

Regulations for Ph.D.

16. "..... The candidate must indicate how far the Thesis embodies the result of his own research or observation, and in what respects his investigations appear to him to advance the study of his subject."

June, 1927.

The accompanying thesis is entirely the result of my own research, except in so far as my ideas have become modified in the course of discussion with members of the philosophical department of Bedford College, and of the College Philosophical Society. I have also been helped by lectures arranged by the British Institute of Philosophical Studies, notably by Mr Russell's course of lectures on "Mind and Matter"; by discussions at meetings of the Aristotelian Society; and by various lectures given in London during the past two years by Dr Broad, Professor A.E. Taylor, and Professor Nunn.

My investigations appear to me to advance the study of causal theory in the following respects:-

I. By an analysis of concrete situations displaying causal connection, they show that commonsense demands spatio-temporal and not merely temporal connection between events in causal sequence.

II. They show that an adequate account of causation can only be given in a philosophical system which has first revised its concepts in accordance with modern scientific theory, and in particular, with the modern assimilation of space and time.

III. They show that the scientific analysis of perception, light radiation, etc., requires us to postulate spatio-temporal continuity of causal process - (not in the sense of continuity, discreteness or compactness of abstract space-time, but in the sense that "something-going-on" must be postulated at every spatio-temporal point within a causal sequence.)

IV. From these three points of view, one condition of causal sequence is seen to be spatio-temporal continuity between events in the sequence, and this required spatio-temporal relationship between cause and effect events is analysed and stated in precise terms in Section V.

V. In this thesis also, Hume's dictum, which seems to me to be axiomatic, that multiplication of similar instances can never produce a relation which was not present in the single instance, is taken seriously, and the causal relation is shown to be a relation discoverable within the single instance. This position is shown to receive support from the modern tendency in physics and psychology, to view the ultimate data of both sciences, as being of the nature of process, or events.

VI. This position also, is shown to throw light on the necessity of the causal relation, which is of the nature of a universal connection within the concrete situation. Thus, inductive process is justified as the progressive acquiring of knowledge of relations within the single instance, and is well grounded in experience, since the universal connections which it seeks, are discoverable in the single given instance.

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R. L. Saw.





Thesis

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Presented for the Degree of  
Doctor of Philosophy in the University of London.

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AN EXAMINATION OF THE NOTION OF CAUSE IN THE  
LIGHT OF RECENT CONTRIBUTIONS TO THE PHILOSOPHY OF NATURE.

PRESENTED FOR THE DEGREE OF  
DOCTOR OF PHILOSOPHY IN THE UNIVERSITY OF LONDON.

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1. Precise statement and analysis of the contemporary view  
of the causal relation:-

- (a) as relating events in sequence.
- (b) as being in some sense a necessary relation.

An Examination of the Notion of Cause in the  
Light of Recent Contributions to the Philosophy of Nature.

following positions:-

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- (a) that the philosophical causal  
relation implies a logical self-contradiction.
- (b) that even if this were not so, there is nothing in  
nature corresponding to the philosophical notion  
of a causal relation.
- (c) that therefore the notion of cause must be confined  
to the notion of temporal sequence of events.

Ruth L. Saw

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without a fundamental revision of concepts in the light of the modern assimilation of space and time.

IV. A. An examination of Professor Whitehead's philosophy of nature, as providing rational grounds for Induction.

B. An account of the theory of causation implicit in Professor Whitehead's system.

V. Elaboration of a causal theory in the light of the foregoing discussions.

VI. The necessity of the Causal Relation.

VII. Summary.

change has been a change not so much in the conceptions with which science deals, as in the emphasis which it places upon its conceptions, and its most characteristic expression is to be found in the theory of relativity. Hitherto, science may be said to have been concerned with the adventures of material entities in space and time. Now it is concerned with spatio-temporal process itself, and it regards space and time, and the material entities themselves, as abstractions from the given concrete reality - spatio-temporal process, or events.

It is obvious that the whole-hearted acceptance of such a position necessitates a revision of the fundamental concepts of philosophy, and Professor Whitehead, in his philosophy of



AN EXAMINATION OF THE NOTION OF CAUSE IN THE LIGHT OF RECENT  
CONTRIBUTIONS TO THE PHILOSOPHY OF NATURE.

I. Introduction.

The facts of sense perception are the data for science, and therefore, for any philosophy of nature, so that a fundamental change of outlook, such as has been taking place in science within the last few years, is bound to be reflected by a corresponding change in the philosophical conception of nature. This change has been a change not so much in the conceptions with which science deals, as in the emphasis which it places upon its conceptions, and its most characteristic expression is to be found in the theory of relativity. Hitherto, science may be said to have been concerned with the adventures of material entities in space and time. Now it is concerned with spatio-temporal process itself, and it regards space and time, and the material entities themselves, as abstractions from the given concrete reality - spatio-temporal process, or events.

It is obvious that the whole-hearted acceptance of such a position necessitates a revision of the fundamental concepts of philosophy, and Professor Whitehead, in his philosophy of



It shares in common with other relations. Its own peculiar nature, is to a large extent occupied with this revision. Starting with spatio-temporal process as the immediately given, he analyses the notions current alike in science, common-sense, and philosophy, such as "object", "point", "moment" etc., and gives them new meanings, so that they do the work required of them by science, and are yet seen to be founded upon the immediately given data of sense. He does not deal explicitly with causation, though he indicates the general direction in which a solution to the problem of causation is, in his opinion, to be found.

Any classical definition of cause is stated in terms of sequence in time. The cause is said to be an event which "immediately precedes" the effect, the effect is the event which "necessarily follows" the cause. Before entering into a discussion of the difficulties of such definitions, as to how, for instance, one event can be said to be the "necessary" consequence of another, it is essential to consider what is meant by saying that one event "precedes" or "succeeds" another.

It would usually be assumed that "precedes" is a notion which can be understood without explanation. It stands for a relation between events which can be immediately apprehended but which cannot be defined. We can assign certain logical characteristics to the relation, such as the qualities of being asymmetrical and transitive, but these qualities

it shares in common with other relations. Its own peculiar quality - successiveness - can only be expressed in terms of experience. Now what we actually apprehend, is the time order of our own sense experiences; in some cases we judge that we are apprehending the actual time order of events as they are occurring in physical space-time; in some cases we judge that the time order we are apprehending is different from the order in which events are "really" happening, as common-sense would say. For example, if we strike a match, we judge that in apprehending the striking of the match followed by a flash, we are apprehending the "real" order of events. If, however, this is immediately followed by perception of a flash from a distant cannon, we judge that, though in our experience the flame from the match preceded the flash from the cannon, the firing of the cannon "really" preceded the striking of the match. Before going any further it will be necessary to examine the grounds for such a distinction.

If "precedes" is to be understood in terms of experience, the firing of the cannon precedes the striking of the match in some derivative sense. What seems to be meant, is that if there is a series of events occurring at the place where the match is situated, and another series of events occurring at the situation of the cannon, then there is an event of the first series which literally precedes the striking of the match and which is simultaneous with an event of the second series which is literally preceded by the firing of the cannon.

Thus, by "real" or objective time order, common sense seems to mean the order in which events occur at a given centre of reference, and it seems to assume that the time orders of these various centres of reference are capable of a point to point correlation by means of the concept of simultaneity.

"Simultaneity" again, is a relation between events which is immediately apprehended, and as in the case of "precedes", common-sense draws a distinction between the class of events which are "really" simultaneous, and those events which are simultaneous in experience. To take the previous example: the striking of the match was simultaneous with other events such as the position of the match-box in space-time. On the other hand, though the flash from the distant cannon was perceived simultaneously with the spent match, common-sense believes that the firing of the cannon was really simultaneous with some earlier event, which can be discovered by comparing clock readings at the two centres of reference. This is obviously not ultimate. The conventions for measuring time at various centres of reference must be correlated by some further device, such as the sending out of messages or light signals from a centre of observation.

Ultimately then, simultaneities are established by means of light signals, and this yields the ordinary scientific meaning of simultaneity — according to which two events are simultaneous if a light signal sent out from each reaches a point equidistant from the two at the same moment. This



appears to be circular, since in order to define simultaneity of two events, we are making use of the notion of two other events which occur in the same place and at the same moment. It is not really circular, because we are taking "simultaneity" as referring primarily to events in the same place, and as being ultimate in this sense, and then extending it to apply to events in different places. It is, however, circular from a different point of view, for we can only explain what we mean by a point being equidistant from two other points by making reference to the sending of light signals or some similar device.

"Simultaneity" then, is seen to refer primarily to events happening in the same place, and only derivatively to events in different places. A.A. Robb, in his "A Theory of Time and Space"<sup>1</sup> goes even further. He here puts forward the view that simultaneity has no meaning, except as referring to events in the same place. He seems to have been led to this position partly by the difficulties arising from Einstein's suggestion that events which are simultaneous for one observer may not be simultaneous for another observer. Obviously, this cannot be the case if simultaneity refers only to events in the same place.

Professor Whitehead differs from both these points of view. Both Robb and the orthodox relativists agree that in its primary meaning, simultaneity refers to events occurring

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(1) Introduction, p.6.

in the same place. The latter hold further, that it is possible to correlate the time order of events occurring in different places by means of clocks and light signals, and thus to establish simultaneities. Professor Whitehead, however, objects that such a theory gives a position of exaggerated importance to light signals. Further, he argues<sup>1</sup> that simultaneity cannot be dependent upon light signals for its meaning, for a blind person can understand the notion. "He knows quite well what it is to bark both his shins at the same moment."

Simultaneity then, for Professor Whitehead, is immediately given. It is a "definite natural relation" between a duration and its parts, and derivatively, between the parts of a duration. Thus, within a given spatio-temporal whole, we can discern parts which bear to each other the relations of simultaneity.

If, however, we consider this position in connection with a passage in "The Principle of Relativity", his point of view does not seem so far removed from that of Robb. In Chapter IV. of this book he says: "The physiological account of the function of the brain as determining the conditions of external perception, presupposes that the events of the brain signify the totality of contemporaneous space."<sup>2</sup> This seems to suggest a view of perception as a physical process starting from the perceived object and ending in the brain of the

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(1) A.N.Whitehead, "The Principles of Natural Knowledge", p.53.

(2) S.Alexander, "The Principle of Relativity", p.63.

(3) A.A.Robb, "A Theory of Time and Space." Introduction,



percipient. Then the simultaneity which we apprehend is the simultaneity of brain processes, i.e., of events occurring in one place. These events, however, signify, or have essential reference to, other events of varying spatio-temporal position. This view is supported by Professor Alexander, who in ~~his~~ ~~his~~ "Space, Time and Deity" says: "Further, it is clear that the mental act stands in a temporal relation to its object; whether of simultaneity or successiveness is not obvious from direct experience."<sup>1</sup>

From this point of view the difficulty which Robb finds in the orthodox relativist view, does not exist. His objection<sup>2</sup> is that if events may be simultaneous for one observer and not for another, one of the first principles of logic, that "a thing cannot both be and not be at the same time", has been set aside. What is simultaneous for each observer however, is the processes taking place in its respective brain or registering mechanism. That is to say, in the primary meaning of the word, the two observers are making judgments of simultaneity about different events. In the derivative sense - the two observers would arrive at similar conclusions, i.e., they would judge that the same two events were simultaneous.

e.g. If a light signal is sent out from points A and B at the same moment, they would be perceived simultaneously at a point C equidistant from A and B and successively at any point D lying between AC or BC. If, however, observers at

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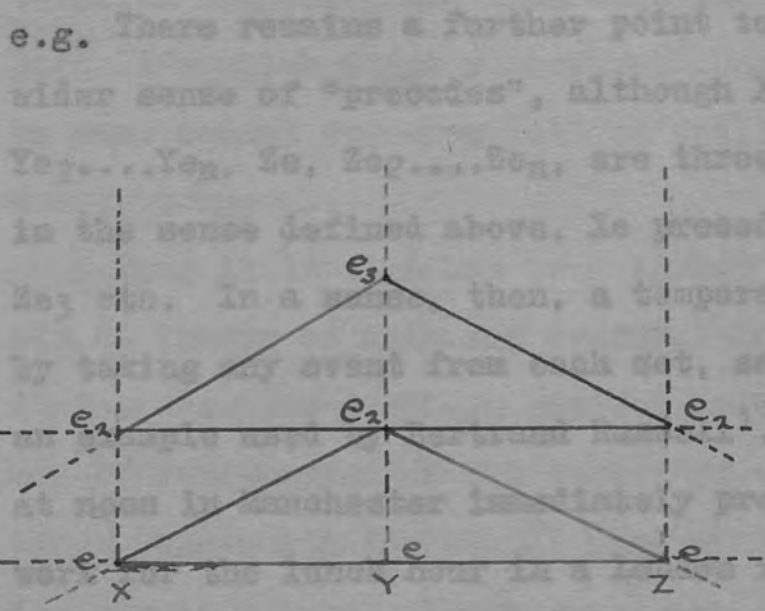
(1) S.Alexander, "Space, Time and Deity." Vol. I p. 27

(2) A.A.Robb, "A Theory of Time and Space." Introduction, p.2.

points C and D had sufficient data to reason from their perceptions to the source of their perceptions, they would arrive at the same conclusion, i.e., that the signals had been sent out from A and B at the same time.

