

# The Relation of Sense-data to Physics

## I. The Problem Stated

PHYSICS is said to be an empirical science, based upon observation and experiment.

It is supposed to be verifiable, i.e. capable of calculating beforehand results subsequently confirmed by observation and experiment.

What can we learn by observation and experiment?

Nothing, so far as physics is concerned, except immediate data of sense: certain patches of colour, sounds, tastes, smells, etc., with certain spatio-temporal relations.

The supposed contents of the physical world are *prima facie* very different from these: molecules have no colour, atoms make no noise, electrons have no taste, and corpuscles do not even smell.

If such objects are to be verified, it must be solely through their relation to sense-data: they must have some kind of correlation with sense-data, and must be verifiable through their correlation *alone*.

But how is the correlation itself ascertained? A correlation can only be ascertained empirically by the correlated objects being constantly *found* together. But in our case, only one term of the correlation, namely, the sensible term, is ever *found*: the other term seems essentially incapable of being found. Therefore, it would seem, the correlation with objects of sense, by which physics was to be verified, is itself utterly and for ever unverifiable.

There are two ways of avoiding this result.

(1) We may say that we know some principle *a priori*, without

the need of empirical verification, e.g. that our sense-data have *causes* other than themselves, and that something can be known about these causes by inference from their effects. This way has been often adopted by philosophers. It may be necessary to adopt this way to some extent, but in so far as it is adopted physics ceases to be empirical or based upon experiment and observation alone. Therefore this way is to be avoided as much as possible.

(2) We may succeed in actually defining the objects of physics as functions of sense-data. Just in so far as physics leads to expectations, this *must* be possible, since we can only *expect* what can be experienced. And in so far as the physical state of affairs is inferred from sense-data, it must be capable of expression as a function of sense-data. The problem of accomplishing this expression leads to much interesting logico-mathematical work.

In physics as commonly set forth, sense-data appear as functions of physical objects: when such-and-such waves impinge upon the eye, we see such-and-such colours, and so on. But the waves are in fact inferred from the colours, not vice versa. Physics cannot be regarded as validly based upon empirical data until the waves have been expressed as functions of the colours and other sense-data.

Thus if physics is to be verifiable we are faced with the following problem: Physics exhibits sense-data as functions of physical objects, but verification is only possible if physical objects can be exhibited as functions of sense-data. We have therefore to solve the equations giving sense-data in terms of physical objects, so as to make them instead give physical objects in terms of sense-data.

## II. Characteristics of Sense-data

When I speak of a "sense-datum," I do not mean the whole of what is given in sense at one time. I mean rather such a part of the whole as might be singled out by attention: particular patches of colour, particular noises, and so on. There is some difficulty in deciding what is to be considered *one* sense-datum: often attention causes divisions to appear where, so far as can be

discovered, there were no divisions before. An observed complex fact, such as that this patch of red is to the left of that patch of blue, is also to be regarded as a datum from our present point of view: epistemologically, it does not differ greatly from a simple sense-datum as regards its function in giving knowledge. Its *logical* structure is very different, however, from that of sense: *sense* gives acquaintance with particulars, and is thus a two-term relation in which the object can be *named* but not *asserted*, and is inherently incapable of truth or falsehood, whereas the observation of a complex fact, which may be suitably called perception, is not a two-term relation, but involves the propositional form on the object-side, and gives knowledge of a truth, not mere acquaintance with a particular. This logical difference, important as it is, is not very relevant to our present problem; and it will be convenient to regard data of perception as included among sense-data for the purposes of this paper. It is to be observed that the particulars which are constituents of a datum of perception are always sense-data in the strict sense.

Concerning sense-data, we know that they are there while they are data, and this is the epistemological basis of all our knowledge of external particulars. (The meaning of the word "external" of course raises problems which will concern us later.) We do not know, except by means of more or less precarious inferences, whether the objects which are at one time sense-data continue to exist at times when they are not data. Sense-data at the times when they are data are all that we directly and primitively know of the external world; hence in epistemology the fact that they are *data* is all-important. But the fact that they are all that we directly know gives, of course, no presumption that they are all that there is. If we could construct an impersonal metaphysic, independent of the accidents of our knowledge and ignorance, the privileged position of the actual data would probably disappear, and they would probably appear as a rather haphazard selection from a mass of objects more or less like them. In saying this, I assume only that it is probable that there are particulars with which we are not acquainted. Thus the special importance of sense-data is in relation to epistemology, not to metaphysics. In this respect, physics is to be reckoned as metaphysics: it is impersonal, and nominally pays no

special attention to sense-data. It is only when we ask how physics can be *known* that the importance of sense-data re-emerges.

### III. Sensibilia

I shall give the name *sensibilia* to those objects which have the same metaphysical and physical status as sense-data, without necessarily being data to any mind. Thus the relation of a *sensibile* to a sense-datum is like that of a man to a husband: a man becomes a husband by entering into the relation of marriage, and similarly a *sensibile* becomes a sense-datum by entering into the relation of acquaintance. It is important to have both terms; for we wish to discuss whether an object which is at one time a sense-datum can still exist at a time when it is not a sense-datum. We cannot ask "Can sense-data exist without being given?" for that is like asking "Can husbands exist without being married?" We must ask "Can *sensibilia* exist without being given?" and also "Can a particular *sensibile* be at one time a sense-datum, and at another not?" Unless we have the word *sensibile* as well as the word "sense-datum," such questions are apt to entangle us in trivial logical puzzles.

It will be seen that all sense-data are *sensibilia*. It is a metaphysical question whether all *sensibilia* are sense-data, and an epistemological question whether there exist means of inferring *sensibilia* which are not data from those that are.

A few preliminary remarks, to be amplified as we proceed, will serve to elucidate the use which I propose to make of *sensibilia*.

