GIBSON, JAMES J., *New Reasons for Realism* , Synthese, 17:2 (1967:juni) p.162

JAMES J. GIBSON

NEW REASONS FOR REALISM

If *invariants* of the energy flux at the receptors of an organism exist, and if these invariants correspond to the permanent properties of the environment, and if they are the basis of the organism's perception of the environment instead of the sensory data on which we have thought it based, then I think there is new support for realism in epistemology as well as for a new theory of perception in psychology. I may be wrong, but one way to find out is to submit this thesis to criticism.

In this paper the theory of perception will first be outlined and then, insofar as they are separable, the reasons for realism will be presented. Only a bare skeleton of the theory need be stated since it has recently been published in book form.[1] It will be convenient to limit the discussion to the central problem of the perception of terrestrial objects and events. Under 'objects' I will include the earth and its fixtures, the comparatively unchanging properties of solid things, in contrast to the sky, where such determinate objects do not exist. Under 'events' I will include moving objects. The problems arising when human gestures, speech, or writing are the sources of perception will be largely excluded, although some reference must be made to pictures.

I. THE THEORY OF INFORMATION-BASED PERCEPTION

Existing theories of perception begin with the unquestioned assumption that it is based on sensations (sense impressions, or sense data), and then go on to postulate some kind of operation that must occur to convert them into percepts. It is taken for granted that sensation is entailed in perception. The theory of information-based perception begins with the assumption that sensory impressions are occasional and incidental symptoms of perception, that they are not entailed in perception. It is therefore not obliged to postulate any kind of operation on the data of sense, neither a mental operation on units of consciousness nor a central nervous operation on the signals in nerves. Perception is taken to be a process of information pickup.

Synthese **17** (1967) 162–172; © *D. Reidel Publishing Co., Dordrecht-Holland*

Copyright (c) 2005 ProQuest Information and Learning Company
Copyright (c) Kluwer Academic Publishers

GIBSON, JAMES J., *New Reasons for Realism* , Synthese, 17:2 (1967:juni) p.162

The channels for sense impressions in animals and men are distinguished from what are called perceptual systems. The former consist of bundles of nerve fibers connecting passive receptors with corresponding points in the brain, and they are supposed to be mutually exclusive. The latter consist of both incoming fibers from organs containing receptors and outgoing fibers back to these organs and they are not supposed to be mutually exclusive but to overlap one another. The sensory nerves are supposed to deliver distinct signals to the brain that elicit correspondingly distinct qualities of experience in this theater of consciousness. The perceptual systems are assumed to make orienting and exploratory adjustments of the perceptual organs and to resonate in a particular way when a distinct kind of information is picked up. The senses yield an awareness of the receptors that have been stimulated by small amounts of energy, radiant, mechanical, thermal, or chemical. The perceptual systems yield an awareness of objects – one that sometimes does not include any awareness of the receptors stimulated. It is admitted that the qualities of sight, sound, touch, taste, and smell are interesting and that they reflect important facts of neurology. They are not to be confused, however, with the acts of looking, listening, touching, tasting, and sniffing which have a quite different neurological basis.

The sensitivity of the retina, the cochlea, the skin, the tongue, and the nasal membrane can be studied by the methods of sensory physiology and classical psychophysics but the shifting patterns of nervous input obtained when the eyes move, the head turns, the hand gropes, and the mouth works are only half of an input-output circle, and this circular act of attention has an entirely different order of sensitivity. It focusses not on stimulation but on stimulus information.

1. *The Existence of Stimulus Information*

The first assumption of this theory of perception is that certain properties of the energy flux at the skin of an active animal do not change, whereas other properties do. The former are invariant, the latter variant. It is further assumed, and can be demonstrated, that the invariants of stimulation correspond to invariant properties of the environment. Hence they are said to be 'information about' the environment. The stimulus energy impinging on a perceiver must have pattern or structure in order to convey information in this meaning of the term. The ambient light,

Copyright (c) 2005 ProQuest Information and Learning Company
Copyright (c) Kluwer Academic Publishers

GIBSON, JAMES J., *New Reasons for Realism* , Synthese, 17:2 (1967:juni) p.162

sound and odor in the surrounding medium, along with the mechanical and chemical contacts that arise from the substratum and its fixtures, are forms of stimulus energy that contain stimulus information.

