Optical Records and Relativity.

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PROBABLY the majority of physicists acknowledge the existence of events (and the clusters of events we call things), out there in the external world, whether we have sensory acquaintance with them or not. They believe that an object of vision is seen only when light-waves, transmitted from some cluster of physical events as their proximate source, reach the retina of the eye, and that on receipt of advenient influence which stirs sundry retinal events, there somehow arises conscious reference to an object of vision. It is not within their province to consider how this conscious reference may best be interpreted. That falls within the province of the psychologist. Just as it is for the physicist to tell the story of the manner in which light-waves take origin in some proximate source, how they reach the retina, and what is the set of physical events in the retinal record, so it is for the psychologist to tell the story of the manner in which conscious reference to the object of vision has come about.

The physicist, then, tells *his* story and leaves the psychologist to tell his story. Broadly speaking, the former is that of radiant influence from its proximate source to its proximate outcome; the latter that of perceptual reference to the object of vision.

I take it that from the physical point of view we may distinguish two sets of events. There is a set of events beyond the confines of our body, and there is a set of events within the confines of our body. In the set of external events there are specialised groups of events from which radiant influence is transmitted in ways which it is for the physicist to describe and interpret. When such radiant influence is advenient to one of the more highly developed organisms, such as we are, it forms an optical "image" on the retina of the eye. A set of events in the pattern of the image is called into being in the spread-out and curved surface of the retina. This "receptor-pattern" may be regarded as a record (within the confines of the organism) of some group of events beyond the confines of the organism. It is no less physical, as a set of inter-related events which occur in the optical record of the retina, than the set of events in the external world which is the proximate source of that record.

Beyond the record, in our present context, the physicist is not concerned to trace the further course of events within the organism. However important this may be for the elucidation of perceptual process, he leaves that to the physiologist. Hence he restricts his inquiry to the task of co-relating (*a*) the events in the proximate source of the record in the external world, with (*b*) the events in the optical record itself; but he cannot get along with this (his proper) task without conscious reference to (*a*) and to (*b*). Since this does not fall within his province, he must accept some working hypothesis as to its nature from those within whose province it does fall for consideration. There are, however, two in the field. It may be (*a*) that the spatio-temporal relations in the retinal record *reveal* those that obtain in the source of that record; that is, that in and through the record the mind directly apprehends the spatio-temporal course of events in

its source; or it may be (*β*) that the nature of conscious reference in perception is such that the object of vision is fashioned on the spatio-temporal configuration of *the record*; that is, that changes in the record are referred to that which is the external source of that record.

With the aid of photography, other optical records than those in the retina may be obtained. But the photographic record, when it is seen, is an object of vision, and therefore implies a retinal record; so that we have here only an instance of vision at second-hand.

Now the first-hand optical record in the retina, or its substitute at second-hand in the photograph, has a quite definite shape, as a snapshot phase of changing spatio-temporal relations therein; and whatever may be that shape in the record, that too is the shape of the object of vision. That which gives an elliptical record is seen, under naïve perception, as elliptical. In matters terrestrial, and in matters that can be brought within the range of manipulation under touch-contact (and its ancillary measuring-rods, callipers, and so forth), there is opportunity for co-relating the spatio-temporal relations in the optical record, and in the source of that record as dealt with by manipulation. There is need for such co-relation; for the shape of a thing, say a coin, as given under reference from touch-manipulation, is often different from the shape of that thing as given in the optical record, and as referred to the object of vision.

Let us admit that the coin as a physical thing is, for our knowledge, a "construct" which we deliberately frame for scientific purposes by combining the net result of all visual and (in the case of this and other terrestrial things) all tactual records obtained in the course of manipulation. It is on this basis that the physicist acknowledges a physical thing existent in its own right; and where vision is concerned, that thing is the source of advenient influence that reaches the retina and gives an optical record. The inquirer in what may be called the field of "classical optics" (briefly characterised as "the science of light regarded as the medium of sight") is one whose special business it is to co-relate the story of physical influence with that of perceptual reference with its location of the object of vision. He has reached certain generalisations with regard to the occurrences he observes in this twofold aspect. Perhaps the most salient is this: No matter how devious the course of a light ray in accordance with the non-homogeneous medium of physical events through which it is transmitted (under refraction, reflection, and so forth), conscious reference to the object of vision is along the line of the final path of that ray by which it reaches the recording retina. This is projective reference or, as Sir Charles Sherrington calls it, "projicience" ("Integrative Action of the Nervous System," p. 324). He distinctly states that it is a *psychical* process. He traces its connexion with the evolution of "distance receptors." Initially naïvely perceptual with meaning (including visual distance) for the practical behaviour of animal life, it leads up, under further mental elaboration, to conscious reference to the object of vision. The gradually

acquired location of the object of vision is commonly interpreted in terms of this elaboration. Under optical inquiry an orderly co-relation of the "place of location" of the object of vision with the "assigned place" of the proximate source of the light rays from a physical object, is set forth in the text-books of classical optics. This is the interpretation of perceptual reference that I labelled (β) in a previous paragraph.