I regard sense-data as not mental, and as being, in fact, part of the actual subject-matter of physics. There are arguments, shortly to be examined, for their subjectivity, but these arguments seem to me only to prove *physiological* subjectivity, i.e. causal dependence on the sense-organs, nerves, and brain. The appearance which a thing presents to us is causally dependent upon these, in exactly the same way as it is dependent upon intervening fog or smoke or coloured glass. Both dependences are contained in the statement that the appearance which a piece of matter presents when viewed from a given place is a

function not only of the piece of matter, but also of the intervening medium. (The terms used in this statement—"matter," "view from a given place," "appearance," "intervening medium"—will all be defined in the course of the present paper.) We have not the means of ascertaining how things appear from places not surrounded by brain and nerves and sense-organs, because we cannot leave the body; but continuity makes it not unreasonable to suppose that they present *some* appearance at such places. Any such appearance would be included among *sensibilia*. If—*per impossibile*—there were a complete human body with no mind inside it, all those *sensibilia* would exist, in relation to that body, which would be sense-data if there were a mind in the body. What the mind adds to *sensibilia*, in fact, is *merely* awareness: everything else is physical or physiological.

### IV. Sense-data Are Physical

Before discussing this question it will be well to define the sense in which the terms "mental" and "physical" are to be used. The word "physical," in all preliminary discussions, is to be understood as meaning "what is dealt with by physics." Physics, it is plain, tells us something about some of the constituents of the actual world; what these constituents are may be doubtful, but it is they that are to be called physical, whatever their nature may prove to be.

The definition of the term "mental" is more difficult, and can only be satisfactorily given after many difficult controversies have been discussed and decided. For present purposes therefore I must content myself with assuming a dogmatic answer to these controversies. I shall call a particular "mental" when it is aware of something, and I shall call a fact "mental" when it contains a mental particular as a constituent.

It will be seen that the mental and the physical are not necessarily mutually exclusive, although I know of no reason to suppose that they overlap.

The doubt as to the correctness of our definition of the "mental" is of little importance in our present discussion. For what I am concerned to maintain is that sense-data are physical, and

this being granted it is a matter of indifference in our present inquiry whether or not they are also mental. Although I do not hold, with Mach and James and the "new realists," that the difference between the mental and the physical is *merely* one of arrangement, yet what I have to say in the present paper is compatible with their doctrine and might have been reached from their standpoint.

In discussions on sense-data, two questions are commonly confused, namely:

(1) Do sensible objects persist when we are not sensible of them? in other words, do *sensibilia* which are data at a certain time sometimes continue to exist at times when they are not data? And (2) are sense-data mental or physical?

I propose to assert that sense-data are physical, while yet maintaining that they probably never persist unchanged after ceasing to be data. The view that they do not persist is often thought, quite erroneously in my opinion, to imply that they are mental; and this has, I believe, been a potent source of confusion in regard to our present problem. If there were, as some have held, a *logical impossibility* in sense-data persisting after ceasing to be data, that certainly would tend to show that they were mental; but if, as I contend, their non-persistence is merely a probable inference from empirically ascertained causal laws, then it carries no such implication with it, and we are quite free to treat them as part of the subject-matter of physics.

Logically a sense-datum is an object, a particular of which the subject is aware. It does not contain the subject as a part, as for example beliefs and volitions do. The existence of the sense-datum is therefore not logically dependent upon that of the subject; for the only way, so far as I know, in which the existence of *A* can be *logically* dependent upon the existence of *B* is when *B* is part of *A*. There is therefore no *a priori* reason why a particular which is a sense-datum should not persist after it has ceased to be a datum, nor why other similar particulars should not exist without ever being data. The view that sense-data are mental is derived, no doubt, in part from their physiological subjectivity, but in part also from a failure to distinguish between sense-data and "sensations." By a sensation I mean the fact consisting in the subject's awareness of the sense-datum. Thus a sensation is a

complex of which the subject is a constituent and which therefore is mental. The sense-datum, on the other hand, stands over against the subject as that external object of which in sensation the subject is aware. It is true that the sense-datum is in many cases in the subject's body, but the subject's body is as distinct from the subject as tables and chairs are, and is in fact merely a part of the material world. So soon, therefore, as sense-data are clearly distinguished from sensations, and as their subjectivity is recognised to be physiological not psychical, the chief obstacles in the way of regarding them as physical are removed.

## V. "Sensibilia" and "Things"

But if "sensibilia" are to be recognised as the ultimate constituents of the physical world, a long and difficult journey is to be performed before we can arrive either at the "thing" of common sense or at the "matter" of physics. The supposed impossibility of combining the different sense-data which are regarded as appearances of the same "thing" to different people has made it seem as though these "sensibilia" must be regarded as mere subjective phantasms. A given table will present to one man a rectangular appearance, while to another it appears to have two acute angles and two obtuse angles; to one man it appears brown, while to another, towards whom it reflects the light, it appears white and shiny. It is said, not wholly without plausibility, that these different shapes and different colours cannot co-exist simultaneously in the same place, and cannot therefore both be constituents of the physical world. This argument I must confess appeared to me until recently to be irrefutable. The contrary opinion has, however, been ably maintained by Dr. T. P. Nunn in an article entitled: "Are Secondary Qualities Independent of Perception?"<sup>1</sup> The supposed impossibility derives its apparent force from the phrase: "*in the same place*," and it is precisely in this phrase that its weakness lies. The conception of space is too often treated in philosophy—even by those who on reflection would not defend such treatment—as

<sup>1</sup> *Proc. Arist. Soc.*, 1909-10, pp. 191-218.

though it were as given, simple, and unambiguous as Kant, in his psychological innocence, supposed. It is the unperceived ambiguity of the word "place" which, as we shall shortly see, has caused the difficulties to realists and given an undeserved advantage to their opponents. Two "places" of different kinds are involved in every sense-datum, namely the place *at* which it appears and the place *from* which it appears. These belong to different spaces, although, as we shall see, it is possible, with certain limitations, to establish a correlation between them. What we call the different appearances of the same thing to different observers are each in a space private to the observer concerned. No place in the private world of one observer is identical with a place in the private world of another observer. There is therefore no question of combining the different appearances in the one place; and the fact that they cannot all exist in one place affords accordingly no ground whatever for questioning their physical reality. The "thing" of common sense may in fact be identified with the whole class of its appearances—where, however, we must include among appearances not only those which are actual sense-data, but also those "sensibilia," if any, which, on grounds of continuity and resemblance, are to be regarded as belonging to the same system of appearances, although there happen to be no observers to whom they are data.