Consider light, for example. Physical optics has been interpreted to imply that light carried information only about atoms, not about objects.[2] But when the student of vision believes this he makes the mistake of adopting the physicist's assumptions about radiant light from energy sources. He needs to make assumptions instead about *ambient* light from the surfaces of the terrestrial world. The latter is subject to laws of perspective geometry, not laws of photon tracks. The student of useful vision should be concerned with ecological optics, not physical optics; with the kind of light by which things are seen, not with the kind of light that is seen. The structure of an array of ambient light from the earth is the same from noon to sunset. Certain properties of this structure are invariant under perspective transformations as the observer moves from place to place. And these invariants are specific to the substances of which objects are composed, to the edges of objects, and to the layout of their surfaces. The intensity of light in any patch of the ambient array varies with the time of day and with the position of the observer, so that it carries *no* information about objects.

The primary receptors in the retina of the eye, the photo-sensitive rods and cones, are stimulated by radiant energy within certain limits of intensity and frequency. At this level the physiology of the eye and the physics of stimulus energy are cognate. It can be shown that the excitation of photo-receptors brings about corresponding sensations of brightness and color under certain special laboratory conditions. But when a retinal image is formed, even one with only a few margins or contrasts, it begins to have structure, and we must shift from physical optics to ecological optics. The retina itself has a structure of inter-connecting nerve fibers, and we must shift from the level of a photo-receptive mosaic to a still-to-be-understood level of higher-order units in the nervous system. The simple correspondence of brightness to intensity and of color to frequency no longer holds. In short, we must think about the stimulus information for the system, not the stimulus energy for the receptors.

2. *The Fact of Invariance over Time*

It is assumed that the pattern of the ambient light, the ambient sound

Copyright (c) 2005 ProQuest Information and Learning Company
Copyright (c) Kluwer Academic Publishers

GIBSON, JAMES J., *New Reasons for Realism* , Synthese, 17:2 (1967:juni) p.162

pressures, and the ambient mechanical pressures on any living animal is continually changing. No stimulus array is ever frozen for any length of time except in the case of a sleeping or otherwise unconscious observer. There is the special case of a laboratory observer who tries to keep still and hold his eyes fixed but even then his eyes, head, and limbs manifest some tremor. Consequently the notion of an unchanging stimulus pattern is an unrealized abstraction, and the even more abstract notion of a fixed constellation of punctate stimuli is a myth. There realities of stimulation involve change in time. Stimulus information about objects resides, therefore, in invariant properties of the transforming array over time. This applies both to vision and to touch.

Taking vision as our example, consider a picture. We have supposed that it is the prototype of visual stimulation instead of the flowing picture that results from locomotion. The information about objects is much reduced in peep-hole vision, that is, in the optic array from a frozen picture, and ambiguities of size, distance, edges, and layout arise in viewing a picture. Such pictorial contradictions have been studied for centuries by painters and psychologists alike. All such ambiguities are removed when the experimenter substitutes the object for its picture so that the observer can walk around the object and see it in different perspectives.

If this is true, the function of a visual system is not to register the perspectives of things, their forms or color patches in the visual field, but to register the invariants that underlie the changing perspectives. Form-perception is an incidental symptom of this capacity, not its basis; the so-called sensations of form that we notice in a picture, or when we consider things as silhouettes, are not entailed in the perceiving of objects. Perception in the newborn does not begin with flat patchwork of innate visual sensations to which depth must be added by some operation such as learning; perception begins at birth with whatever capacity the infant has to pick up the invariants in the stimulus flux that are significant for him.

3. *The Process of Extracting Invariants over Time*

The invariant properties of a changing stimulus array correspond to the invariant properties of the environment. What about the *variant* properties? The child must learn to separate the invariants from the variants

Copyright (c) 2005 ProQuest Information and Learning Company
Copyright (c) Kluwer Academic Publishers

GIBSON, JAMES J., *New Reasons for Realism* , Synthese, 17:2 (1967:juni) p.162

more and more precisely as he grows up, and to focus his attention on them if he is to learn more and more about the world. He typically does so by exploration, that is, by changing the stimulus patterns on his eyes and skin so as to isolate what remains unchanged. During exploration of a stationary world, all such changes or transformations specify nothing more than his own movements. They have subjective reference to his own body. Since each transformation is obtained as a 'feedback' from a movement, he can reverse the transformation by reversing his movement. The child can thus *control* the variants but not the invariants of stimulation. This fact probably has something to do with the way in which he can extract the latter from the mixture.

