he tested the ability of an observer to discriminate between objects by touch alone. He points out that ten different fingers could touch the objects in any number of combinations to obtain a variety of cutaneous pressure sensations. These pressure sensations alone could never be related uniquely to any object under the conditions of the experiment. The unified perception of an object must have come from the bones as well as the skin. In spite of the diversity of energy pickup there must be an invariance in the information thus obtained.

Since Gibson is primarily working in visual perception it is natural that he should devote a large portion of his book to it. He bases his entire approach on the idea that vision is employed to extract information necessary for getting about in the world. In any illuminated terrestrial space there is a network of converging and diverging rays of reflected light which constitutes the set of places where an observer might be. The study of the possibilities for stimulation by this ambient light is termed ecological optics. It is Gibson's contention that that portion of the ambient array which affects an organism, including its transformations over time, is specific to a given perception. Perceiving does not require organizing by the observer's brain, because all of the information basic to a given perceptual event is contained in the stimulus array. This represents a departure from the other major theorists in perception. The author describes some of the conditions which lead to perceiving certain attributes such as distance, curvature, corners, and solidity. Here, too, it is invariant relationships in the array which lead to given perceptions rather than specific physical attributes of the stimulus expressed in energy terms.

One of the more suggestive chapters in the book deals with visual scanning. Gibson makes the valid point that the idea of the retinal image can be misleading. It is misleading not because there is no retinal image but because it connotes that there is a stable picture of the world in the eye. This is not true, because the eye is always on the move. It flits from here to there, creating a time-varying set of images. In spite of this, the world appears to be stable. Portions of the room not seen at a given moment are still part of a permanent behavioral environment. This does not suggest to Gibson that the mind must retain each fleeting glimpse of the world in storage, thereby putting together a new "picture" of every strange room that we may happen to enter. He holds that, instead of integrating successive visual sensations in memory, each glimpse plays a role similar to the roles played by the fingers in simultaneous grasping. The apprehension of a room is accomplished by the detection of invariant properties which are revealed over time. This approach may be suitable for some very interesting research.

The book has many faults. One of these is that its style is deceptively simple. The book is entirely lucid. However, it is written in the manner of an introductory text. The redundancy characteristic of this style of

writing would probably annoy the more sophisticated reader. Yet it is the latter person who should read it, not the neophyte who could not appreciate the meaning of the book. There is also much that Gibson says with which I cannot agree. The brain does have processing functions. In this regard Gibson has overstated his case. Also, psychophysics may still be relevant, though its usefulness must hinge upon a set of assumptions different from those ascribed to it by Gibson. There are many conjectures in the book which need further support before they can be accepted. But it is this feature of the book that makes it most valuable. It is suggestive in a substantive sense, and it has novel insights into how one should view the problems of perception. This novelty is particularly valuable, for it succeeds in upsetting modes of thought which have become traditional over the past 150 years.

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The Development of Unified Field Theories

Einstein's Unified Field Theory. M. A. TONNELAT. Translated from the French edition (Paris, 1955) by Richard Akerib. Gordon and Breach, New York, 1966. 198 pp., illus. $10.

The special theory of relativity was developed by Einstein for the express purpose of bringing classical particle mechanics into conformity with Maxwell's theory of the electromagnetic field. Once this task was accomplished, it was natural for him to inquire whether the remaining known classical field, that of gravitation, could be expressed in a fashion consistent with the new relativistic mechanics. The well-known heuristic considerations based on the fundamental character of the principle of equivalence of gravitation and acceleration, or, equivalently, the equality of passive gravitational mass and inertial mass, led Einstein to revise both relativistic mechanics and Newtonian gravitation theory. The resulting General Theory of Relativity was able to incorporate the Maxwell theory with very minor and natural modifications. That stage of development having been obtained, there appeared to be no further logical necessity or even heuristic argument to require further revision or alteration of the truly imposing edifice which Einstein had constructed.

Nevertheless, Einstein felt an esthetic compulsion to unify in a much more intimate fashion the two known classical fields, much as Maxwell previously had unified the electric and the magnetic fields into a single geometric entity. Lacking any semblance of a heuristic guide, the attempts at unification of gravitation and electromagnetism necessarily became highly formal mathematical generalizations of the four-dimensional Riemannian geometry of General Relativity. A far from exhaustive enumeration of generalizations that have been considered by Einstein and others includes five-dimensional Riemannian geometries, conformal geometries, projective geometries, similarity geometries, spaces of distant parallelisms, Finsler spaces, nonsymmetric metrics, spaces with torsion, complex symmetric metrics, Hermitian metrics, and bitensor metrics. Because of the lack of any physical guiding principle, these formal generalizations rather typically suffered from an ambiguity in the interpretation of the symbols of the formalism. Not only did this multiplicity of possible generalizations, the ambiguity of interpretation, and the lack of any true necessity for a formal unification of gravitation and electromagnetism cause concern with unified field theories gradually to dwindle, but, much more significantly, two developments of contemporary physics ended virtually all interest in such theories. One of these developments was the discovery of nuclear forces, or, equivalently, meson fields, which made a mere unification of gravitation and electromagnetism of questionable interest. The other was the development of quantum theory, which undermined the role of a classical field theory as a fundamental building block of nature.

It is a testimony to the current lack of interest in unified field theories that despite the fact that the book under review is a translation of a text published more than a decade ago, no significant development in the intervening years has made the work the least bit dated. In this work Tonnelat has chosen to limit herself to spaces with nonsymmetric metrics and torsion, in view of the fact that it was precisely such theories that preoccupied Einstein in the last years of his life. Within this context, she has performed the very valuable service of organizing, as coherently and systematically as possible, a presentation of material by several authors which has been scattered throughout dozens of scientific journals. It is strikingly to the credit of this work that, contrary to the practice of most authors, no pretense is made of presenting anything approximating a completed theory or even an agreed-upon interpretation. In fact, where possible, ambiguities of interpretation are pointed out and discussed.

In view of the criticisms of unified field theories given above, the question naturally arises whether there is any value in pursuing the subject. Let us therefore enumerate several arguments in favor of such a pursuit: (i) the many generalizations enumerated above have proved to be an extraordinary fountainhead of ideas for purely mathematical investigations; (ii) the analysis of unfamiliar theories provides an excellent testing ground for new physical ideas; (iii) the methods developed for analyzing the generalized geometries of the unified theories can prove to be very useful and powerful when applied to General Relativity; and (iv) although they are at the moment out of fashion, one should surely tread with caution before discarding ideas which flowed from the intuition of one of the most extraordinary and fertile minds in the history of science. I am reminded of the uncanny intuition of Newton, who, despite his own discovery of "Newton's rings," continued to insist that light consisted of corpuscles. The anomaly of partial reflection of light by glass was effectively attributed to a breakdown of strict microscopic determinism—in Newton's words, the light corpuscles had fits!

In conclusion, I strongly recommend that every serious student familiar with Riemmanian geometry and General Relativity should have some exposure to various thoughts and works in unified field theories. Furthermore, I can think of no better, clearer, more comprehensive presentation of a particularly important version of unified field theory than that of Tonnelat. In providing a very clear and readable translation, Richard Akerib has performed a commendable service.

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