Under (α)—the doctrine of direct apprehension—the interpretation is quite different. It is advocated by new realists of the type of Prof. Alexander, by critical realists of the older type (represented by Prof. Dawes Hicks), and of the newer type (represented by Prof. Santayana). It underlies Prof. Whitehead's "Concept of Nature" and Mr. Bertrand Russell's "Analysis of Mind." It is certainly widely accepted on grounds not always clearly set forth; and it has authoritative expression.

What is its interpretation of conscious reference? Subject to correction, I think it comes to this in its selective form as advocated by Prof. Alexander. The entity which we call a mind is "compresent" with a vast number of certain other entities named, let us say, "sensa." Just as, in physical regard, physical influence flows in to some given physical entity from some other physical entity or entities, so too, in psychical regard, psychical influence flows in to the mind from some sensum or sensa with which it is compresent, or, at any rate, the mind is affected by them; and on receipt of such influence (or such affection) there is what we call reference on the part of that mind to the sensum or sensa. Reference, therefore, is the psychical reaction of the mind in its relation to sensa, and it discloses or reveals the intrinsic nature of the sensum with which the mind is compresent. Revelation of this order is illustrated by the direct apprehension of a certain kind of sensa in vision.

Such in its essential features is, if I mistake not, the doctrine of reference which is alternative to that of projicience or projection. The sense-organs—in our context the retinal records—are only *instrumental* to direct apprehension, for example, of a distant sensum which has in itself the quality of redness. It may be true enough that, whenever colour vision is in evidence, there always occur in the receptor-pattern of the retina, or the choroid, certain complex chemical changes. But what of that? It merely shows (if such be the facts) that the bodily instrument used by the mind in direct apprehension is of such and such a nature. It may be that it takes the human infant some seven or eight weeks clearly to focus and locate an object of vision, and perhaps another seven or eight weeks (cf. Milicent Shinn, "Biography of a Baby") to co-relate the seeing and the manipulation of that which then becomes for its apprehension one and the same object. What of that? It merely shows, if the inference from the observed facts be valid, that the physiological means subservient to the psychical end of apprehension are subject to a process of progressive development. Physiologists and biologists discuss such subsidiary matters. Direct apprehension on the part of the mind is there from the first and all the time.

We have then an α -interpretation and a β -interpretation, both distinctively concerned with a mental or psychical process; and the point of emphasis is that

there are *alternative* hypotheses as to the nature and outcome of conscious reference in naïve perception. The difference between them may be illustrated by the alternative interpretations of "mirror images." When a man shaves all that happens, in manipulative touch under the razor, to his chin that he cannot see, happens also to the mirror image that he does see. Clearly there is need for co-relating these several events. The interpretation of classical optics is familiar enough. On the "sensum theory"—either in its "selective" or in its "generative" form—the co-relation of the visual sensa, apprehended as mirror-images, with the tactual sensa apprehended under manipulation of the razor (together with sundry auditory and olfactory sensa) demands a much more intricate and elaborate treatment such as is discussed in Mr. Broad's "Scientific Thought." There are, then, two quite different interpretations. Of these one or other claims acceptance under the searching criticism which leads from an initial assumption to acknowledgment of its validity as a basis for further procedure.

Furthermore, apart from the projicience or projection entertained as a policy in classical optics, and discussed from an evolutionary point of view by Sir Charles Sherrington—apart, let us say, from the biological and psychological arguments in favour of reference *from* the record *to* the object of vision—it is sufficiently well known that there is, in the wider field of thought, a philosophical hypothesis based wholly on projicience—that which Prof. Wildon Carr has presented in "The Theory of Monads"; and it is also pretty clear that other idealist systems, in so far as objective, proceed on the basis of the hypothesis of projicience rather than of that of direct apprehension. So here again—apart from "subjectivism," which we may regard as out of court—we have to realise that there are *two* alternative interpretations of conscious reference, no doubt in somewhat variant forms.

Revert now to the concept of the optical record, photographic or retinal. All that we experience in visual perception when there is an object of vision implies an optical record, whatever else it may imply in focussing the eyes and in the very complex set of factors concerned in the perception of visual distance. In the case of a coin, all that we visually know concerning it is based on a vast number of varying optical records with intrinsic spatial relations of positional points distinguishable within it. On this basis we speak of the object of vision as round, elliptical, and so forth. Speaking of the coin: Such and such (we say) it is as object of vision. But what is *it*?

There are other records of "it"—those based on tactual contact-records, with behaviour in manipulation. These, too, are records of "the coin." We co-relate these contact-records with those optical records, and we incorporate both in a pretty consistent scheme where each has meaning in terms of the other. In the optical record we take into consideration (*a*) the point of view from which the record is obtained, (*b*) the physical path of the light-waves that reach that record from some physical source, and so on. Then, concurrently, we co-relate the whole set of optical records with the whole set of contact-records given in respect of the things, such as the coin, which lie within the limited reach of manipulation. Combining all the data

afforded by all the records, we construct "the coin" as it has, step by step, taken form in our knowledge based on these records. But what is "it"? What is "the coin"? Some may say it is just this construct. Others may say: This no doubt it is for the knowledge which gradually took form in our childhood. But this construct is founded on conscious reference—if you like on a great number of co-related acts of referring—to a physical thing, existent "on its own" independently of all such percipient processes.