An example may make this clearer. Suppose there are a number of people in a room, all seeing, as they say, the same tables and chairs, walls and pictures. No two of these people have exactly the same sense-data, yet there is sufficient similarity among their data to enable them to group together certain of these data as appearances of one "thing" to the several spectators, and others as appearances of another "thing." Besides the appearances which a given thing in the room presents to the actual spectators, there are, we may suppose, other appearances which it would present to other possible spectators. If a man were to sit down between two others, the appearance which the room would present to him would be intermediate between the appearances which it presents to the two others: and although this appearance would not exist as it is without the sense-organs, nerves and brain, of the newly arrived spectator, still it is not

unnatural to suppose that, from the position which he now occupies, *some* appearance of the room existed before his arrival. This supposition, however, need merely be noticed and not insisted upon.

Since the "thing" cannot, without indefensible partiality, be identified with any single one of its appearances, it came to be thought of as something distinct from all of them and underlying them. But by the principle of Occam's razor, if the class of appearances will fulfil the purposes for the sake of which the thing was invented by the prehistoric metaphysicians to whom common sense is due, economy demands that we should identify the thing with the class of its appearances. It is not necessary to *deny* a substance or substratum underlying these appearances; it is merely expedient to abstain from asserting this unnecessary entity. Our procedure here is precisely analogous to that which has swept away from the philosophy of mathematics the useless menagerie of metaphysical monsters with which it used to be infested.

## VI. Construction versus Inferences

Before proceeding to analyse and explain the ambiguities of the word "place," a few general remarks on method are desirable. The supreme maxim in scientific philosophising is this:

*Wherever possible, logical constructions are to be substituted for inferred entities.*

Some examples of the substitution of construction for inference in the realm of mathematical philosophy may serve to elucidate the uses of this maxim. Take first the case of irrationals. In old days, irrationals were inferred as the supposed limits of series of rationals which had no rational limit; but the objection to this procedure was that it left the existence of irrationals merely optative, and for this reason the stricter methods of the present day no longer tolerate such a definition. We now define an irrational number as a certain class of ratios, thus constructing it logically by means of ratios, instead of arriving at it by a doubtful inference from them. Take again the case of cardinal

numbers. Two equally numerous collections appear to have something in common: this something is supposed to be their cardinal number. But so long as the cardinal number is inferred from the collections, not constructed in terms of them, its existence must remain in doubt, unless in virtue of a metaphysical postulate *ad hoc*. By defining the cardinal number of a given collection as the class of all equally numerous collections, we avoid the necessity of this metaphysical postulate, and thereby remove a needless element of doubt from the philosophy of arithmetic. A similar method, as I have shown elsewhere, can be applied to classes themselves, which need not be supposed to have any metaphysical reality, but can be regarded as symbolically constructed fictions.

The method by which the construction proceeds is closely analogous in these and all similar cases. Given a set of propositions nominally dealing with the supposed inferred entities, we observe the properties which are required of the supposed entities in order to make these propositions true. By dint of a little logical ingenuity, we then construct some logical function of less hypothetical entities which has the requisite properties. This constructed function we substitute for the supposed inferred entities, and thereby obtain a new and less doubtful interpretation of the body of propositions in question. This method, so fruitful in the philosophy of mathematics, will be found equally applicable in the philosophy of physics, where, I do not doubt, it would have been applied long ago but for the fact that all who have studied this subject hitherto have been completely ignorant of mathematical logic. I myself cannot claim originality in the application of this method to physics, since I owe the suggestion and the stimulus for its application entirely to my friend and collaborator Dr. Whitehead, who is engaged in applying it to the more mathematical portions of the region intermediate between sense-data and the points, instants and particles of physics.

A complete application of the method which substitutes constructions for inferences would exhibit matter wholly in terms of sense-data, and even, we may add, of the sense-data of a single

person, since the sense-data of others cannot be known without some element of inference. This, however, must remain for the present an ideal, to be approached as nearly as possible, but to be reached, if at all, only after a long preliminary labour of which as yet we can only see the very beginning. The inferences which are unavoidable can, however, be subjected to certain guiding principles. In the first place they should always be made perfectly explicit, and should be formulated in the most general manner possible. In the second place the inferred entities should, whenever this can be done, be similar to those whose existence is given, rather than, like the Kantian *Ding an sich*, something wholly remote from the data which nominally support the inference. The inferred entities which I shall allow myself are of two kinds: (a) the sense-data of other people, in favour of which there is the evidence of testimony, resting ultimately upon the analogical argument in favour of minds other than my own; (b) the "sensibilia" which would appear from places where there happen to be no minds, and which I suppose to be real although they are no one's data. Of these two classes of inferred entities, the first will probably be allowed to pass unchallenged. It would give me the greatest satisfaction to be able to dispense with it, and thus establish physics upon a solipsistic basis; but those—and I fear they are the majority—in whom the human affections are stronger than the desire for logical economy, will, no doubt, not share my desire to render solipsism scientifically satisfactory. The second class of inferred entities raises much more serious questions. It may be thought monstrous to maintain that a thing can present any appearance at all in a place where no sense-organs and nervous structure exist through which it could appear. I do not myself feel the monstrosity; nevertheless I should regard these supposed appearances only in the light of a hypothetical scaffolding, to be used while the edifice of physics is being raised, though possibly capable of being removed as soon as the edifice is completed. These "sensibilia" which are not data to anyone are therefore to be taken rather as an illustrative hypothesis and as an aid in preliminary statement than as a dogmatic part of the philosophy of physics in its final form.