Let us note that the detecting of those variants of stimulation that can be controlled is not a channel of sense or a mode of sensation. The classical sense of kinesthesis does not cover it. Nor is this kind of detection a kind of perception. It is best described as a component of all the perceptual systems, the *propriospecific* component.

We can now take a further step. We note that not all transformations are caused by movements of the observer. Some are produced by motions of objects in the world, such as falling bodies, rolling stones, and moving animals. How can the child separate the variants caused by external events from the variants caused by his bodily movements? How can he know that the whole world has not moved, for example, whenever he moves his eyes? This is an old and controversial question in psychology. A possible answer is, by extracting a still higher order of invariant. The uncontrollable variation, the one that cannot be reversed by reversing an exploratory movement, is information for an external event just as the invariant that remains after a controllable variation is information for an external object. If the *extracting of invariants over time* is the key process in perception, it can be assumed to occur at higher levels, including those called 'intellectual'.

4. *The Continuity of Perception with Memory and Thought*

All theories of sensation-based perception imply a categorical distinction between perception and memory, the former depending on *present* stimulation and the latter on a retrieval of the traces of *past* stimulation. A difficulty for these theories is that no sharp division between perceiving and remembering can be discovered in experience. The present merges

Copyright (c) 2005 ProQuest Information and Learning Company
Copyright (c) Kluwer Academic Publishers

GIBSON, JAMES J., *New Reasons for Realism* , Synthese, 17:2 (1967:juni) p.162

with the past indistinguishably, and no good criterion has been found to separate them. The theory of information-based perception, on the other hand, implies that perception and memory are not sharply separated, either logically or phenomenally, since the dimension of time has been incorporated in the very definition of stimulus information.

Present stimulation is supposed to appear directly in consciousness as sensation. Past stimulation is supposed to have left traces that can appear in consciousness as memory images. Percepts are often supposed to be mixtures of sensations and memory images. Concepts and thoughts are supposed to be pure memory images without any admixture of sensations. The trouble with this theory is that perceivers are seldom able to distinguish by introspection between the sensations and the memories, and thinkers, although sometimes aware of images, often report that their thoughts are 'imageless'.

The theory of information-based perception avoids these difficulties by assuming that neither sensations nor images are entailed in having knowledge of the world. The resonating of a cognitive system to invariants over time implies attention to objective facts, present, past, or future. The symptoms of stimulation may or may not appear as sensations in perception. The symptoms of casting one's attention over the whole world or over a great span of time may or may not appear as images in thought. It makes no difference, for they are incidental to knowledge, not essential for it.

In this theory, the old problem of how single memory images of an object might be fused into a concept is no longer a problem. The problem of how a concept might be imposed on a new percept disappears. The puzzle of the invariance of perception despite varying sensations, the 'constancy' of the phenomenal size, shape, and color of objects, is no longer a puzzle. And the really staggering problem of the phenomenal persistence of objects when they are no longer 'present to the senses' because they have been hidden by other objects is quite capable of solution when we realize that the awareness of an object does not depend on an awareness of its patch of color in the visual field.

5. *Summary*

Four hypotheses have been outlined above: (1) the existence of stimulus information, (2) the fact of invariance over time, (3) the process of ex-

Copyright (c) 2005 ProQuest Information and Learning Company
Copyright (c) Kluwer Academic Publishers

GIBSON, JAMES J., *New Reasons for Realism* , Synthese, 17:2 (1967:juni) p.162

tracting invariants over time, and (4) the continuity of perception with memory and thought. Whether or not they are verifiable (and this is not the place for a marshalling of evidence) they go together and provide a theory of perception. Granting it some plausibility, what does it imply about the old philosophical puzzles of our knowledge of the external world and our confidence in it?

II. IMPLICATIONS FOR EPISTEMOLOGY

It seems to me that these hypotheses make reasonable the common-sense position that has been called by philosophers direct or naïve realism. I should like to think that there is sophisticated support for the naïve belief in the world of objects and events, and for the simple-minded conviction that our senses give knowledge of it. But this support is hard to find when the senses are considered as channels of sensations; it becomes easy when they are considered as perceptual systems.

Highly ingenious philosophical arguments have been advanced in this century that give roundabout support for the common man's position. It is my impression (although I could be wrong) that all these forms of realism presuppose what I have called the theory of sensation-based perception, and that this is why the arguments have to be roundabout. What happens if we entertain the theory of information-based perception?