The outcome of this discussion seems to be that simultaneity is a relation which is immediately apprehended - that it holds primarily between events happening in the same place - but that given certain conditions, and under certain assumptions, the time order of events occurring in different places may be approximately correlated.

We thus arrive at the conception of many time orders relative to various centres of reference. Any one order will give the life history of the object by means of which the centre of reference is defined, for science, the life history of a particle, for common-sense, the life history of a perceptual object. A moment in any time order, will be a perspective of the universe from the point of view of the object with reference to which the particular time order is defined. Thus, if a time order is defined by reference to an object Y, Y conceives this time order as running parallel to the time orders of objects X and Z. That is to say, Y conceives that any event  $Y_e$  in its life history, could be correlated with events in the life history of X and Z, say  $X_e$  and  $Z_e$ , even though its reception of news of the happening of  $X_e$ , and  $Z_e$ , is simultaneous with an event in its own life history  $Y_{e2}$ , which is later than  $Y_e$  in a strict sense.



The real simultaneity of events in this diagram, is in events  $e_2$  and  $e_3$ , which represent an event in the life history of  $Y$  and also the reception of news of the happening of  $Xe$  and  $Ze$ .

Simultaneity is, however, inferred to hold between events  $Xe$ ,  $Ye$ , and  $Ze$ , so that these three events are simultaneous in a derived sense. Common-sense conceives of the possibility of thus correlating the totality of events; thus we read in books of travel in the recently discovered lands of the world, of trees that "were saplings when Socrates drank the hemlock". This correlation, however, is only approximate, and the conception of a moment as an abstract element of time occupied by events which are simultaneous in a derived sense, is scientifically valueless. Such a moment is represented in the diagram by the horizontal lines. A moment in the sense of a perspective from a given event  $Ye$  is represented by lines converging towards  $Ye_2$ . Such an abstract stretch of time as a moment in the former sense, seems to be what Mr H.H.Price, in a paper<sup>1</sup> read to the Aristotelian Society, described as an "angelic sense field".

(1) "Mill's View of the External World", by H.H. Price. Session 1926-27 of the Aristotelian Society.



There remains a further point to be considered. In the wider sense of "precedes", although  $Xe, Xe_2 \dots Xe_n, Ye, Ye_2 \dots Ye_n, Ze, Ze_2 \dots Ze_n$ , are three separate time orders in the sense defined above,  $Xe$  precedes  $Ye_2$ , etc.,  $Ye_2$  precedes  $Ze_3$  etc. In a sense, then, a temporal series can be formed by taking any event from each set, say  $Xe_1, Ye_5, Ze_9$ . To take an example used by Bertrand Russell<sup>1</sup>. The blowing of a hooter at noon in Manchester immediately precedes the stopping of work for the lunch hour in a London factory. Mr Russell gives this as an example of "regularity of sequence", so that in his sense of the word, it is a causal sequence. If this conclusion, which is quite contrary to the common-sense usage of the term "causal", is to be avoided, either the meaning of "precedes" must be limited to its primary sense, by relation to a centre of reference, so that  $E_1$  precedes  $E_2$  only if  $E_1$  and  $E_2$  are events in spatio-temporal and not merely in temporal sequence, or causal sequence must be confined to precedence in its narrower sense. Thus, the condition that "the cause must immediately precede the effect" would be restated as "the cause must precede in spatio-temporal sequence, the effect". The former course seems undesirable, since there is a very clear sense in which an eclipse of the sun precedes the final preparations for photographing the eclipse, though there is a wide spatial interval between them, and though the preparations are complete before the eclipse becomes visible. It will therefore be necessary to limit causal sequence to spatio-

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(1) "The Analysis of Mind", p.97.

temporal sequence, and thus rule out such instances as Russell's which display temporal sequence alone. That is to say, causal sequence will be spatio-temporal, and not merely temporal. This limitation has been worked out by A.A. Robb<sup>1</sup> in his "A Theory of Time and Space". In this book, he shows that space-time displays conical order and that any event may be represented as the vertex of two cones. One of these cones represents the causal past of the event, and the other its causal future. These cones are defined by reference to the velocity of light, since this is the greatest velocity. Only those events are within the cone, from which it would be possible for some influence to reach the event which is being considered as the vertex of the cone, i.e., from which it would be possible for a ray of light to travel. Robb is working out his theory with reference only to optics, but for a general causal theory it seems that the causal past of an event should be defined differently for each different aspect of the event. For instance, if we are considering the perceptual experiences of a human organism at a given moment, as an event at the vertex of such a cone, the sphere of influence for visual experiences will be wider than the sphere of influence for auditory experiences. The firing of the cannon would lie within the causal past of the event if we consider it in its aspect as a transmitter of light waves, but not in its aspect as a transmitter of sound waves.

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(1) "A Theory of Time and Space", Introduction.



This narrowing down of the sphere of influence according to the type of event which is being considered, is carried out by common-sense in everyday life. If a man has been shot, only the events within a certain spatio-temporal radius are considered as being possibly in causal connection with the murder. The radius is determined by the distance which a bullet will carry, and by the time it would take to traverse this distance. If the man has been stabbed, the sphere of influence would be considerably narrower. The essence of an alibi is to show that the accused man was at some spatio-temporal position outside the sphere of influence.

Thus, the cause of an event lies within a certain spatio-temporal field, and the extent of this field is determined by the rate at which the influence with which we are dealing is propagated. It now remains to be considered whether any event which lies within the sphere of influence of another event is in causal connection with that event, or if only certain events are to be considered as the cause. In the latter case, according to what principles are the causal events to be marked off from the other events lying within the sphere of influence?

At first sight, the former position seems obviously false. When a man has been shot, for instance, the sequence of events between the firing of the gun and the entering of the bullet into his body is the cause of his death in the most obvious sense. The other events taking place in the environment seem to have merely accidental spatio-temporal

The answer to this question depends, in the first place, on the nature of the change which is being considered. In the case of the man killed by the bullet, the change known as the effect is a change in structure following on a collision at a certain place between two material bodies. In this case, the causal history of the effect is not interrupted. It is the sequence of events leading up to the collision. In other words, the causal sequence has not been interrupted. The environment of a causal sequence seems to provide the passive conditions under which the sequence takes place. The conditioning field is not, however, as Bertrand Russell says, the whole state of the universe at the moment preceding the effect event, but the sphere of influence or the causal past of the effect event. The extent of this will vary according to the kind of change which is being considered.

It is not true, however, even when "environment" is taken in this limited sense, that a complete statement of the cause must include a description of the environment. All that is necessary is that the environment should fulfil certain conditions, which might be described shortly as the conditions of non-interference.

We have now arrived at the conception of a certain spatio-temporal region which provides the passive conditions of an event, and marked out within this region, a route followed by a sequence of events known as a causal sequence. How is this route to be distinguished from the many other possible routes within this spatio-temporal region?

The answer to this question depends, in the first place, on the kind of change which is being considered. In the case of the man killed by the bullet, the change known as the effect is a change in structure following on a collision at a certain rate between two material bodies. In this case, the causal route is easily to be discovered. It is the sequence of events forming the history of the moving material body. If we were to start from the other point of view and consider the change in the motion of the bullet as the effect, then the causal sequence would be the events forming the history of the stationary material object.

The analysis of an effect event involving contact between material bodies is comparatively simple. Such contact between material bodies takes place under one or other of the following sets of conditions. Either both bodies are in motion relative to the environment, or one is at rest and the other in motion relative to the environment. In either case, collision between the two bodies may involve a change in the rate and direction of the motion of one body, and a change in the structure of the other, as for example, when a bird is shot in flight or at rest. Either case may involve change in the structure of both bodies, as in the case of a collision between two motors. Where neither of these effects takes place, the first case involves change in the direction and rate of the motion of both bodies; the second case involves change in the motion of one body, and the communication of motion to the other. The effect event would ordinarily be said to begin at the moment of



contact between the bodies. Up to this moment, there has certainly been change; the speed at which the bodies in motion have been travelling, for example, has been changing in a uniform way - except in the case of a living body, when more complex factors are involved. This kind of change, however, is not usually considered as causal. According to common-sense usage, the inauguration of motion or some such change is causal, but the subsequent events are non-causal. Thus the event which sets going a series of movements, is the cause of the whole series.

In all cases then, of change in motion or position of material bodies, except in the case of living organisms, actual contact between the bodies is involved. It follows from this, that no event which is not in spatio-temporal contact with the effect event, can be considered as the cause of change in motion, position or structure of an object, which is the effect event.

Besides change in motion, position and structure of material objects, the only other change which is apprehended as taking place in nature, is change in the perceptible or sense qualities of objects. This kind of change is much more complicated, because sense qualities do not stand in a simple two-termed relationship to events. "Being red" is not a quality of any one event; it involves at least three sets of events:-

- a. The generating events. (the colour has "really" changed)
- b. Events throughout the intervening medium.
- c. The percipient event. (the visual organs of the

observer.

Thus, change in sense qualities is not a simple linear series of events. It is change throughout a whole sphere of events. When for instance, a leaf gradually changes in colour from green to brown, this does not merely mean that there has been a change in the generating events in which the leaf is situated, but also in the events radiating out from the leaf, so that if a suitable organism be placed at any position in the neighbourhood of the leaf, a correspondingly changed sense quality is apprehended. This might be expressed as Mr Russell puts it, when he says that light is propagated spherically<sup>1</sup>.

"Change in sensible qualities" then, is an ambiguous phrase which may denote change in any one of these sets alone, or in two or more sets in combination. It is therefore important in analysing change in sensible qualities, to point out which set or sets of events are involved in the change, and thus to analyse the apparently single complicated change into series of events of which some may and some may not exhibit change. Thus in any given perceptual situation, such as the sensing of a fading red patch, there are at least three ways in which the change may have been brought about:

- (i) The source of light may have been obscured, so that the change originates in the events in the intervening medium.
- (ii) The change may lie in the generating event, (as common-sense would say, the colour has "really" changed)
- (iii) There may be change in the visual organs of the observer.

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(1) Lectures on "The Analysis of Matter".



In any one of these three states of affairs, the change has been reduced to a linear series of events. In the first case, the cause of change seems to be the placing of an obstacle between the source of light and the generating events, such as the passing of a cloud over the sun. The second change would be a change in the chemical composition of the object situated in the generating events, as when the colour of a curtain fades through continued exposure to the sun. The causal process would then be the stream of events generated in the sun, i.e., what would be called the rays of the sun, which process ends at the surface of the curtain. In the third case, the change is in the physiological structure, and the causal process would be a series of events originating in some part of the organism and ending in the organs of sight.