## VII. Private Space and the Space of Perspectives

We have now to explain the ambiguity in the word "place," and how it comes that two places of different sorts are associated with every sense-datum, namely the place *at* which it is and the place *from* which it is perceived. The theory to be advocated is closely analogous to Leibniz's monadology, from which it differs chiefly in being less smooth and tidy.

The first fact to notice is that, so far as can be discovered, no sensible is ever a datum to two people at once. The things seen by two different people are often closely similar, so similar that the same *words* can be used to denote them, without which communication with others concerning sensible objects would be impossible. But, in spite of this similarity, it would seem that some difference always arises from difference in the point of view. Thus each person, so far as his sense-data are concerned, lives in a private world. This private world contains its own space, or rather spaces, for it would seem that only experience teaches us to correlate the space of sight with the space of touch and with the various other spaces of other senses. This multiplicity of private spaces, however, though interesting to the psychologist, is of no great importance in regard to our present problem, since a merely solipsistic experience enables us to correlate them into the one private space which embraces all our own sense-data. The place *at* which a sense-datum is, is a place in private space. This place therefore is different from any place in the private space of another percipient. For if we assume, as logical economy demands, that all position is relative, a place is only definable by the things in or around it, and therefore the same place cannot occur in two private worlds which have no common constituent. The question, therefore, of combing what we call different appearances of the same thing in the same place does not arise, and the fact that a given object appears to different spectators to have different shapes and colours affords no argument against the physical reality of all these shapes and colours.

In addition to the private spaces belonging to the private

worlds of different percipients, there is, however, another space, in which one whole private world counts as a point, or at least as a spatial unit. This might be described as the space of points of view, since each private world may be regarded as the appearance which the universe presents from a certain point of view. I prefer, however, to speak of it as the space of *perspectives*, in order to obviate the suggestion that a private world is only real when someone views it. And for the same reason, when I wish to speak of a private world without assuming a percipient, I shall call it a "perspective."

We have now to explain how the different perspectives are ordered in one space. This is effected by means of the correlated "sensibilia" which are regarded as the appearances, in different perspectives, of one and the same thing. By moving, and by testimony, we discover that two different perspectives, though they cannot both contain the same "sensibilia," may nevertheless contain very similar ones; and the spatial order of a certain group of "sensibilia" in a private space of one perspective is found to be identical with, or very similar to, the spatial order of the correlated "sensibilia" in the private space of another perspective. In this way one "sensible" in one perspective is correlated with one "sensible" in another. Such correlated "sensibilia" will be called "appearances of one thing." In Leibniz's monadology, since each monad mirrored the whole universe, there was in each perspective a "sensible" which was an appearance of each thing. In our system of perspectives, we make no such assumption of completeness. A given thing will have appearances in some perspectives, but presumably not in certain others. The "thing" being defined as the class of its appearances, if  $\kappa$  is the class of perspectives in which a certain thing  $\theta$  appears, then  $\theta$  is a member of the multiplicative class of  $\kappa$ ,  $\kappa$  being a class of mutually exclusive classes of "sensibilia." And similarly a perspective is a member of the multiplicative class of the things which appear in it.

The arrangement of perspectives in a space is effected by means of the differences between the appearances of a given thing in the various perspectives. Suppose, say, that a certain penny appears in a number of different perspectives; in some it

looks larger and in some smaller, in some it looks circular, in others it presents the appearance of an ellipse of varying eccentricity. We may collect together all those perspectives in which the appearance of the penny is circular. These we will place on one straight line, ordering them in a series by the variations in the apparent size of the penny. Those perspectives in which the penny appears as a straight line of a certain thickness will similarly be placed upon a plane (though in this case there will be many different perspectives in which the penny is of the same size; when one arrangement is completed these will form a circle concentric with the penny), and ordered as before by the apparent size of the penny. By such means, all those perspectives in which the penny presents a visual appearance can be arranged in a three-dimensional spatial order. Experience shows that the same spatial order of perspectives would have resulted if, instead of the penny, we had chosen any other thing which appeared in all the perspectives in question, or any other method or utilising the differences between the appearances of the same things in different perspectives. It is this empirical fact which has made it possible to construct the one all-embracing space of physics.

The space whose construction has just been explained, and whose elements are whole perspectives, will be called "perspective-space."

### VIII. The Placing of "Things" and "Sensibilia" in Perspective Space

The world which we have so far constructed is a world of six dimensions, since it is a three-dimensional series of perspectives, each of which is itself three-dimensional. We have now to explain the correlation between the perspective space and the various private spaces contained within the various perspectives severally. It is by means of this correlation that the one three-dimensional space of physics is constructed; and it is because of the unconscious performance of this correlation that the distinction between perspective space and the percipient's private

space has been blurred, with disastrous results for the philosophy of physics. Let us revert to our penny: the perspectives in which the penny appears larger are regarded as being nearer to the penny than those in which it appears smaller, but as far as experience goes the apparent size of the penny will not grow beyond a certain limit, namely, that where (as we say) the penny is so near the eye that if it were any nearer it could not be seen. By touch we may prolong the series until the penny touches the eye, but no further. If we have been travelling along a line of perspectives in the previously defined sense, we may, however, by imagining the penny removed, prolong the line of perspectives by means, say, of another penny; and the same may be done with any other line of perspectives defined by means of the penny. All these lines meet in a certain place, that is, in a certain perspective. This perspective will be defined as "the place where the penny is."