Now whether this belief or acknowledgment of the independent existence of a specific cluster of physical events which is the source of no less physical records is justifiable at the bar of logic or not, I submit that the man of practical common sense, and the man of science as physicist, *do* proceed, in all their workaday hours, on the basis of this acknowledgment, as a policy if not as a creed. I feel confident that most physicists, and the general public who are interested in the outcome of their inquiries, do claim that recently acquired knowledge with regard to relativity demands not only a radical modification of policy in dealing with the physical universe, which was a "going concern" long before man came on to the scene of events, but also a radical modification of the orthodox scientific creed now spoken of, in the past tense, as that of "classical mechanics."

A physical outsider meddles with relativity at his peril. He may, however, ask questions, even if he be not competent to make assertions. Here let it be said that, unless he be smitten with the incurable disease of senile folly, he must freely and fully accept all that physical science has securely established in its splendid advance since the days of his youth. That being so, he may still venture to ask questions.

(1) Are we not, in the crucial issues that arise under physical relativity, dealing only with optical records, photographic or retinal, and with an acknowledged physical source of those records?

(2) Must we not regard the records as physical no less than their source?

(3) Are we not, from the nature of the phenomena in evidence, precluded from obtaining any contact-records, under touch-manipulation, of the spatio-temporal events in the distant source, though we deal largely, on this wise, with the optical record, spectroscopic or other, on the photographic plate?

(4) Are we not, therefore, in physical regard, co-relating, under some relevant transformation formula, Lorentzian or other, the physical events optically recorded, with the distant source-events thus recorded?

(5) Is not the outcome: Such and such is the correlation of *these* events with *those*?

(6) May we, on the basal principle of relativity, give primacy in "reality" to either set of events thus co-related, since each is acknowledged as physically "real" in the same sense?

(7) In terms of so-called "warping," are we justified in saying more than that these source-events or those record-events are "warped"—*i.e.* stand in need of transformation—each relatively to the other?

(8) Is it not for convenience of policy only that "warp" is assigned to one or the other?

(9) If, as a matter of scientific creed, primacy in "reality" be given to one or the other, and we be

bidden to believe that these and not those are "warped," is this on strictly physical grounds?

(10) Or is it on grounds other than physical—*meta*-physical in the Aristotelian sense—namely, in accordance with a doctrine of perceptual reference, *i.e.* of the nature of a *mental* process (however simple or however complex) and its outcome?

(11) Is there one universally accepted doctrine of perceptual reference in vision, or are there two, (a) direct apprehension, and (β) projicience (or projection)?

(12) Since, as a matter of plain history, there have been, and still are, two different hypotheses, is it for the physicist as such to pronounce judgment one way or the other?

(13) If (a) be accepted by this or that physicist on the basis of one of the two "metaphysical" hypotheses, should not this be stated?

(14) If the physicist, as a wise cobbler, sticks to his last, and says that the nature and origin of perceptual reference is not his business, should he not leave the matter open? If it be no concern of his, *qua* physicist, should he not hand it over to those who make it their special province of inquiry?

(15) If some of those who have given careful and prolonged consideration to this problem in all its bearings (and its bearings are many) regard the balance of evidence as, in their judgment, in favour of visual projicience, does this imply rejection of physical relativity or of any valid inference therefrom?

(16) What does all this mean for the man in the street, or the smoking-room, who is interested in such matters?

Expressed in terms which may *perhaps* be "understood of the people," it means something like this:

(i.) All the established results of physical science, as such, and all valid inferences therefrom, are fully and gladly accepted.

(ii.) There are two quite different hypotheses in respect of perceptual reference. On *this* hypothesis, just as the shape of a coin as seen from any given position is that of the "image" on the retina; just as the partially immersed rod looks bent because such is its record in the retinal receptor-pattern; just as the "mirror image" of a man's chin is located differently by its owner and the barber who shaves him; just as, in these terrestrial matters of common experience, what happens in the record is the basis of all that we see, and is projiciently referred to the set of physical events which give that record; so too are all spatio-temporal changes as optically recorded (subject to Lorentzian or other transformation) projiciently referred to their distant physical source—for such is the nature of vision.

(iii.) It follows that "local spaces" and "local times" are, broadly speaking, illusions of vision, none the less interesting, none the less matters for scientific inquiry, none the less germane to the policy of physical interpretation, but still having their seat in the optical record and not in the source of events thus recorded, though projiciently referred thereto.

(iv.) It follows, too, that if transformation of events be interpreted in terms of projicience and not in terms of direct apprehension, the source-events themselves are nowise transformed, and the scientific creed of classical mechanics stands in no need of revision.