Thus, all causation seems ultimately to involve either change in relative position or motion of objects, or change in structure due to spatio-temporal continuity between events. In the case of the propagation of light, however, the change is in the microscopic structure, and the objects which thus change their position, motion, etc., relative to one another are scientific objects. This change can never be perceptible, however, so that only the formal mathematical properties of scientific objects can be known; the self-identity of an electron then, is purely theoretical. We have no means of identifying an electron of one date with an electron of a later date, so that it is impossible for us to define causal

routes in terms of single electrons. The cause of change in microscopic structure, which is perceived as change in sensible qualities of objects, cannot then, be brought under the same formula as change in relative motion, position, etc., of material bodies. Change in perceptible qualities involves change in motion of an infinite number of scientific objects, so that from our point of view, cause of such change is action and reaction between systems of scientific objects as a whole. That is to say, there is no one event which immediately precedes and is in spatio-temporal contact with such an event as a change in perceptible qualities, at any rate in such a clear sense as in the case of contact between material bodies. It is more correctly described as a stream of events in contact with the whole surface. Analogously with the case of motion, however, the cause of such change might be considered to be the generation of this stream of events. Thus one cause of the fading of colours, would be the radiation of light rays from the sun.

The propagation of sound involves vibration, which may be caused either by the motion of physical objects or by contact between physical objects. The cause of sound, then, and of change in sound can be analysed in the same way as change in motion etc., of material objects. The effect event was taken as beginning at the moment of contact between the material bodies, while the causal series of events was the causal route marked out by one or other of the material bodies

within the sphere of influence, which provides the passive conditions. In the case of change in visual qualities, however, there is nothing corresponding to this causal route within a passive field. The whole of the causal sphere seems to exert an influence upon the visual qualities of events. The atmosphere and light rays are continuously exerting influence upon the colour of material objects, and both the atmosphere and light rays, are pervasive. No change in the light or atmosphere in the environment of an event can be represented as a linear series of events. It pervades the whole environment.

So far, no controversial points have been raised. Everyone would agree that if there is anything in nature corresponding to the ordinary notion of cause, it must be either the event or some character of the event which immediately precedes the effect event, or it must relate the effect event to the event immediately preceding it. The account which has been given of the notions of "preceding" and "simultaneous" does not depart from common-sense usage. It aimed at making the notions quite precise, and at making explicit the assumptions that underlie the usage of the terms in science and in everyday life.

Now if there is anything in nature corresponding to the ordinary notion of cause, the effect event must have some kind of essential connection with the immediately preceding event. Common-sense expresses this connection by saying that if the



cause had not taken place, the effect could not have taken place. If the cause is defined as the immediately preceding event, this is mere tautology, but something more than this is meant by a necessary connection between cause and effect. The cause of an event is not merely the antecedent of an event; it is the invariable antecedent.

Now it is obvious, as Mr Russell points out<sup>1</sup>, that an invariable antecedent cannot possibly be an event considered merely as an event. An event has essential reference to a particular date and place, so that the phrase "invariable antecedent" is self-contradictory. An antecedent is something which occurs in time, i.e., an event, and as such cannot recur, which invariability can only be predicated of something which recurs under certain stated conditions. The two essentials of cause then, as understood by common-sense, cannot be predicated of the same subject. The conclusion to be drawn from this is not, however, that the notion of cause is self-contradictory and therefore impossible, but that there is probably some further distinction to be drawn in order to make the notion precise and accurate.

If the two essential properties of cause cannot be applied to the same subject, it seems probable that the causal event possesses two aspects, and that the apparently incompatible qualities are predicable respectively of these distinct aspects of the one event. Thus the first condition, that the cause

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(1) Proceedings of the Aristotelian Society, Presidential Address for Session 1912-13



must immediately precede the effect, states the condition under which a causal character may be manifested. The second condition, invariability, applies to the causal character itself, and states that the causal character is of such a kind that whenever it is manifested in an event, the succeeding event will display a certain other character. That is to say, the first condition applies to the cause considered as an event taking place within a certain sequence of events, and states that it must occupy a certain spatio-temporal position relative to the effect event. The second condition applies to the character manifested by this event. This distinction seems to have some bearing on the two meanings which may be given to the phrase "explanation of an event". An event may be held to be explained when the particular sequence of events which caused it has been pointed out, or it may be explained by showing that the causal sequence is an instance of a general causal law. In the former case, the first aspect of cause is more prominent; in the latter the second aspect of cause is emphasized.

The difference between these two modes of explanation throws light on the nature of the causal relation. In the first case, a sequence of events in all its concreteness is indicated as the causal sequence. When however, an explanation of the second type is sought, the process is one of isolating the important factors from a mass of irrelevant detail<sup>1</sup>. From what point of view are some of the characters of events in

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(1) cf. Professor Kemp Smith's discussion in Chapter VII. "Prolegomena to an Idealist Theory of Knowledge".

been shown to be more than a relation of mere observed causal sequence "irrelevant"? For a theory of causation which holds the causal relation to be nothing but observed regularity of sequence, the only answer can be that the irrelevant characters are those characters which have been known to vary while the effect characters remain constant. That is to say, the regularity of sequence has been observed to fail. But there are some instances in which the regularity of sequence among the characters of events has not been observed to fail, and yet nobody supposes that the characters are causally connected. In such a case as the working of a platform ticket machine, the emergence of the ticket has always been observed to follow on the placing of a brown penny in the slot, yet no one supposes that the brownness of the penny is causally relevant to the effect. It may be said that it is known through experience of other causal sequences, that the colour of an object does not affect the way in which the object moves and sets others moving. This, however, is not the same thing as showing that the regularity of sequence has broken down in a given instance. It points out that experience can show a given factor to be causally irrelevant in spite of its constant recurrence in a causal sequence, so that mere observed regularity of events has been shown to be insufficient as a definition of the causal relation.

Thus the causal relation as holding between events involves precedence in space-time. The relation considered as holding between the characters of events in sequence has

been shown to be more than a relation of mere observed regularity. It now remains to be shown what further characteristics are possessed by the causal relation considered as a relation between characters of events.

It is obviously not a relation of the same type as the relation between the properties "being a triangle", and "having its angles together equal to two right angles". This latter relation is a relation between ideas, as Hume put it, and is independent of the existence of any particular instances. The causal relationship on the other hand has essential reference to process in space-time. The essence of the relationship between cause and effect characters is that they shall develop in time, or characterise events in sequence. The relationship cannot then be necessary in the sense that if the causal character is given, the effect character can be deduced. The effect character cannot be deduced from the causal character alone, but given the cause character and the law of change relating to an event displaying such a character, the effect can be deduced. To take the most simple kind of example again - the case of contact between material bodies; given the constitution of the bodies, and the rate and direction of their motion, the effect could be calculated.

These laws of change, however, can only be discovered empirically. They are generalisations from the modes of behaviour of material bodies, and behaviour is essentially action and reaction between bodies. Thus, the constitution of any material body taken in isolation will not enable its



mode of behaviour to be predicted. It can only be observed. It is of course the case that when once a law of change has been established, it can be used to deduce the behaviour of similar bodies under similar circumstances; it is also true that the law itself may have been deduced from some higher law, but the fact remains that the establishing of a law of behaviour presupposes observation of modes of behaviour either of the class of bodies to which the law applies, or of the wider class to which the higher law applies.

Any kind of causal law then, implies certain judgments of irrelevance. For instance, only certain characters of material bodies such as shape, size, etc., are relevant to their laws of motion and all other characters are ignored. The same applies to the characters of events in the environment. Thus recurrence of an event in causal sequence does not require the event and its environment to be duplicated in all its concrete detail. All that is required is that the characters relevant to the kind of causal sequence which is being considered, should be as nearly identical as possible. The condition stated in this restricted form does not seem to be impossible of fulfilment as Mr Russell argues. He tries to show first that the notion of cause is self-contradictory and therefore impossible, and secondly, that if this were not so there is nothing in nature corresponding to the notion.

His view of causation will be discussed in detail in the next section; after this, Mr Johnson's treatment of the subject



will be considered, as the most adequate expression of a view which, while it does not hold that causation is impossible either logically or physically, has yet not taken into complete account the modern assimilation of space and time. This fundamental revision in science necessitates a similar revision in philosophy, so that a considerable part of this thesis will be occupied with the philosophy of Professor Whitehead, in which he has entered upon such a revision. An attempt will then be made to work out a theory of causation along similar lines; this theory should be consistent with Professor Whitehead's conception of substance.

cannot be said to be "always true", or "true under all circumstances". A proposition is either true or false, and it is meaningless to say it is necessary, or true under all circumstances. It may be pointed out in passing, that this applies also to Mr Russell's definition of cause as "regularity of sequence among events". If a particular event cannot be an invariable antecedent, neither can it recur in an observed regular sequence. Both definitions refer to something which can recur, and which is therefore not an event. In both cases, then, it must be the characters of events to which the definition applies.

Mr Russell then goes on to show that in the philosophical sense, i.e., as an invariable antecedent, there is no such thing in nature as a cause. He reaches this conclusion from

two different points of view, which are, however, connected. He first attempts to show that the philosophical requirement that the

II. Mr Russell's Treatment of Causation. cannot possibly be satisfied, and that therefore there must always

The most systematic statement of Mr Russell's views on causation is to be found in his Presidential Address to the Aristotelian Society in 1912. In this article, he first deals with the definition of cause as the "necessary antecedent" of the effect. He shows that this definition cannot apply to a particular event, but only to a kind of event. Mr Russell expresses this in terms of propositions and of propositional functions. He points out that the statement of a causal law cannot be said to be "always true", or "true under all circumstances". A proposition is either true or false, and it is meaningless to say it is necessary, or true under all circumstances. It may be pointed out in passing, that this applies also to Mr Russell's definition of cause as "regularity of sequence among events". If a particular event cannot be an invariable antecedent, neither can it recur in an observed regular sequence. Both definitions refer to something which can recur, and which is therefore not an event. In both cases, then, it must be the characters of events to which the definition applies.

Mr Russell then goes on to show that in the philosophical sense, i.e., as an invariable antecedent, there is no such thing in nature as a cause. He reaches this conclusion from

contiguous, therefore there must be a finite interval between two different points of view, which are, however, connected. He first attempts to show that the philosophical requirement that the cause should immediately precede its effect, cannot possibly be satisfied, and that therefore there must always be a finite interval between cause event and effect event. His next point is that in this finite interval, some other event may occur which prevents the effect, so that it is always theoretically possible that a cause may occur, and not be followed by its expected effect. That is to say, there is no such thing as an invariable antecedent, and therefore, no such thing as a cause in the ordinary philosophical meaning of the word. If we attempt to guard against this possibility by bringing the environment into the statement of a cause, we shall have to go on until we bring in the state of the whole universe, and it is highly improbable that the state of the whole universe will ever recur. Mr Russell thinks that he has thus established his position that there are no causes in nature, but before accepting this conclusion, it will be necessary to examine his arguments in more detail. His argument in support of the first position, that the cause cannot immediately precede the effect may be put briefly thus:-

Cause must be either a process or a state. If it is a process, only its last moment can influence the effect, since the assumption is that cause and effect must be contiguous. But since the time series is compact, no two moments can be



contiguous; therefore there must be a finite interval between the last moment of the cause, and the first moment of the effect. On the other hand, if the cause is static, why should it "after existing placidly for some time, suddenly explode into its effect"?

The first part of the argument depends on the assumption that the time series is compact, and since Mr Russell goes on to apply his conclusions to a concrete state of affairs, it will first be necessary to examine the meaning of the proposition - "The time series is compact" - with reference to a concrete sequence of events. The compactness of the time series is sometimes expressed by saying that between any two moments there must be a third moment, and analogously for space - between any two points there must be a third point. Any concrete sequence of events, however, is spatial as well as temporal, so that this property of "compactness", considered in reference to a concrete state of affairs, should be stated in terms of space-time. Mr Russell's argument could then be restated in the following terms:-

Cause must be either a process or a state. If it is a process, only its last instantaneous event (or its state during the last moment) can influence the effect, since the assumption is that cause and effect must be contiguous. But since spatio-temporal series are compact no two point events can be contiguous, therefore there must be a finite spatio-temporal interval between the last instantaneous state of the cause, and the first instantaneous state of the effect.