It is now evident in what sense two places in constructed physical space are associated with a given "sensibile." There is first the place which is the perspective of which the "sensibile" is a member. This is the place *from* which the "sensibile" appears. Secondly there is the place where the thing is of which the "sensibile" is a member, in other words an appearance; this is the place *at* which the "sensibile" appears. The "sensibile" which is a member of one perspective is correlated with another perspective, namely, that which is the place where the thing is of which the "sensibile" is an appearance. To the psychologist the "place from which" is the more interesting, and the "sensibile" accordingly appears to him subjective and where the percipient is. To the physicist the "place at which" is the more interesting, and the "sensibile" accordingly appears to him physical and external. The causes, limits and partial justification of each of these two apparently incompatible views are evident from the above duplicity of places associated with a given "sensibile."

We have seen that we can assign to a physical thing a place in the perspective space. In this way different parts of our body acquire positions in perspective space, and therefore there is a meaning (whether true or false need not much concern us) in saying that the perspective to which our sense-



data belong is inside our head. Since our mind is correlated with the perspective to which our sense-data belong, we may regard this perspective as being the position of our mind in perspective space. If, therefore, this perspective is, in the above defined sense, inside our head, there is a good meaning for the statement that the mind is in the head. We can now say of the various appearances of a given thing that some of them are nearer to the thing than others; those are nearer which belong to perspectives that are nearer to "the place where the thing is." We can thus find a meaning, true or false, for the statement that more is to be learnt about a thing by examining it close to than by viewing it from a distance. We can also find a meaning for the phrase "the things which intervene between the subject and a thing of which an appearance is a datum to him." One reason often alleged for the subjectivity of sense-data is that the appearance of a thing may change when we find it hard to suppose that the thing itself has changed—for example, when the change is due to our shutting our eyes, or to our screwing them up so as to make the thing look double. If the thing is defined as the class of its appearances (which is the definition adopted above), there is of course necessarily *some* change in the thing whenever any one of its appearances changes. Nevertheless there is a very important distinction between two different ways in which the appearances may change. If after looking at a thing I shut my eyes, the appearance of my eyes changes in every perspective in which there is such an appearance, whereas most of the appearances of the thing will remain unchanged. We may say, as a matter of definition, that a thing changes when, however near to the thing an appearance of it may be, there are changes in appearances as near as, or still nearer to, the thing. On the other hand we shall say that the change is in some other thing if all appearances of the thing which are at not more than a certain distance from the thing remain unchanged, while only comparatively distant appearances of the thing are altered. From this consideration we are naturally led to the consideration of *matter*, which must be our next topic.

## IX. The Definition of Matter

We defined the "physical thing" as the class of its appearances, but this can hardly be taken as a definition of matter. We want to be able to express the fact that the appearance of a thing in a given perspective is causally affected by the matter between the thing and the perspective. We have found a meaning for "between a thing and a perspective." But we want matter to be something other than the whole class of appearances of a thing, in order to state the influence of matter on appearances.

We commonly assume that the information we get about a thing is more accurate when the thing is nearer. Far off, we see it is a man; then we see it is Jones; then we see he is smiling. Complete accuracy would only be attainable as a limit: if the appearances of Jones as we approach him tend towards a limit, that limit may be taken to be what Jones really is. It is obvious that from the point of view of physics the appearances of a thing close to "count" more than the appearances far off. We may therefore set up the following tentative definition:

The *matter* of a given thing is the limit of its appearances as their distance from the thing diminishes.

It seems probable that there is something in this definition, but it is not quite satisfactory, because empirically there is no such limit to be obtained from sense-data. The definition will have to be eked out by constructions and definitions. But probably it suggests the right direction in which to look.

We are now in a position to understand in outline the reverse journey from matter to sense-data which is performed by physics. The appearance of a thing in a given perspective is a function of the matter composing the thing and of the intervening matter. The appearance of a thing is altered by intervening smoke or mist, by blue spectacles or by alterations in the sense-organs or nerves of the percipient (which also must be reckoned as part of the intervening medium). The nearer we approach to the thing, the less its appearance is affected by the intervening matter. As we travel further and

further from the thing, its appearances diverge more and more from their initial character; and the causal laws of their divergence are to be stated in terms of the matter which lies between them and the thing. Since the appearances at very small distances are less affected by causes other than the thing itself, we come to think that the limit towards which these appearances tend as the distance diminishes is what the thing "really is," as opposed to what it merely seems to be. This, together with its necessity for the statement of causal laws, seems to be the source of the entirely erroneous feeling that matter is more "real" than sense-data.

Consider for example the infinite divisibility of matter. In looking at a given thing and approaching it, one sense-datum will become several, and each of these will again divide. Thus *one* appearance may represent *many* things, and to this process there seems no end. Hence in the limit, when we approach indefinitely near to the thing, there will be an indefinite number of units of matter corresponding to what, at a finite distance, is only one appearance. This is how infinite divisibility arises.

The whole causal efficacy of a thing resides in its matter. This is in some sense an empirical fact, but it would be hard to state it precisely, because "causal efficacy" is difficult to define.

What can be known empirically about the matter of a thing is only approximate, because we cannot get to know the appearances of the thing from very small distances, and cannot accurately infer the limit of these appearances. But it is inferred *approximately* by means of the appearances we can observe. It then turns out that these appearances can be exhibited by physics as a function of the matter in our immediate neighbourhood; e.g. the visual appearance of a distant object is a function of the light-waves that reach the eyes. This leads to confusions of thought, but offers no real difficulty.

One appearance, of a visible object for example, is not sufficient to determine its other simultaneous appearances, although it goes a certain distance towards determining them. The determination of the hidden structure of a thing, so far as it is possible at all, can only be effected by means of elaborate dynamical inferences.