1. *Immediate or Direct Experience*

The doctrine that all we ever experience directly is the flow of our sense data implies that our experience of objects and events is indirect. Perception is mediated by sensation. This doctrine leads straight to the sense-datum controversy, since it is just plain false to assert that sense data are all we ever experience 'directly'.

For this doctrine we now have a substitute. There can be direct or immediate awareness of objects and events when the perceptual systems resonate so as to pick up information *and* there can be a kind of direct or immediate awareness of the physiological states of our sense organs when the sensory nerves as such are excited. But these two kinds of experience should not be confused, for they are at opposite poles, objective and subjective. Only the former should be called perceptual experience. There can be an awareness of other bodily organs than the sense organs,

Copyright (c) 2005 ProQuest Information and Learning Company
Copyright (c) Kluwer Academic Publishers

GIBSON, JAMES J., *New Reasons for Realism* , Synthese, 17:2 (1967:juni) p.162

as in hunger or pain, and these are also properly called sensation. The concentrating of inner attention on the states of the receptors, however, as occurs when we are aware of after-images, double images, and 'ringing in the ears', is unnatural. Psychologists, philosophers, and schizophrenics who make a habit of it are called 'introspective' or 'introverted' by the common man.

What about *indirect* awareness? This term should now be reserved primarily for the apprehension of things and events by means of surrogates or human artifacts, including pictures, words, sound-reproducing devices, and microscopes. I suspect that the experience is called indirect in such cases to the extent that there is a concurrent *direct* perception of the surface of the picture, the sounds or letters of the words, the scratching of the record, and the sight of the turntable, in short, of the mediator as such. Whether or not the terms *indirect* and *mediated* should be applied to cases of apprehension by judgment and inference I am uncertain. But I am quite certain that there is no such thing as a phonograph record in the ear and no such thing as a picture in the eye – no reproduction of an external event or object that the organ transmits to the brain.

2. *The Detection of Colors and Sounds*

The man-in-the-street has always supposed that the colors of objects are one thing, whereas the colors of a rainbow or a sunset or an oil-slick are a different matter. He sees the color of a surface *in* the surface, although he may see other colors that appear to be in the light. But this simple fellow has been told he is wrong ever since Newton's discovery of spectral wavelengths, for colors are only in the light, not in objects. Even more, he is told by physical optics and physiological optics that colors are only in *him* since light consists of waves (or photons – both are true, sorry!). The poor man is bewildered but he goes on seeing colors in surfaces. More exactly, he sees very much the same color in the same surface despite change in the amount, kind, and direction of the illumination falling on it. The light is variant, the color is invariant, so of course he sees the color in the surface, not in the light.

Ecological optics, I think, gives promise of assuring him that he is right after all. It postulates stimulus information in the ambient light from a layout of reflecting surfaces, as noted. The various reflectances of these surfaces, their types of natural pigmentation, help to determine

Copyright (c) 2005 ProQuest Information and Learning Company
Copyright (c) Kluwer Academic Publishers

GIBSON, JAMES J., *New Reasons for Realism* , Synthese, 17:2 (1967:juni) p.162

the structure of the ambient light. The invariants of structure that specify classes of natural pigments (as in ripe *vs.* unripe fruit, for example) are highly complicated and remain to be worked out, but some progress is being made in doing so.

Physical acoustics tells the man-in-the-street that sensations of loudness, pitch, and pitch mixture are in his head, and only arise because they correspond to the variables of sound waves in the air. He could not possibly *hear* a mechanical event; he can only infer it from the data. But nevertheless he goes on hearing natural events like rubbing, scraping, rolling, and brushing, or vocal events like growling, barking, singing and croaking, or carpenter's events like sawing, pounding, filing, and chopping. Ecological acoustics would tell him that the vibratory event, the source of the waves, is specified in certain invariant properties of the wave train. These properties (the transients for example) are the same over the whole field of sound waves centered on the mechanical disturbance and extending outward in the medium. Information about the event is physically present in the air surrounding the event. If the man is within earshot, he hears the event.

In short, there is a proper meaning of the word 'color' that refers to a distinctive feature of a solid substance. There is a proper meaning of the word 'sound' that refers to a distinctive feature of a mechanical disturbance. The doctrine of secondary qualities comes from a misunderstanding.