In this restatement of the argument, an interesting point is to be observed. In the original argument, it was stated that "the time series" is compact. In the restatement, however, the form of this proposition had to be altered. It is impossible to speak of "the spatio-temporal series" - we were obliged to say instead "spatio-temporal series are compact". What does this new proposition mean? It is usual to represent "the time series" as a straight line, and any moment of the time series as one point in the straight line, but a spatio-temporal series, to put it very crudely, would have to be a "solid" line. That is to say, a "moment" in a spatio-temporal series must itself be spatial. Further, any such spatio-temporal causal series of events must possess characters of some sort. Now to say of such a series as this, that "there must be a finite interval between the last moment of the cause and the first moment of the effect", seems to mean that the cause event must end at a moment  $t$ , and the effect event must begin at a moment  $t_1$ , and that between  $t$  and  $t_1$ , there must be a finite interval. But how can an event end? Events pass into new events - as Mr Russell<sup>1</sup> himself expresses it - events "overlap", both in time and space, so that the only way in which events can be said to possess boundaries, i.e., "end" in space or time, is in virtue of their characters. To say that there must be a finite interval between cause and effect, then, must mean

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(1) Lectures of "The Analysis of Matter".

The lapse of time by adopting the convention of a series that the cause event manifests a certain character C, and that the effect event manifests a certain character E, but that between the manifestation of the two characters, there is a finite interval, i.e., an uncharacterised event. Now it is obvious that perception affords no grounds for such an assumption as this, and perceptual space-time at any rate, seems to be not compact, but continuous. To say that space-time is continuous, seems to me but another way of expressing the "passage" of events.

The compactness of the time series, at any rate as Mr Russell states it, seems to lead to other implications besides those which he draws in this article. Not only is causal sequence impossible on this assumption - but also any kind of sequence. Take any event E. E must endure for a finite time, and can therefore be split up into a number of shorter events. The same is true of each one of these shorter events, so that E may be split up into an infinite number of events,  $e_1, e_2, \dots, e_n$ . Between any two of these, there must be a finite interval (if Russell is correct) therefore an infinite number of finite intervals must elapse before one event can succeed another. This is obviously not true of time as experienced. Our experience of time - or rather of events in spatio-temporal relation with one another - is not of a succession of moments at all, but of an unbroken duration passing continuously into a new duration. This is obscured by the fact that it is only possible to measure

the lapse of time by adopting the convention of a series of disconnected events occupying equal time intervals, such as the ticking of a clock. Then between any two of these events, there must be a finite interval, or it would be impossible to count the ticks - i.e., measure the lapse of time. But the interval is continuous with the ticks, or there would have to be an interval between the tick and the interval, which is absurd, besides leading to an infinite regress.

The assumption that the time series is compact, seems to be not only contrary to common-sense, but meaningless, when it is applied to time as perceived at any rate. If space and time are relations between events, it is difficult to see what can be meant by saying that space and time are infinitely divisible, or even to see what can be meant by the division of space and time. We can divide events in space-time, but if space and time are abstracted from events any kind of division can only be theoretical, and the entities thus arrived at, are intellectual constructions, having their basis in experience, but not forming part of experience. It is a fallacy, after having arrived at these abstract conceptual moments, to attempt to apply the conclusions to concrete states of affairs as Russell then goes on to do. We cannot conceive of each of these infinitely small moments as occupied by part of an event with an infinitely small interval between each part. When we are dealing with concrete events, it is necessary to start from the other point

of view, and take the concrete spatio-temporal process itself as the ultimate given entity.

It might be argued that the whole of the preceding argument is invalid, since it rests on the notion of an infinitely small event, a notion which Mr Russell does not assume; in fact his definition<sup>1</sup> of a point is especially framed so as to avoid assuming either that there is or that there is not, a smallest event of a diminishing series. While admitting this, it seems to me that Mr Russell's argument that there must be a finite interval between the last moment of the cause and the first moment of the effect, implies that there must be a finite interval between any two moments. He is not basing his argument on the particular nature of a causal series, but on series of events in general, so that his conclusion that there must be a finite interval between two events in causal sequence, can also be applied to events in temporal sequence alone - if such a series is possible.

The difficulties seem to arise from the confusion between two different views of time, firstly as a relation between events, and secondly as the "stuff" of events. If time is a relation between events, then a moment of time is also a relation between events. Mr Russell's argument, however, seems to imply that moments are the relata related by infinitely small intervals of time. Thus, time is both

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(1) Lectures on "The Analysis of Matter".



the relata and the relations in a temporal series. It might be argued that a moment is nothing but an infinitely small event with its irrelevant properties disregarded, but from this point of view, an event is indistinguishable from an interval. Time is an abstraction from the property of events expressed by Professor Whitehead as "extension", and by this process, we are not arriving at a unit of experience, but at an intellectual construction.

All science and philosophies of nature must be based upon our sense experiences, that is, upon the experiences of a certain type of organism. It seems strange, then, that philosophers and scientists are so reluctant to take the unit of experience of this type of organism as what is ultimately given. It is true that this unit would be more or less arbitrary, but in our effort to avoid this arbitrary element, we are obliged to form the conception of infinite divisibility, since it would be arbitrary to stop at any given point. This conception is very useful in mathematics, but the entities which it yields, points, moments, etc., are only related to experience in a highly abstract way. Compactness then, is an attribute of conceptual time, i.e., of time considered apart from events, and perceptual time is neither discrete nor compact, but just continuous.

Mr Russell's arguments gain much of their plausibility from his habit of reasoning from the abstract nature of time, and then applying the results of this reasoning to concrete

examples. Thus, later on in his article, he applies the argument quoted above to the case of a penny placed in a ticket machine, which is wrecked by an earthquake before it can deliver the ticket. This is given as an example of a case in which something occurs to prevent the effect in the interval which must elapse between cause and effect. Thus, it is implied that the very nature of time is sufficient to render uncertain the connection between cause and effect - a connection which has always been held to connote certainty as one of its most important attributes.

If the foregoing reasoning has been correct, and the nature of our perception of time adequately described, then this objection may be dismissed at once. It will be as well, however, to deal with it in detail, and thus exhibit the nature of perceptual time from another point of view.

The placing of a penny in a ticket machine sets going a process which normally ends in the delivery of the ticket, the whole process occupying a finite duration. Speaking loosely, we might say that placing the penny in the slot caused the delivery of the ticket, and in this sense, there is an interval between cause and effect. But during every part of this interval, some part of the whole process is taking place, so that if we take as short an interval as possible between the beginning and end of the process, that interval will still exhibit process. It is a falsification of the facts to represent the process as an infinite series

of states each enduring for an infinitely short period, and each separated from the next by an infinitely short interval. Further, the fact that placing a penny in the ticket machine has not ended in the delivery of the ticket as usual, does not necessarily indicate that the causal connection is merely a connection which has been observed to hold between certain sequences of events, but which may break down at any time. It merely indicates the trivial fact that it is possible to modify a causal process at any stage. In this case, some other series of events has come into spatio-temporal contact with the series under consideration, and modified the subsequent events; i.e., the series of events which may be called "the earthquake" and the placing of the penny in the slot have jointly caused the process ending in a wrecked machine, with the penny somewhere inside it according to the stage at which its series of events came into contact with the earthquake series.

His next point is that if the cause is to be described so that it is quite sure to be followed by the same effect on its recurrence, the state of the environment must be taken into account. Continuing with the same example, a description of the ticket machine is not enough to ensure necessity. In other words, if the ticket machine were exactly the same, but standing in a different environment, the same effect might not be produced. Thus, if we are to be quite sure that the cause and effect are related necessarily, we must take the complete cause, which is the machine and its environment.

The environment cannot be limited to a particular area, so that we are forced to take into account the whole state of the universe. It is practically impossible that the universe should ever again be in a precisely similar state, so that if cause is defined as a necessary antecedent, the notion is quite futile.

At this point, Robb's conception of time as displaying conical order is relevant, since it enables us to limit the environment of a causal event in a quite precise way. It is unnecessary to take the whole state of the universe into account, because what is happening in South America, for example, cannot possibly have any effect on a platform ticket standing in a London station until a certain interval has elapsed. Conversely, only events taking place within a certain spatio-temporal region are causally relevant, and it would be possible to calculate this region precisely in the case of familiar kinds of movements, such as the motions of material bodies, light waves, etc. In the case of the earthquake, the rate at which its effects move may not be known quite precisely, but it is known that it cannot exceed a certain rate, so that a spatio-temporal region could be found, and within this region must lie any disturbance which could modify the effect. The shorter the time interval which is being considered, the smaller the spatial area which must be taken into account. For instance, if we take the cause as the state of affairs lasting ten seconds before the penny



is put into the machine, only a small spatial area need be taken into account. An event taking place within the ten seconds preceding the placing of the penny in the machine must be very near in order to prevent the effect.

It is necessary, then, to include a certain spatio-temporal area in the statement of the cause, but even this limited environment need not be duplicated in detail. Just as the colour of the machine, the design on its case, and such details are irrelevant to the process of receiving the penny and delivering the ticket, so only certain factors in the environment need be taken into account. In Mr Russell's example, only actual movements of material bodies or disturbances of the material bodies in contact with the machine are relevant. Thus the only essential conditions in such a case are that within the preceding ten seconds there should be no material body moving towards the machine, and no disturbance travelling through the earth towards the machine within a radius of a certain number of yards. It is not at all impossible that these conditions should be fulfilled.

Mr Russell further makes the point that in the advanced sciences, such as physics, no use is made of the notion of cause. The reason for this is probably that the scientific objects such as atoms, electrons, etc. are only arrived at by inference from experience, so that their only properties are the formal properties of size, weight, motion, etc. The

it is the cause of Y, for this is all "cause" means.

individuality of such scientific objects is thus theoretical, and the events with which science actually deals are the statistical effects of the motions of many of these objects. Thus the physicist ignores the concrete individuality of physical objects, while the individuality of the objects with which he deals is only theoretical, so that there is no place for the notion of cause and effect.

Having freed the notion of cause from the "metaphysical absurdities" with which it has been entangled, Mr Russell is free to consider the true meaning which cause may bear, and he comes to the conclusion that this meaning is, observed regularity of sequence among events. Although there are no such things as causes in nature, in the accepted philosophical sense of the word "cause", there are certain "fairly dependable regularities", and by saying that one event causes another, we merely mean that there has been observed as a matter of fact a regularity in the sequence in which events occur. There is no necessity in this connection - "X causes Y" does not mean "X must be followed by Y" - but merely "X has always been observed to precede Y". It follows that the only possibility of mistake in stating a causal sequence lies in erroneous observation. It is meaningless to say "X was mistakenly thought to be the cause of Y", because so long as X is thought to be the cause of Y - i.e. has been observed constantly to precede Y - it is the cause of Y, for this is all "cause" means.

If, for instance, we have always thought that a certain kind of mushroom was poisonous, and then discover that in one case it was eaten, and no harmful effects followed, it does not show that we were mistaken in our analysis of the former cases, because in our experience up to that time, eating this mushroom had always been followed by death, and was therefore the true cause. It has now ceased to be the cause, though it was truly the cause in the former cases, and this is not nonsensical or self-contradictory on Russell's theory.

It may be said that, until we have performed some kind of test, we do not know whether the sequence "eating mushroom - illness - death" is a "fairly dependable regularity", but the very acknowledgement of the necessity for a test, presupposes some other connection between events than mere observed regularity. We cannot devise any test for finding out "observed regularity" - we merely observe it.

It also follows, as Mr Russell himself points out, that all kinds of sequences which common sense refuses to regard as causal, will be causal in his sense. In the "Analysis of Mind", he says that on his view, a hooter sounding in Manchester is just as much the cause of London workmen going to dinner, as is the sounding of the hooter in their own factory - since both hooters invariably sound just before the men in the London factory leave off work. But in what sequence of events does the hooter in Manchester

precede the stoppage of work in the London factory? This can only be considered as a temporal sequence if time is separated from space and the temporal aspect of the events is considered out of relation to the spatial aspect. There is an interval between the two events, and even though the interval is in this case "space-like", it is only from a very artificial point of view that they can be considered as in temporal sequence.