## X. Time<sup>2</sup>

It seems that the one all-embracing time is a construction, like the one all-embracing space. Physics itself has become conscious of this fact through the discussions connected with relativity.

Between two perspectives which both belong to one person's experience, there will be a direct time-relation of before and after. This suggests a way of dividing history in the same sort of way as it is divided by different experiences, but without introducing experience or any thing mental: we may define a "biography" as everything that is (directly) earlier or later than, or simultaneous with, a given "sensible." This will give a series of perspectives, which *might* all form parts of one person's experience, though it is not necessary that all or any of them should actually do so. By this means, the history of the world is divided into a number of mutually exclusive biographies.

We have now to correlate the times in the different biographies. The natural thing would be to say that the appearances of a given (momentary) thing in two different perspectives belonging to different biographies are to be taken as simultaneous; but this is not convenient. Suppose *A* shouts to *B*, and *B* replies as soon as he hears *A*'s shout. Then between *A*'s hearing of his own shout and his hearing of *B*'s there is an interval; thus if we made *A*'s and *B*'s hearing of the same shout exactly simultaneous with each other, we should have events exactly simultaneous with a given event but not with each other. To obviate this, we assume a "velocity of sound." That is, we assume that the time when *B* hears *A*'s shout is half-way between the time when *A* hears his own shout and the time when he hears *B*'s. In this way the correlation is effected.

What has been said about sound applies of course equally to light. The general principle is that the appearances, in different

<sup>2</sup> On this subject, compare *A Theory of Time and Space*, by Mr. A. A. Robb (Camb. Univ. Press), which first suggested to me the views advocated here, though I have, for present purposes, omitted what is most interesting and novel in his theory. Mr. Robb has given a sketch of his theory in a pamphlet with the same title (Heffer and Sons, Cambridge, 1913).

perspectives, which are to be grouped together as constituting what a certain thing is at a certain moment, are not to be all regarded as being at that moment. On the contrary they spread outward from the thing with various velocities according to the nature of the appearances. Since no *direct* means exist of correlating the time in one biography with the time in another, this temporal grouping of the appearances belonging to a given thing at a given moment is in part conventional. Its motive is partly to secure the verification of such maxims as that events which are exactly simultaneous with the same event are exactly simultaneous with one another, partly to secure convenience in the formulation of causal laws.

### XI. The Persistence of Things and Matter

Apart from any of the fluctuating hypotheses of physics, three main problems arise in connecting the world of physics with the world of sense, namely:

1. the construction of a single space;
2. the construction of a single time;
3. the construction of permanent things or matter.

We have already considered the first and second of these problems; it remains to consider the third.

We have seen how correlated appearances in different perspectives are combined to form one "thing" at one moment in the all-embracing time of physics. We have now to consider how appearances at different times are combined as belonging to one "thing," and how we arrive at the persistent "matter" of physics. The assumption of permanent substance, which technically underlies the procedure of physics, cannot of course be regarded as metaphysically legitimate: just as the one thing simultaneously seen by many people is a construction, so the one thing seen at different times by the same or different people must be a construction, being in fact nothing but a certain grouping of certain "sensibilia."

We have seen that the momentary state of a "thing" is an

assemblage of "sensibilia," in different perspectives, not all simultaneous in the one constructed time, but spreading out from "the place where the thing is" with velocities depending upon the nature of the "sensibilia." The time *at* which the "thing" is in this state is the lower limit of the times at which these appearances occur. We have now to consider what leads us to speak of another set of appearances as belonging to the same "thing" at a different time.

For this purpose, we may, at least to begin with, confine ourselves within a single biography. If we can always say when two "sensibilia" in a given biography are appearances of one thing, then, since we have seen how to connect "sensibilia" in different biographies as appearances of the same momentary state of a thing, we shall have all that is necessary for the complete construction of the history of a thing.

It is to be observed, to begin with, that the identity of a thing for common sense is not always correlated with the identity of matter for physics. A human body is one persisting thing for common sense, but for physics its matter is constantly changing. We may say, broadly, that the common-sense conception is based upon continuity in appearances at the ordinary distances of sense-data, while the physical conception is based upon the continuity of appearances at very small distances from the thing. It is probable that the common-sense conception is not capable of complete precision. Let us therefore concentrate our attention upon the conception of the persistence of matter in physics.

The first characteristic of two appearances of the same piece of matter at different times is *continuity*. The two appearances must be connected by a series of intermediaries, which, if time and space form compact series, must themselves form a compact series. The colour of the leaves is different in autumn from what it is in summer; but we believe that the change occurs gradually, and that, if the colours are different at two given times, there are intermediate times at which the colours are intermediate between those at the given times.

But there are two considerations that are important as regards continuity.

First, it is largely hypothetical. We do not observe any one

thing continuously, and it is merely a hypothesis to assume that, while we are not observing it, it passes through conditions intermediate between those in which it is perceived. During uninterrupted observation, it is true, continuity is nearly verified; but even here, when motions are very rapid, as in the case of explosions, the continuity is not actually capable of direct verification. Thus we can only say that the sense-data are found to *permit* a hypothetical complement of "sensibilia" such as will preserve continuity, and that therefore there *may* be such a complement. Since, however, we have already made such use of hypothetical "sensibilia," we will let this point pass, and admit such "sensibilia," as are required to preserve continuity.

Secondly, continuity is not a sufficient criterion of material identity. It is true that in many cases, such as rocks, mountains, tables, chairs, etc., where the appearances change slowly, continuity is sufficient, but in other cases, such as the part of an approximately homogeneous fluid, it fails us utterly. We can travel by sensibly continuous gradations from any one drop of the sea at any one time to any other drop at any other time. We infer the motions of sea-water from the effects of the current, but they cannot be inferred from direct sensible observation together with the assumption of continuity.