3. *Public Experience and Private Experiences*

The ecology of stimulus information, as distinguished from the physics of stimulus energy, describes fields of available stimulation. In any given air space there exist fields of three types: (1) overlapping fields of airborne compression waves from mechanical events ('sounds'), (2) interpenetrating fields of perspective projections from reflecting surfaces ('sights') and, (3) fields of diffusing volatile substances from plants and animals ('odors').[3] They rise and fall in intensity, but they have been generally available to the ears, eyes, and noses of terrestrial animals for millions of years. They have controlled the locomotion of animals toward or away from the sources of these fields. They constitute what might be called public information for the perception of events, objects, and organisms.

The ambient stimulation for an individual perceiver at any one location in such an air space is not the same as at any other location, but the in-

Copyright (c) 2005 ProQuest Information and Learning Company
Copyright (c) Kluwer Academic Publishers

GIBSON, JAMES J., *New Reasons for Realism* , Synthese, 17:2 (1967:juni) p.162

formation is the same and, since he moves about, he can have the same perceptions that another perceiver could have. A whole crowd of perceivers, in fact, could all hear, see, and smell the same things. They could also hear, see, and perhaps smell each other. Each one, finally, could hear his own voice and footsteps and see his own body.

Now I suggest that this state of affairs can define what might be called levels of increasing 'privacy' of perception. All observers can obtain exactly the same information about a tree if they all walk around it and get the same perspectives. Each observer gets a somewhat different set of perspectives of his own hands than any other observer gets, although there is much in common. But the perspective of one's own nose is absolutely unique and no one else can ever see it from that particular point of view. It is a completely private experience. It is always there whenever one's eyes are open – or rather it is always 'here'.[4]

The tree, the hand, the nose, are increasingly *private*. The negative afterimage is still more private, and in a special way. It is a pure *sensation*, we say.

What about sensations? If it is right to say that these curious experiences are a sort of detection of the physiological states of the sense organs then they are the most private of all forms of awareness. No one else can have my sense data. No one else can experience my headaches or my hunger or my heartbeat for that matter. But if we agree that knowledge of the world is not in principle reducible to sense data, as I urge, there is no reason to be puzzled by the contradiction between the private nature of sensations and the public nature of perception. If sensations are the basis of perception there is every reason for attempts to show that they are not as private as they seem, no matter what intellectual acrobatics are required. But if they are not the basis of perception we can relax and allow them their place at the subjective pole of experience without danger of falling into the ridiculous pit of solipsism.

4. *Summary*

Both the psychology of perception and the philosophy of perception seem to show a new face when the process is considered at its own level, distinct from that of sensation. Unfamiliar conceptions in physics, anatomy, physiology, psychology, and phenomenology are required to clarify the separation and make it plausible. But there have been so many dead ends

Copyright (c) 2005 ProQuest Information and Learning Company
Copyright (c) Kluwer Academic Publishers

GIBSON, JAMES J., *New Reasons for Realism* , Synthese, 17:2 (1967:juni) p.162

in the effort to solve the theoretical problems of perception that radical proposals may now be acceptable. Scientists are often more conservative than philosophers of science. I end, therefore, as I began, with a plea for help.

Psychology Department, Cornell University

REFERENCES

[1] J. J. Gibson, *The Senses Considered as Perceptual Systems*, Boston 1966. This represents the present form of the theory. A less developed stage (part of which I would no longer defend) can be found in 'Perception as a Function of Stimulation', in *Psychology: A Study of a Science*, Vol. I: *Sensory, Perceptual, and Physiological Formulations* (ed. by S. Koch), New York 1959. A still more immature theory can be found in *The Perception of the Visual World*, Boston 1950. The germ of it is in 'Studying Perceptual Phenomena', in *Methods of Psychology*, ed. by T. G. Andrews, New York 1948.

[2] This implication, and the further one that we can only *know* about particles, not objects, seemed overwhelming to me and to many other scientists 37 years ago. I read it in A. S. Eddington, *The Nature of the Physical World*, New York 1929. It took me years to get over it. I now realize that Eddington's physical world was that of the sky, not the earth.

[3] The volatile parts of plants and animals are sometimes called 'essences' by odor-chemists. This suggests the fact that the vapors of many things specify them, that is distinguish them from other things, and this is what I mean by information about things.

[4] What happens when a man sees his nose in a mirror, a *virtual* nose, is interesting but it has too many ramifications to be followed up here.

Copyright (c) 2005 ProQuest Information and Learning Company
Copyright (c) Kluwer Academic Publishers