Even with this limitation, namely, that there must be spatial contiguity as well as regularity of sequence in a causal sequence of events, it seems that the causal relation connotes something more than mere regularity of sequence. Common sense certainly does not regard invariable sequence among events as the same thing as causal connection. There are series of events in which we recognise invariability of sequence. Among these series, we distinguish further some which are causally connected and some which are not, which plainly shows that we do not at any rate intend to mean the same relation by "cause" and "invariable antecedent". For instance, before a train enters a station, the signal must always be lowered, but we do not look on the lowering of the signal as the cause of the train entering the station.

It may be that we are not justified in making such a distinction between series of events, and that there is no characteristic of one kind of series which does not also



belong to the other - but this will be considered later on, in the account of the nature of the causal connection. At present, it is sufficient to point out that such a distinction is invariably drawn, and that it is at least not obvious that there is no basis for it in reality.

The conclusion from this examination of Mr Russell's treatment of cause, seems to be that it has not yet been proved that the notion of cause is impossible either logically or physically, so that we are free to assume its existence with the plain man, and go on to consider its characteristics.

At first sight, Johnson's distinction between occurrences and continuents seems not to correspond to a distinction within the real world. The events which are continually taking place, are distinguished among themselves as forming part of the life history of different objects, which are regarded as being more or less permanent among the flux of events, and the series of events which is the life history of "one thing" constitutes some kind of unity. This unity has been analysed in various ways, but every philosopher would agree that such a series of events must possess at least spatio-temporal continuity and a certain degree of qualitative similarity among the events. So this Mr Johnson adds causal relation between occurrences, and further a unique relation which can only be expressed by saying that the

(1) W.E. Johnson, *Logic*, (Chiefly Part II.).

occurrents inhering in one and the same continuant. This, however, see III. Mr Johnson's Theory of Cause.<sup>1</sup> relatives, as  
a means for the other relations in combination, namely spatio-  
temporal. In his account of causation, Mr Johnson insists that  
 the notions of cause and substance are mutually interdependent,  
 and can only be understood in reference to one another. Just  
 as the universe is not adequately described by a catalogue  
 of isolated occurrences, so the relation of causation is not  
 between occurments regarded as isolated entities, but as  
 inhering in substances - continuants in Mr Johnson's  
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(1) W.E. Johnson, *Logic*, (Chiefly Part III.).

occurrents inhere in one and the same continuant. This, however, does not seem to be so much a further relation, as a name for the other relations in combination, namely spatio-temporal continuity and causal connection between its successive states. There seems to be no further relation discoverable. When we say, for instance, that an accident is part of the life history of a certain man, we mean that it is connected with the other events of his life in these specified ways. *has happened in the interval. It is true that*

*in* Mr Johnson argues that we must postulate some kind of unity beyond mere spatio-temporal continuity, for even if we say that in the physical world, the observed spatio-temporal continuity is our sole ground for calling a series of events one thing, yet there is the psychical continuant - namely the observer of the continuity. Thus, this unique kind of unity has merely been shifted from one kind of continuant and to another, and still has to be accounted for. The only basis for this argument seems to be the fact that whenever we speak of a series of events as constituting one thing, we assume that spatio-temporal continuity among the events in the series could be observed. But in the notion of spatio-temporal continuity itself, there is no essential reference to an observer, and indeed, we postulate such continuity of events which are not being observed at all. *such simultaneous*

*ment* Mr Johnson's main arguments for the necessity of assuming some kind of continuant are drawn from the nature of change

events occupy different spatial positions and therefore cannot be distinguished by their spatial positions. This is the case with causation, but before coming to these, there are two further minor arguments which must be considered. The first is this: If at one moment points A and B are occupied and C and D unoccupied, and at a later moment, A and B are unoccupied and C and D occupied, then unless we assume two continuants - i.e., the entities which moved - we cannot distinguish between a movement from A to D and B to C, or a movement from A to C and B to D, and cannot therefore state precisely what has happened in the interval. It is true that in describing what had happened in the interval we should say that one particle moved from A to C and another from B to D, but this presents no new argument. The point again is, do we mean anything more by this than that there was a continuous series of qualitatively similar events between A and C and between B and D?

The second argument refers to psychological continuants, and is briefly this: Two mental events are taking place simultaneously. Since they cannot be referred to different spatial positions, they cannot possibly be distinguished unless we assume different continuants in which they inhere. This seems a very unreal kind of argument. If it were possible to confuse two such mental events, it would be impossible to distinguish them, but both cases are equally inconceivable. We cannot even know of the existence of two such simultaneous mental events unless they are in some kind of connection with physical events (possibly causal connection). These physical



events occupy different spatial position and therefore cannot be confused. Thus we can distinguish between the simultaneous mental events known as Brown's toothache and Smith's toothache, because Brown's toothache is in causal connection with the state of Brown's teeth and a later visit to his dentist, both of these events being in spatio-temporal continuity with the other events of his life, while Smith's toothache is in causal connection with the series of events which is Smith's life history.

It seems then, that the continuant is most usefully to be regarded not as an existent, but as a logical construction from the properties of a series of events which common-sense would call "one thing". The properties of such a series of events are:-

- (i) Spatio-temporal continuity among the events forming the series.
- (ii) Some kind of casual connection among the events.
- (iii) A certain degree of similarity among the characters of the events - or qualitative continuity.

Mr Johnson's position, however, receives its strongest support from his examination of the notions of change and causality, and it is significant that in his treatment of change, he makes use of these words: "<sup>1</sup>.... in place of the somewhat obscure term change, I shall introduce the notion of alterable as opposed to unalterable states of a thing." His view is that the term change can only be applied to successive events if they are referred to the same continuant, and

<sup>1</sup> Pt III p 66

since this seems to be a very widely spread view, it will be as well to examine it in detail.

According to Mr Johnson, the continuant cannot be said to change, since it is that which continues to exist while its states may alter or continue unaltered. Neither is it the occurrent which changes. Occurrents merely succeed one another, and when change takes place, it means that one occurrent is being succeeded by another. It is the modes of manifestation of which the continuant is capable that may truly be said to change. Thus a leaf does not change from green to red in Autumn - the leaf persists through all change. Neither does the greenness of the leaf change: it merely ceases to be. It is the colour of the leaf which passes from its determinate mode green to its determinate mode red. Thus, the two kinds of identity are necessary to a true conception of change - the substantival identity of the continuant, and the adjectival identity of the determinable. The continuant seems to be qualified by the determinable, and any one of its particular states by one determinate mode of the determinable. Thus, a physical continuant possesses the properties of being coloured and shaped, and this means that at any given particular time, the physical continuant will possess some determinate colour and shape.

This account accords very well with common sense use of the terms, and at first sight, the statement that there must be something which changes seems self-evident. When,

however, the notion of change is considered more closely, the notion of a subject of change does not seem to be necessarily involved. Change would generally be admitted to have taken place when the following conditions are fulfilled:-

- (i) Events  $e_1, e_2, \dots, e_n$  are spatially and temporally continuous. In many cases, not only the cause, but the effect is continuous.
- (ii) Events  $e_1, e_2, \dots, e_n$  differ qualitatively from one another.

These seem to be the only necessary conditions, and since the first condition gives the most important quality of a series of events which leads us to call the series one thing, it is easy to see how the idea of a subject of change arises. This insistence on the something that changes, seems to be due to the desire to account for the spatio-temporal continuity observed among events: the events are perceived as in spatio-temporal continuity because they are manifestations of one entity. This, however, seems an unnecessary and illegitimate inference. We perceive the continuity because it is there to be perceived, and beyond this we cannot go.

Mr Johnson further insists that the occurrent antecedent to an effect occurrent cannot be considered as alone constituting the cause. There is a further factor to be taken into account - the property of the continuant or continuants to which the occurrent is to be referred. Thus, to take his own example; to a man who has lost his sense of taste and smell, "drinking ether" differs from the occurrent "drinking

water" in no perceptible quality, i.e., the two occurrents are, for him, indistinguishable, and the difference in their effects can only be accounted for by the property of "being poisonous" which is possessed by the continuant in which the one occurrent inheres, and not by the continuant in which the other inheres. In many cases, not only the cause, but the effect also must be stated in terms of the property of a continuant. In such cases, the effect occurrent manifests a change in a property of the continuant in which it inheres, as, for instance, when steel is heated to a certain temperature and loses its magnetic properties. This change in the property of the continuant is manifested in the occurrents inhering in it, which, after the change, all show a change in their mode of reaction. Thus, for Johnson, the causal relation is a relation holding between an occurrent with a specific property of the continuant in which it inheres, and another occurrent with a specific property of the continuant in which it in its turn inheres. The continuants may be the same in both cases, or the occurrents may inhere in different continuants. In the former case we have immanent, and in the latter case, transient<sup>eu</sup> causation.

In view of the importance of the notion of "property" for an understanding of Johnson's treatment of causality, it will be necessary to analyse in detail the meaning of the term. Johnson points out that properties of a continuant are causal properties. By this, he means that when it is properties of a continuant in any given causal reaction. In



said that an object possesses a certain property, it is meant that when it is placed under certain stated sets of conditions, it will react in certain stated ways. For instance, "Ether is poisonour" means that if ether is introduced into a certain type of organism, certain specific reactions will be set up within the organism. By stipulating for a certain type of organism, we are requiring that the second continuant involved should also possess a specific property, though this property has no name. Correlatively to the term "poisonous" it might be called "poisonable". The properties of a continuant are, then, arrived at inductively, by reasoning from the observed behaviour of the continuant under certain recurring sets of conditions. The property itself is never to be observed. What is observed, is some determinate reaction to a determinate set of conditions, just as a determinable such as "colour" is never to be observed, but only a determinate colour, such as a specific shade of red. Mr Johnson would probably not agree that the two cases are analogous. For him, the occurrent and the continuant are related by the simple two-termed relationship of inherence, but in order that the determinable colour may be manifested in one of its determinates, i.e., in order that an occurrent of colour may exist, a whole set of conditions is necessary, just as in the case of poisoning by ether. There must be light and a receptive organism, just as much as the continuant and its property.

This analogy throws light on the part played by the properties of a continuant in any given causal reaction. In

describing the series of events which culminates in the perception of colour, we should not need to include the properties of the two continuants that the one must be coloured or perceptible, and the other capable of perceiving colour. This would be tautologous. In the same way, in considering a specific case of poisoning by ether, it is unnecessary to take into account the fact that we are dealing with two continuants, one of which is capable of poisoning and the other of being poisoned. This again is tautologous, and to say that ether is poisonous while water is not, does not account for the difference in the effects of "drinking ether" and "drinking water", as Johnson thinks. It expresses this difference. The difference can only be explained by a scientific account of the two continuants, and would probably be found to consist in difference of chemical constitution, or in microscopic structure. There is, however, an important point which is emphasized by Mr Johnson's treatment of causality, and by his insistence upon the properties of the continuant. It is important to point out that in any given causal reaction, we are not merely concerned with the cause occurrent and the effect occurrent, but that there is some further factor involved. This factor seems to be, not a property of the continuant, but the state of the whole continuant at the time of the causal reaction. Thus, when poison is introduced into a

human organism, it is necessary to take the whole state of the organism into account. It is part of the "causal past" of the effect event. Though this condition or structure of the continuant is not what Mr Johnson means by the properties of a continuant, there is a connection. It is in consequence of the possession of such a structure that a determinate reaction takes place when the continuant is placed under a given set of conditions, and it is in virtue of such determinate reactions that a given property is attributed to the continuant. Thus, when steel is magnetised, the microscopic structure of the steel is modified in a certain way. This change of structure is manifested in the way in which the steel reacts to certain conditions, and could be expressed by saying that the steel has gained the property of magnetism.