The characteristic required in addition to continuity is conformity with the laws of dynamics. Starting from what common sense regards as persistent things, and making only such modifications as from time to time seem reasonable, we arrive at assemblages of "sensibilia" which are found to obey certain simple laws, namely those of dynamics. By regarding "sensibilia" at different times as belonging to the same piece of matter, we are able to define *motion*, which presupposes the assumption or construction of something persisting throughout the time of the motion. The motions which are regarded as occurring, during a period in which all the "sensibilia" and the times of their appearance are given, will be different according to the manner in which we combine "sensibilia" at different times as belonging to the same piece of matter. Thus even when the whole history of the world is given in every particular, the question what motions take place is still to a certain extent arbitrary even after the

assumption of continuity. Experience shows that it is possible to determine motions in such a way as to satisfy the laws of dynamics, and that this determination, roughly and on the whole, is fairly in agreement with the common-sense opinions about persistent things. This determination, therefore, is adopted, and leads to a criterion by which we can determine, sometimes practically, sometimes only theoretically, whether two appearances at different times are to be regarded as belonging to the same piece of matter. The persistence of all matter throughout all time can, I imagine, be secured by definition.

To recommend this conclusion, we must consider what it is that is proved by the empirical success of physics. What is proved is that its hypotheses, though unverifiable where they go beyond sense-data, are at no point in contradiction with sense-data, but, on the contrary, are ideally such as to render all sense-data calculable when a sufficient collection of "sensibilia" is given. Now physics has found it empirically possible to collect sense-data into series, each series being regarded as belonging to one "thing," and behaving, with regard to the laws of physics, in a way in which series not belonging to one thing would in general not behave. If it is to be unambiguous whether two appearances belong to the same thing or not, there must be only one way of grouping appearances so that the resulting things obey the laws of physics. It would be very difficult to prove that this is the case, but for our present purposes we may let this point pass, and assume that there is only one way. Thus we may lay down the following definition: *Physical things are those series of appearances whose matter obeys the laws of physics.* That such series exist is an empirical fact, which constitutes the verifiability of physics.

## XII. Illusions, Hallucinations, and Dreams

It remains to ask how, in our system, we are to find a place for sense-data which apparently fail to have the usual connection with the world of physics. Such sense-data are of various kinds, requiring somewhat different treatment. But all are of the sort that would be called "unreal," and therefore, before embarking

upon the discussion, certain logical remarks must be made upon the conceptions of reality and unreality.

Mr. A. Wolf<sup>3</sup> says:

"The conception of mind as a system of transparent activities is, I think, also untenable because of its failure to account for the very possibility of dreams and hallucinations. It seems impossible to realise how a bare, transparent activity can be directed to what is not there, to apprehend what is not given."

This statement is one which, probably, most people would endorse. But it is open to two objections. First, it is difficult to see how an activity, however un-"transparent," can be directed towards a nothing: a term of a relation cannot be a mere non-entity. Secondly, no reason is given, and I am convinced that none can be given, for the assertion that dream-objects are not "there" and not "given." Let us take the second point first.

(1) The belief that dream-objects are not given comes, I think, from failure to distinguish, as regards waking life, between the sense-datum and the corresponding "thing." In dreams, there is no such corresponding "thing" as the dreamer supposes; if, therefore, the "thing" were given in waking life, as e.g. Meinong maintains,<sup>4</sup> then there would be a difference in respect of givenness between dreams and waking life. But if, as we have maintained, what is given is never the thing, but merely one of the "sensibilia" which compose the thing, then what we apprehend in a dream is just as much given as what we apprehend in waking life.

Exactly the same argument applies as to the dream-objects being "there." They have their position in the private space of the perspective of the dreamer; where they fail is in their correlation with other private spaces and therefore with perspective space. But in the only sense in which "there" can be a datum, they are "there" just as truly as any of the sense-data of waking life.

(2) The conception of "illusion" or "unreality," and the correlative conception of "reality," are generally used in a way which

<sup>3</sup>"Natural Realism and Present Tendencies in Philosophy," *Proc. Arist. Soc.*, 1908-9, p. 165.

<sup>4</sup>*Die Erfahrungsgrundlagen unseres Wissens*, p. 28.

embodies profound logical confusions. Words that go in pairs, such as "real" and "unreal," "existent" and "non-existent," "valid" and "invalid," etc., are all derived from the one fundamental pair, "true" and "false." Now "true" and "false" are applicable only—except in derivative significations—to *propositions*. Thus wherever the above pairs can be significantly applied, we must be dealing either with propositions or with such incomplete phrases as only acquire meaning when put into a context which, with them, forms a proposition. Thus such pairs of words can be applied to *descriptions*,<sup>5</sup> but not to proper names: in other words, they have no application whatever to data, but only to entities or non-entities described in terms of data.

Let us illustrate by the terms "existence" and "non-existence." Given any datum  $x$ , it is meaningless either to assert or to deny that  $x$  "exists." We might be tempted to say: "Of course  $x$  exists, for otherwise it could not be a datum." But such a statement is really meaningless, although it is significant and true to say "My present sense-datum exists," and it may also be true that " $x$  is my present sense-datum." The inference from these two propositions to " $x$  exists" is one which seems irresistible to people unaccustomed to logic; yet the apparent proposition inferred is not merely false, but strictly meaningless. To say "My present sense-datum exists" is to say (roughly): "There is an object of which 'my present sense-datum' is a description." But we cannot say: "There is an object of which ' $x$ ' is a description," because ' $x$ ' is (in the case we are supposing) a name, not a description. Dr. Whitehead and I have explained this point fully elsewhere (*loc. cit.*) with the help of symbols, without which it is hard to understand; I shall not therefore here repeat the demonstration of the above propositions, but shall proceed with their application to our present problem.