The use of the term "property" implies a further important quality of the structure of a continuant. It implies that this structure is relatively permanent, and that therefore the behaviour of a continuant under given sets of conditions is more or less calculable, or subject to law. Not only so; it further implies that there is some identity of structure among continuants which are said to possess the same property, and it is therefore a very important notion in the theory of generalisation. Both of these implications are equally important. It is just as much an assumption, for which grounds must be inductively sought, that a continuant will



react in similar ways to similar states of affairs at different dates in its life, as that two similar continuants will react in similar ways to similar states of affairs.

Though Mr Johnson's treatment of causation is valuable in these respects, it cannot be regarded as finally satisfactory. The two essential aspects of the causal relation, that it should relate universal aspects of concrete states of affairs do not seem to be represented by Mr Johnson's two concepts, the continuant and the occurrent. It might seem at first sight that the continuant, regarded as the unification of the occurrents which are determinates under various determinables could represent the concrete state of affairs, while the occurrent represented the universal aspect. But Mr Johnson seems to regard the occurrent as the concrete reality, having essential reference to space and time, while the continuant is the underlying changeless subject of change. One quality of concrete reality, that it is in essential relation to space-time, is possessed by the occurrent, though the occurrent is merely one aspect of any given concrete event. The other quality of concrete reality, the grasping of many aspects into one whole, belongs to the continuant.

For Mr Johnson, then, causal process is a succession of occurrents held together by being in relation to the same continuant. The occurrents last for varying lengths of



time, but change cannot lie within an occurrent, change consists in the ceasing to exist of one occurrent, and the coming into existence of another in succession. Thus, change is a succession of isolated unchanging entities, isolated in the sense that one must cease to exist before the next can come into existence, but connected by bearing the same relationship to the same changeless and enduring entity, the continuant. The continuant is thus a necessary element in Mr Johnson's system, for it restores to nature its continuity, which his analysis of process in terms of isolated entities had destroyed.

The scientific analysis of experience, however, seems to reveal a nature which cannot be adequately described in terms of Mr Johnson's conceptions alone. Science shows nature as a continual process which cannot be expressed as a series of states. Any part of the process, however small, will itself reveal process, and to say, for instance, that a flower has remained blue throughout a given period, i.e., that a blue occurrent has persisted for a certain time, is only an approximation to the truth that the events taking place where the flower is situated, at the situation of the perceptive organism, and throughout the intervening medium have remained relatively constant in all relevant respects throughout the given period. That is to say, the occurrent is an abstraction from a very complicated network of events. The scientific analysis of experience, moreover, reveals nature as spatio-

temporal and not merely temporal process. Continuants are not merely side by side in space, they are interconnected by the system of events which is nature just as an event in the early life history of a continuant is connected with the later events in the life of the continuant, by a temporal series of events.

It would seem, then, that the conception of nature as a system of occurrents inherent in continuants is too clear cut and simple to express nature adequately. The facts of perception show that the relation of an occurrent to the system of events which Mr Johnson names the continuant, cannot be a simple two-termed relation such as the relation of inherence. It seems much more adequate to conceive the occurrent, as Professor Whitehead seems to do, as a term in a multiple relation - other terms involved in this relation being the perceptive organism and the intervening medium. Occurrents which are determinate values of the determinables colour and shape fit in to Mr Johnson's system much more easily than occurrents under other determinables. There is a difficulty, however, in the case of delusive visual perception. In which continuant, for instance, can the mirror image of a pin be said to inhere? If it inheres in the continuant known as the pin, what relation does it bear to the occurrents arising from ordinary perception of the pin? In the case of ordinary visual perception, it is fairly easy to discover something corresponding to Mr Johnson's relation of

inherence between occurrent and continuant, but in the case of perception of sound, the inadequacy of his account of nature is more clearly to be seen. In which continuant would the music from a peal of bells be said to inhere? The music pervades a wide spatio-temporal area and could be perceived by a suitably constituted organism situated at any point within this region. From different points within this region, different occurrents would be perceived. What is the relation of these occurrents to one another? The analysis of such a set of events as this into occurrents existing side by side in space and succeeding one another in time seems to be wholly arbitrary and artificial.

Another difficulty in Mr Johnson's account of nature is that he seems to have taken no account of scientific objects. The great merit of his treatment is that in it, the distinctions drawn by common sense are systematically and clearly set out. It seems, however, to need a continuation in which the scientific view of the universe may also be taken into account.

Further, a relation between events which will correspond more or less closely to the common sense notion of a causal relation. This position is a full statement of the problem of the problem. Some might say that if there is any specific relation between events which may be called a "necessary connection", it must be discoverable in a single instance, for no amount of mere multiplication of instances will ever produce a new relation



which was not present in the single instance.

Their respective associates of the "single instance".

#### IVa. The Grounds of Inductive Inference in

#### Professor Whitehead's Philosophy of Nature.

It is axiomatic in Professor Whitehead's philosophy that any properties which we attribute to nature, however abstract they may be, must be derivable from the "immediate occasion of awareness". Thus, for him, the problem of induction resolves itself into the problem of discovering what characteristics are possessed by the immediately given which will justify inference beyond itself. It is obvious that in working out a complete answer to this question all inter-relatedness among events will be relevant, and that from such an analysis should emerge not only spatio-temporal relationships, but also some relation between events which might be called "community of character", so that there is in nature, some ground of generalisation. Further, a relation between events which will correspond more or less closely to the common sense notion of a causal relation. This position is a full acceptance of Hume's statement of the problem. Hume pointed out that if there is any specific relation between events which may be called a "necessary connection", it must be discoverable in a single instance, for no amount of mere multiplication of instances will ever produce a new relation



which was not present in the single instance.

Their respective accounts of the "single instance", however, diverge very widely; for Hume, perception discloses series of discrete entities - sense impressions - which it is the function of the mind to combine into sets. These sets are called "things" if their members are together in space and time, and causal series if they constantly succeed each other. Hume thus assumes connection in space and time between these entities, but, for him no other connection has its grounds in nature. For Whitehead, any sense impression is given "embedded in relatedness", so that, for instance, a percept is not only given as a factor in a spatio-temporal continuum, it also "conveys" associated percepts of other senses and exhibits its peculiar character in virtue of many other events, such as the events which are taking place at the source of light - at the retina of the eye and all through the intervening medium. Thus, for Whitehead, the fundamental fact of nature is not an isolated sense impression, but a duration, which is a perspective of the universe from the standpoint of a given percipient event. "Perception is an awareness of events, or happenings, forming a partially discerned complex within the background of a simultaneous whole of nature. . . . . This background is that complete event which is the whole of nature simultaneous with the percipient event, which is itself part of that whole. Such a complete whole of nature is called a 'duration'."<sup>1</sup> Perception thus discloses

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(1) "The Principles of Natural Knowledge" (1st ed.) Ch. VI. 16.

the fact that any event is a factor within a larger whole, also the fact that a duration must possess "temporal thickness", i.e., must exhibit process within itself. Perception then is always of nature as a process, or as a system of events which are continually passing into new events. Modern psychology affords a prima facie support for such a position. Consciousness is not to be conceived as a series of momentary states. It is described by such metaphors as James' "the stream of consciousness", and the "specious present" is regarded as essentially of the nature of process, in which is to be discerned what Professor Stout calls the "not yet"<sup>1</sup>, and the "no more" consciousness. That is to say, apprehension of the immediately present event includes vague apprehension of what might be called a temporal background just as much as it includes vague apprehension of a spatial background. A similar view is expressed by William James in the following well-known passage: "The practically cognised present is no knife-edge, but a saddle-back with a certain breadth of its own, and from which we look in two directions into time. The unit of composition of our perception of time is a duration with a bow and a stern, as it were a rearward and a forward-looking end."<sup>2</sup> M. Bergson also, as is well-known, lays great emphasis upon the continuity of past, present and future, and upon the impossibility of setting up definite limits within

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(1) "Manual of Psychology", Bk III, Pt II, Ch.V. Section 3.

(2) "Principles", Vol.I, p.609.

experience. He says: "Nous pouvons parler du corps comme d'une limite mouvante entre l'avenir et le passé, comme d'une pointe mobile que notre passé pousserait incessamment dans notre avenir."<sup>1</sup>

A duration may be analysed in various ways, by considering first one and then another of its properties, but there are certain dominant characteristics which lead to accepted modes of analysis. One such characteristic of events is that they are sometimes the situations of perceptual objects. This is a given empirical fact, it does not follow from the nature of an event that it should be the situation of a perceptual object. Another such characteristic is the property of events that they are continually passing into other events. This "passage" is spatial as well as temporal, and may be expressed by saying that an event has no boundaries, neither spatial nor temporal. Any boundaries which we set up in nature are made possible in virtue of the objects situated in events.

Within any duration, there is an area of complete discrimination shading off indefinitely into an area of less and less complete discrimination, so that perception never presents a complete whole for knowledge. Any discriminated event discloses relations to other events which may be partially discriminated or merely apprehended as relata in the spatio-temporal continuum of which the discriminated event is a part.

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(1) "Matière et Mémoire", Ch.II, p.74.



These relata are "known by relatedness". Professor Whitehead also expresses this fundamental property of nature by saying that one event is "significant of" every other. Each event is significant of every other in the sense that the discriminated scheme of spatio-temporal relationships within an isolated portion of experience, determines the scheme of spatio-temporal relations for the whole of experience. That is to say, perception discloses the fact that space-time is uniform, and that this uniformity is such that it must extend beyond the perceptual field so as to include all nature.

It will at once be admitted that perception does disclose a field of discriminated occurrences, and also that this field bears the character of incompleteness in that there is a fringe of occurrences which are vaguely apprehended as being relata in various relationships, to events within the field of discrimination. Thus, at any moment, experience includes events which are dimly apprehended as bearing the relation of "before" and "after" to the event which is being discriminated, and there are events dimly apprehended as forming a spatial background to an event on which our attention is fixed. It may, however, be doubted whether this vague apprehension of an "outer fringe" is a sufficient basis for declaring that the uniformity of space and time observed within the field must extend to the whole of nature. Perception discloses the fact that it extends beyond the perceptual field, but can we go further than this? Detailed spatio-temporal relations can be



of events abstracted from perceived nature. The non-uniformity worked out as holding within the observed field, but can they be inferred to hold throughout nature? Spatio-temporal relations are abstractions from the more concrete relation of extension - so that if perception is to yield a knowledge of the whole of nature as a uniform spatio-temporal continuum, the property of extension must manifest itself as belonging of necessity to every event. Within the field of discrimination, it is certainly true that every event extends over other events and is itself extended over by other events. But this is also true of partially discriminated events within the "outer fringe"; in fact this is what we mean when we say that the perceptual field has no definite boundary. But if these partially discriminated events possess the property of extension, the field of the relation of "extends over" must be indefinitely extended so as to include the whole of nature. When then, we speak of spatio-temporal uniformity as reigning throughout nature, it is not a question of extending a property from an observed to an unobserved field - but of drawing out the implications of an observed property. Otherwise, the uniformity among events could not be used as the basis of induction - it would itself be an instance of induction.

It seems, however, that for a philosophy of nature based on experience, there can be no meaning in saying that space and time is not uniform, because by space and time we mean perceived space and perceived time, i.e., some property

of events abstracted from perceived nature. The non-uniformity of space and time can then only mean that there is a discontinuity within the apprehended process of nature, which is inconceivable. For by the very fact of our recognising a process as discontinuous with the rest of our experience, we recognise that it does not form part of the whole process of nature. For instance, common sense regards dreams as in some quite intelligible sense "unreal". This is not a case of applying a standard of normality obtained from part of our experience to another part - it is a judgment passed upon the immediately given. A dream is perceived as not possessing certain characters which we assume to be possessed by any process of nature - i.e., uniformity with the spatio-temporal processes of the rest of nature. This fact then - that dreams are assumed to be unreal - is merely an instance of our general assumption that nature exhibits spatio-temporal uniformity, and cannot be used as Whitehead uses it, to prove that nature is such a uniform system. It is presupposed in experience, and cannot be proved by experience.