The fact that "existence" is only applicable to descriptions is concealed by the use of what are grammatically proper names in a way which really transforms them into descriptions. It is, for example, a legitimate question whether Homer existed; but here "Homer" means "the author of the Homeric poems," and is a

<sup>5</sup>Cf. *Principia Mathematica*, Vol. I, § 14, and Introduction, Chap. III. For the definition of *existence*, cff. § 14. 02.

description. Similarly we may ask whether God exists; but then "God" means "the Supreme Being" or "the *ens realissimum*" or whatever other description we may prefer. If "God" were a proper name, God would have to be a datum; and then no question could arise as to His existence. The distinction between existence and other predicates, which Kant obscurely felt, is brought to light by the theory of descriptions, and is seen to remove "existence" altogether from the fundamental notions of metaphysics.

What has been said about "existence" applies equally to "reality," which may, in fact, be taken as synonymous with "existence." Concerning the immediate objects in illusions, hallucinations, and dreams, it is meaningless to ask whether they "exist" or are "real." There they are, and that ends the matter. But we may legitimately inquire as to the existence or reality of "things" or other "sensibilia" inferred from such objects. It is the unreality of these "things" and other "sensibilia," together with a failure to notice that they are not data, which has led to the view that the objects of dreams are unreal.

We may now apply these considerations in detail to the stock arguments against realism, though what is to be said will be mainly a repetition of what others have said before.

(1) We have first the variety of normal appearances, supposed to be incompatible. This is the case of the different shapes and colours which a given thing presents to different spectators. Locke's water which seems both hot and cold belongs to this class of cases. Our system of different perspectives fully accounts for these cases, and shows that they afford no argument against realism.

(2) We have cases where the correlation between different senses is unusual. The bent stick in water belongs here. People say it looks bent but is straight: this only means that it is straight to the touch, though bent to sight. There is no "illusion," but only a false inference, if we think that the stick would feel bent to the touch. The stick would look just as bent in a photograph, and, as Mr. Gladstone used to say, "the photograph cannot lie."<sup>6</sup>

<sup>6</sup> Cf. Edwin B. Holt, *The Place of Illusory Experience in a Realistic World*, "The New Realism," p. 305, both on this point and as regards *seeing double*.

The case of seeing double also belongs here, though in this case the cause of the unusual correlation is physiological, and would therefore not operate in a photograph. It is a mistake to ask whether the "thing" is duplicated when we see it double. The "thing" is a whole system of "sensibilia," and it is only those visual "sensibilia" which are data to the percipient that are duplicated. The phenomenon has a purely physiological explanation; indeed, in view of our having two eyes, it is in less need of explanation than the single visual sense-datum which we normally obtain from the things on which we focus.

(3) We come now to cases like dreams, which may, at the moment of dreaming, contain nothing to arouse suspicion, but are condemned on the ground of their supposed incompatibility with earlier and later data. Of course it often happens that dream-objects fail to behave in the accustomed manner: heavy objects fly, solid objects melt, babies turn into pigs or undergo even greater changes. But none of these unusual occurrences *need* happen in a dream, and it is not on account of such occurrences that dream-objects are called "unreal." It is their lack of continuity with the dreamer's past and future that makes him, when he wakes, condemn them; and it is their lack of correlation with other private worlds that makes others condemn them. Omitting the latter ground, our reason for condemning them is that the "things" which we infer from them cannot be combined according to the laws of physics with the "things" inferred from waking sense-data. This might be used to condemn the "things" inferred from the data of dreams. Dream-data are no doubt appearances of "things," but not of such "things" as the dreamer supposes. I have no wish to combat psychological theories of dreams, such as those of the psycho-analysts. But there certainly are cases where (whatever psychological causes may contribute) the presence of physical causes also is very evident. For instance, a door banging may produce a dream of a naval engagement, with images of battleships and sea and smoke. The whole dream will be an appearance of the door banging, but owing to the peculiar condition of the body (especially the brain) during sleep, this appearance is not that expected to be produced by a door banging, and thus the dreamer is led

to entertain false beliefs. But his sense-data are still physical, and are such as a completed physics would include and calculate.

(4) The last class of illusions are those which cannot be discovered within one person's experience, except through the discovery of discrepancies with the experiences of others. Dreams might conceivably belong to this class, if they were jointed sufficiently neatly into waking life; but the chief instances are recurrent sensory hallucinations of the kind that lead to insanity. What makes the patient, in such cases, become what others call insane is the fact that, within his own experience, there is nothing to show that the hallucinatory sense-data do not have the usual kind of connection with "sensibilia" in other perspectives. Of course he may learn this through testimony, but he probably finds it simpler to suppose that the testimony is untrue and that he is being wilfully deceived. There is, so far as I can see, no theoretical criterion by which the patient can decide, in such a case, between the two equally satisfactory hypotheses of his madness and of his friends' mendacity.

From the above instances it would appear that abnormal sense-data, of the kind which we regard as deceptive, have intrinsically just the same status as any others, but differ as regards their correlations or causal connections with other "sensibilia" and with "things." Since the usual correlations and connections become part of our unreflective expectations, and even seem, except to the psychologist, to form part of our data, it comes to be thought, mistakenly, that in such cases the data are unreal, whereas they are merely the causes of false inferences. The fact that correlations and connections of unusual kinds occur adds to the difficulty of inferring things from sense and of expressing physics in terms of sense-data. But the unusualness would seem to be always physically or physiologically explicable, and therefore raises only a complication, not a philosophical objection.

I conclude, therefore, that no valid objection exists to the view which regards sense-data as part of the actual substance of the physical world, and that, on the other hand, this view is the only one which accounts for the empirical verifiability of

physics. In the present paper, I have given only a rough preliminary sketch. In particular, the part played by *time* in the construction of the physical world is, I think, more fundamental than would appear from the above account. I should hope that, with further elaboration, the part played by unperceived "sensibilia" could be indefinitely diminished, probably by invoking the history of a "thing" to eke out the inferences derivable from its momentary appearance.