Any theory of the non-uniformity of space-time accepts this presupposition of common sense, but it claims that the uniformity is only apparent, and that the scientific interpretation of experience needs a non-uniform theory of physical space-time. However this may be, the fact remains that nature undoubtedly appears to us as a uniform spatio-temporal continuum, and the important point is, that for a philosophy of

nature such as that elaborated by Whitehead, nature is what it appears to be. Nature may possess other characteristics which are derivable from the apparent characters, but the apparent characters are never delusive, in the sense that an event could be completely characterised without reference to the apparent characters. Apparent characters are features of the real world. *intrinsic characters are irrelevant*

It would therefore seem that the uniformity of space-time is given in the immediate occasion of awareness, just as much as redness is given, and that it is thus a necessary presupposition of a philosophy which takes nature to be "that which is given in perception through the senses". If nature is "that which is given in perception through the senses", it is self-contradictory to hold that an event may be apprehended as continuous, and yet may be made up of discrete parts. This would be to assert that properties which belong to events do not belong to parts of an event. This is, of course, true of certain kinds of properties. If an event has the property of being the situation of a perceptual object, it is clear that this property does not belong to parts of the event. It is also clear that there are, on the other hand, certain properties which belong to events as events which must also belong to parts of the events. Thus the property of "extending over", belongs to events merely as events; it does not belong to some events and not to others, but to all events alike. How then can it ever be possible to distinguish a



certain class of events which alone do not possess this property? of which possess some kind of connection with

It is, then, not an assumption to say as Whitehead does, that every event extends over other events. It is inference from an observed property of events, and arguments derived from psychological investigations into the existence of a minimum sensible are irrelevant.

It is, of course, possible to hold, as Russell does, that physical space-time must be distinguished from perceptual space-time and that we are justified in inferring greater complexity in the former if physical considerations seem to require it. This kind of view, is, however, foreign to the whole spirit of Professor Whitehead's philosophy. For him, there is only one nature - the structure of interconnected events, and all entities are equally real characters of these events. Entities of different types stand in different kinds of relationships to the events, but space-time is an abstraction from events considered merely as events, and apart from the objects standing in various relationships to them; spatio-temporal relations, then, will possess the same properties whichever kind of object is being considered.

If the "immediate occasion of awareness" is to provide adequate grounds for inductive processes, not only must it manifest itself as a factor in a uniform spatio-temporal

i.e., for generalisation from the mere fact of co-occurrence



system, but also as a factor in a system of events the characters of which possess some kind of connection with one another. It is quite possible to conceive a perfectly uniform spatio-temporal system in which changes occur with no further apparent uniformity and in which the characters of the events have no essential connections with one another. Mere spatio-temporal uniformity then, does not provide sufficient grounds for reasoning from the characters of the present event to the characters of other events; it will thus be necessary to examine more closely Professor Whitehead's analysis of the "immediate occasion of awareness", in order to discover if there is any further property discoverable which will justify such inference to the specific characters of events in the unobserved field.

The uniformities which induction seeks to establish were divided by J.S. Mill into two classes - uniformities of coexistence, and uniformities of sequence. This classification will be adopted for the present, since each of these two kinds of uniformity needs a specific property of the given event for its grounds within the present fact. It will be seen later that the processes by which these two kinds of uniformity are established involve a common element, but the respect in which they differ is first to be considered. In order then, that the immediately given may afford grounds for the establishing of uniformities of coexistence, i.e., for generalisation from the mere fact of coexistence

of qualities to an essential connection of qualities - the immediate occasion of awareness must be apprehended as possessing qualities which do not merely coexist. This has purposely been expressed in a self-contradictory manner, in order to show the false assumption underlying the usual statement of the problem of induction. Hume has said the last word on this point. "It appears then, that this idea of necessary connexion amongst events arises from a number of similar instances, which occur, of the constant conjunction of these events, nor can that idea ever be suggested by any one of these instances, surveyed in all possible lights and positions. But there is nothing in a number of instances, different from every single instance, which is supposed to be exactly similar; except only, that after a repetition of similar instances, the mind is carried by habit, upon the appearance of one event, to expect its usual attendant and to believe that it will exist."<sup>1</sup>

Hume's conclusion was that there was no such relation discoverable in the single instance, and that therefore the notion of "necessary connexion" is strictly meaningless, in the sense that it is a notion which stands for nothing in the natural world. A truer conception of the "single instance", however, leads Professor Whitehead to the conclusion that we do not start with mere coexistence and infer a necessary

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(1) "Philosophical Essays concerning Human Understanding", Essay VII.

connection from a multiplicity of instances of mere coexistence. The necessary connection is given in the single instance. It is not, of course, a sense impression relating sense impressions such as Hume was seeking, but it is an element in any given perceptual situation. Any given percept, say green, is given "embedded in relatedness", and the kind of relatedness which is here relevant is called "conveyance" by Professor Whitehead. The factor "greenness", "conveys" associated percepts of other senses, and this "conveyance" is not a mere association of formerly disconnected sense impressions. Professor Lloyd Morgan<sup>1</sup> expresses this same fact of perception by insisting that there is no such thing as a "bare sensation". In the case of a novel sensation, what is conveyed is a kind of "schema" which is afterwards to be filled in by experience. Lloyd Morgan's moor-hen, hearing the dog bark for the first time, according to this view, did not receive a bare auditory sensation, but a complex impression the other details of which were vague and unspecified. This seems to be part of Professor Whitehead's meaning when he speaks of the perceptual object as a "control of ingression". What is given in the "immediate occasion of awareness" is not a set of percepts which happen to be apprehended as coexisting; it is a perceptual object manifesting itself as possessing various properties. We do not apprehend greenness, smoothness

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(1) In discussion at a meeting of the Aristotelian Society, Session 1926-27.



and coolness as a coexisting set of qualities - we apprehend a blade of grass.

It might be argued that this merely shows that any perceptual object must possess specific values of several determinables, and not what these specific values must be. It shows, for instance, that a blade of grass must possess a determinate colour, a determinate shape, etc. It does not show that "greenness" is in essential connection with "coolness", and it is this latter kind of uniformity which induction aims at establishing. The reply to this, is that the essential connection of determinables with one another is a sufficient basis for induction; as Professor Whitehead says in another connection: the perceptual object is a limitation of pure contingency. It is not to be expected, however, that the necessary connections among the characters of the causal sequence which is the given instance, will be immediately obvious. Much knowledge of the characters of an event is necessary, at any rate in the majority of cases, before the necessary connections within the immediate occasion of awareness are to be discerned. The trained eye perceives interconnections among the characters of events which would not be apparent to the ordinary observer, but the connections are there whether they are discerned or not.

It now remains to be seen whether the "immediate occasion of awareness" possesses any property which will justify causal inference, and if so, what this property is. Professor Whitehead says: "Each event essentially signifies the whole structure",



and he goes on to point out that the cognisance of an entity implies awareness of something other than itself - it is only individualised in contrast to a vaguely apprehended background. That is to say, apprehension of an event is always apprehension of the event as signifying something beyond itself. In his later book "Science and the Modern World", Professor Whitehead goes even further. Not only does each event signify the whole structure of events - it is the whole structure of events, but viewed from its own particular standpoint. This further conception of the relation of a given event to the whole structure of events is expressed by the notion of "mirroring".<sup>1</sup> Each event is said to "mirror" every other, so that in a sense each event is the whole universe, or rather a perspective of the universe. An event is the grasping of "a diversity of aspects into the unity of a pattern", and in speaking of events in this connection, Professor Whitehead says: "Each event corresponds to two such patterns; namely, the pattern of aspects of other events which it grasps into its own unity, and the pattern of its aspects which other events grasp into their own unities." An event, then, cannot be confined to one spatio-temporal region. It is wherever its influence is felt, but its influence is felt everywhere and at all times. "Whatever merges into actuality implants its aspects in every individual event."

If by "aspects" of an event is meant its characters, and not merely its spatio-temporal relationships, it would seem

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(1) This notion is developed in Chapters VII. and IV.

that Professor Whitehead's system in its later developments is open to the charge which he himself foresees in "The Principle of Relativity".<sup>1</sup> Here he says that if an event is only completely itself with its relationships, and if its relationships embrace the whole structure of events it might be thought that in order to know completely an event we must know it with its relationships. That is to say, in order to know a single event, we must know the whole structure of events. Since the latter is impossible for the finite mind, it would follow that complete knowledge of a single event is impossible. If this objection were valid, Professor Whitehead thinks it would be fatal to his system, but he thinks it can be shown to be invalid in the following way. There are two kinds of knowledge; knowledge by adjective and knowledge by relationship. Knowledge of any given event, say of a green patch, is cognisance by adjective, but this involves knowledge of other factors. Any event is apprehended as having a date and a place. Date and place have meaning only in reference to other events, and these other events are known by relatedness. Thus, in order completely to know an event, it must be apprehended as occupying a specific position within a uniform spatio-temporal system, and this is not an impossible condition. It would only be impossible if knowledge by adjective of its spatio-temporal background were necessary to complete knowledge of an event. Professor Whitehead also expresses this by saying that complete knowledge of an event

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(1) p.22.

implies knowledge of its essential, but not of its contingent relationships. Its spatio-temporal relationships then, are essential, while its relationships to objects or characters are contingent. of occasion is implied in such a view of

If the relationship of events to objects is purely contingent, it seems that the conception of an event as a factor in a systematic structure of events will not afford a sufficient basis for causal inference. Professor Whitehead, however, goes on to point out that though the relation of events to objects is contingent, there are some objects which, by the simplicity of their relations to certain specific events, are a limitation of contingency. Such objects are perceptual and scientific objects which stand in a simple two-termed relation to the events which they characterise. It is the aim of science to discover such simple adjectives of events, and in doing so, it is discovering laws of nature, or uniformities among the characters of events. Thus, in apprehending an event as the situation of a perceptual object, we are apprehending within the given present fact, the laying down of conditions for the characters of future events. The perceptual object as the control of ingression of sense objects into events, not only limits the contingency of the coexistence of characters, but also of the sequence of characters.

"The immediate occasion of awareness" has thus been shown by Professor Whitehead to possess such relatedness among its parts, that it manifests itself as in essential spatio-temporal relationship with the whole structure of events, and to possess



such a character that its relationship to the characters of other events is controlled in certain specified ways, and is therefore not purely contingent. It now remains to be considered what view of causation is implied in such a view of nature.

of what he calls 'theories of the bifurcation of nature'. The aim of natural philosophy is to exhibit 'the coherence of the known', and in order to do this, the philosopher must seek to discover and to analyze the various elements within nature and to exhibit the interrelations among these elements. In this analysis, everything that is perceived is to be regarded as within nature. 'We may not pick and choose. For us the red glow of the sunset should be as much part of nature as are the molecules and electric waves by which our science would explain the phenomenon.'<sup>3</sup> It follows from this that the only conception of cause which is of any value to the scientist, and therefore to natural philosophy, is as a relation within nature, relating elements of nature. Any theory therefore, which regards perception as the result of interaction between nature and mind, i.e., as an ultra natural element causally connected with elements within nature, is scientifically valueless. Any theory of 'secondary' qualities then, must be rejected as having an

(1) "The Concept of Nature", Ch. II.  
(2) "The Principles of Natural Knowledge", Preface p. vii.  
(3) "The Concept of Nature", p. 27.



unwarranted distinction within nature as to what is really,  
and what is only apparently part of nature.

IVb. Professor Whitehead's Theory of Causation.

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One of Professor Whitehead's great contributions to the philosophy of nature, is his rejection, as scientifically valueless, of what he calls<sup>1</sup> theories of the "bifurcation of nature". The aim of natural philosophy is to exhibit "the coherence of the known"<sup>2</sup>, and in order to do this, the philosopher must seek to discover and to analyse the various elements within nature and to exhibit the interrelations among these elements. In this analysis, everything that is perceived is to be regarded as within nature. "We may not pick and choose. For us the red glow of the sunset should be as much part of nature as are the molecules and electric waves by which men of science would explain the phenomenon."<sup>3</sup> It follows from this that the only conception of cause which is of any value to the scientist, and therefore to natural philosophy, is as a relation within nature, relating elements of nature. Any theory therefore, which regards perception as the result of interaction between nature and mind, i.e., as an ultra natural element causally connected with elements within nature, is scientifically valueless. Any theory of "secondary qualities" then, must be rejected as making an

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- (1) "The Concept of Nature", Ch.II.  
 (2) "The Principles of Natural Knowledge", Preface p.vii.  
 (3) "The Concept of Nature", p.29.

unwarranted distinction within nature as to what is really, and what is only apparently part of nature.

The causal relation must then, be discoverable within nature, and moreover, within what Hume calls "the single instance", for Professor Whitehead accepts Hume's position that mere accumulation of similar instances can do nothing towards producing a relation which was not present in the single instance. Hume failed to find any character in the single instance which would justify inference beyond itself; that is to say, he failed to find a necessary relation such as the causal relation, within the single instance. However, he assumes<sup>1</sup> nature to be a spatio-temporal system, although on his own principles, spatio-temporal relations are no more to be discovered in nature than is a necessary relation. His position is well summed up in the Appendix to the Treatise, where he says that there are two principles which he cannot render consistent, but neither of which can he renounce. The two principles are: "That all our distinct perceptions are distinct existences, and that the mind never perceives any real connexion among distinct existences."<sup>2</sup> These two principles are obviously only inconsistent on the assumption that

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(1) "An annalist or historian, who should undertake to write the history of Europe during any century, would be influenced by the connexion of contiguity in time and place. All events, which happen in that portion of space, and period of time, are comprehended in his design, though in other respects different and unconnected. They have still a species of unity amidst all their diversity." Philosophical Essays, III. Quoted by Professor Whitehead in "Uniformity and Contingency". Proceedings of Aristotelian Society, 1922-23.

(2) Selby - Bigg edition, p.636.

as a matter of fact, the mind does perceive connections in nature, and this assumption is made by Hume, although he can find no grounds for it in nature. Professor Whitehead thinks that an examination of the single instance provides rational grounds for such an assumption and that nature discloses itself to perception as an interconnected system of events, interconnected by spatio-temporal relationships among its parts, and further, by necessary relationships among its characters. This character of the event which Hume failed to find, and which justifies inference beyond the event, is its significance of something beyond itself. This significance is first of all spatio-temporal. The event is apprehended as a factor in a uniform spatio-temporal system. This assumption is presupposed in Hume's philosophy, though he cannot justify it. Secondly, this significance is due to the fact of the ingression of sense objects, from the apprehension of which we immediately pass to the perception of the perceptual object. The perceptual object is the missing character of events, in which is grounded, inference from the present to the future, and from the present to the past. "Thus in modern scientific phraseology, a perceptual object means a present focus and a field of force streaming out into the future."<sup>1</sup>

The general relationship which characters or objects bear to events is the relation of "ingression". This includes the

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(1) "Uniformity and Contingency", p.17. Proceedings of the Aristotelian Society, 1922-23.



different percipient events to a common apparent situation, as relation of "situation", which a scientific object bears to its historical route, and which a perceptual object bears to the series of events making up its life history, the relation of "influencing" which a scientific or perceptual object bears to its field, and the relation of "being conditioned by", which a sense object bears to its system of conditioning events. Thus the notions of causation, situation and predication, are all subsumed by Professor Whitehead under the one head of "ingression". In working out the theory of causation implicit in Professor Whitehead's philosophy of nature, then, it will first be necessary to consider the relations of the various types of object to one another. The immediate data of sense awareness are, of course, the sense objects. There could be no knowledge of nature without sense awareness of such factors as "red", "smooth", "cool", etc., but these factors are not given as "separate and distinct existences" as Hume thought; if they were, then it would be impossible to bring them into connection with one another. What is given as discrete and separate cannot be formed into classes or sets so as to produce the illusion of "one thing". Thus, though the sense objects are the immediate data, and though they are apparent characters of events in the most obvious sense of the word "apparent", yet they are presented as indicating something other than themselves. The reference of sense objects of different senses to a common apparent situation, as when we see and touch red velvet, and the reference of sense objects ingredient in



different percipient events to a common apparent situation, as when two people see the same chair, discloses the sense object as indicating more or less accurately the situation of its causal character. In Professor Whitehead's language, the sense object "conveys" the perceptual object. The converse relation to "conveys" seems to be "exhibiting itself by means of". The sense object conveys the perceptual object, and the perceptual object exhibits itself by means of the sense object. "The grass exhibits itself as green, the bell exhibits itself as tolling, the sugar as tasting, the stone as touchable."<sup>1</sup> The perceptual object is thus a recognised permanence among the characters of events. It is the character of a spatio-temporal region that it should exhibit itself in certain ways. Thus, a perceptual object, such as a blade of grass, is the character of its situation that it should exhibit itself as green, narrow, cool, etc. In considering a blade of grass and its sensible qualities we have to take account of the percipient events, the event which is the situation of the blade of grass, and the events throughout the intervening medium. Thus, both the perceptual object and the sense objects through which it exhibits itself may be said to be ingredient throughout a spatio-temporal region, but they are ingredient in a different sense. The sense object is ingredient in the sense that it does not stand in a simple two-termed relationship to any event or set of events, but needs the whole set of events for its

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(1) "Uniformity and Contingency", p.17. Proceedings of the Aristotelian Society, 1922-23.

condition. The blade of grass only exhibits itself as green to a suitable organism and when it is in a suitable environment. The perceptual object is ingredient throughout a spatio-temporal region in the sense that its characters determine the characters of other events in this region, which may be called its causal future, or analogously with scientific objects - its field. The perceptual object, as compared with the sense object then, is a causal character of events, though compared with the physical and the scientific object, it is the apparent character of its situation. In the second edition of the "Principles of Natural Knowledge", Professor Whitehead points out<sup>1</sup> that the distinction between apparent and causal characters is not fundamental: "it is relative to a deliberately limited point of view". It seems, however, that the sense object is very different from objects of other types; it has no "causal future", and cannot be regarded as anything but an apparent character from any point of view. All the other types of objects, however, are capable of being regarded as apparent characters of events in the sense that they are recognised permanences among events, so that from this point of view, the distinction is not ultimate. Miss Stebbing, in an article on Professor Whitehead's "Perceptual Object" says: "It would not be too much to say that Professor Whitehead's whole philosophy of nature depends upon this rejection, (i.e., the rejection of any fundamental distinction between causal

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(1) p.204.

and apparent character) and consequently demands a new theory of causation."<sup>1</sup> This is not too strong when we are considering the status of the various types of object within nature. Every object has equal claims with every other to be regarded as elements of nature, for they are all given in perception. That is to say, they are equally real. They differ from one another merely in their degree of abstraction, though this difference is relative to a point of view. From the point of view of perception, sense objects are the given concrete reality. In making precise and definite their relations to events, we are led to apprehension of the perceptual object as the control of ingression of sense objects. The perceptual object is still not precise and accurate enough for science, which passes to the physical objects as the causal character of the event in which the perceptual object is situated. Certain observed permanences in the behaviour of physical objects leads to the recognition of scientific objects as the ultimate causal characters of events. For science, then, the scientific object is concrete reality, from which all other characters of events are deducible. From the point of view of importance for causation, however, it seems that a distinction must be drawn between the ingression of the various types of object. The ingression of the sense object has no significance for the future,

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(1) "The Journal of Philosophy", Vol. XXIII. No. 8, p. 207.

it cannot be said to "develop" as the other objects do - it merely is. Not only has the sense object no causal future, in the strict sense of the word it has no situation.

It was said above that the perceptual object is a control of ingression of sense objects in events, and this notion is of great importance for Professor Whitehead's causal theory. He seems to mean by it, the fact that the presence of a perceptual object as situated in a given event, modifies the character of events in the neighbourhood in such a way that it manifests itself by means of sense objects to a suitable organism placed in any position in the environment. The facts of perspective lead us to suppose that from any point in the neighbourhood of a chair a slightly different sense object or set of sense objects "conveying" the chair would be perceived. This class of sense objects - i.e., from every possible point of view - is the chair on any such theory of common sense things as that developed by Bertrand Russell in "Our Knowledge of the External World", and in lectures on "The Analysis of Matter". This view was also held by Professor Whitehead in his earlier writings. The "control" theory of perceptual objects developed later; its first systematic expression is in Chapters II and IV of "The Principle of Relativity".

This view of the perceptual object as a control in the sense of a centre of perspectives is, however, not the most important sense of ingression for causation. In this sense,



the perceptual object is the causal character influencing the apparent character of events, and in this sense, it is equally ingredient throughout its whole field. But in "The Concept of Nature", Professor Whitehead says: "The waves as they roll on to the Cornish Coast tell of a gale in Mid-Atlantic: and our dinner witnesses to the ingression of the cook into the dining room."<sup>1</sup> The dining room chairs are ingredient throughout their neighbourhood, and therefore in the dinner on the dining room table, but not in the same sense as the cook is ingredient in the dinner. The cook seems to be ingredient in the dinner in the special sense that she has caused change in the causal and not merely in the apparent characters of the set of events we may call collectively "the dinner". For the same reason, the kitchen fire is ingredient in the dinner in a sense in which the kitchen chairs are not ingredient in the dinner, though they were situated in, and ingredient throughout the neighbourhood of the dinner during a certain period. Thus in the first sense of ingression, the causal relation seemed to hold between causal characters and apparent characters; in the second sense between the causal characters of different events. This change in causal characters of events may be compared with Mr Johnson's change in the property of a con-tinuant. Both these changes can only be manifested in change of sense objects in Professor Whitehead's system, or of occurrents in that of Mr Johnson, but this sensible change

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(1) p.146.

exhibits a certain permanence and continuity, so that we pass from it to an apprehension of change in causal characters. Common sense would call this latter kind of change the only real change that takes place in nature. It would hold that the dinner is not "really" changed by being brought from the pantry and set upon the kitchen table, though it has a different set of objects ingredient in it. It is not "really" changed when the electric light is turned on, though it manifests itself under a changed set of sense objects. Its "real" change begins when the cook takes the eggs and breaks them, and mixes them with flour, etc., and then places them on the stove, though this "real" change is only apprehended by means of changed sense objects. Professor Whitehead points out<sup>1</sup> that in the case of some events, ingression takes a peculiar form, what may be called a more concentrated form, and this peculiar form of ingression is the relation of "situation", "The storm is a gale situated in Mid-Atlantic with a certain latitude and longitude, and the cook is in the kitchen."<sup>2</sup> Since situation is only a special form of the relation of ingression, it may be that this second kind of ingression which results in a change of causal character in other events, and not merely in apparent character, is a kind of "spreading of concentration" of the relation of situation. Thus, it is much easier to define the situation of the cook when she is in

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(1) "The Concept of Nature", p.146.

(2) " " " " p.147.

repose than when she is

moving about and busying herself with the dinner, so that though the event in which the cook is situated cannot be defined precisely in either case, yet it is much wider and more undefined in the latter. In the same way, the fire has a much vaguer situation than a chair. A chair has precise boundaries so far as sense objects of sight and touch are concerned, but the fire has not even this amount of precision. The flames leap up, and smoke rises up through the chimney, and its heat is felt throughout a wide region. This is not exactly analogous with the way in which its sense objects of sight are ingredient in the neighbouring events, for the perception of sense objects of sight is not a sign of change in the causal characters of the percipient event, while heat if it is sufficiently intense, may cause change in the causal character of surrounding events, as for instance, when meat is cooked. Thus, it seems that all causal characters, perceptual, physical and scientific objects, are situated, or are ingredient in a peculiarly concentrated form throughout a more or less precisely defined spatio-temporal region; that they are ingredient throughout their whole spatio-temporal environment in the sense that an electron is ingredient throughout its field, but that in the case of objects moving relatively to their environment, the "situation" is indefinitely widened, so that there is change in the causal characters of the situation, and not merely in apparent characters. This latter state of affairs seems to be what common



sense means by causal sequence, and since it seems to involve the convergence and coincidence of historical routes of objects - (perceptual, physical, or scientific), it fits in well with the analysis of natural changes in the Introduction.

Since situation and causation are modes of the one relation of ingression, it follows that there must be spatio-temporal continuity between cause and effect event. An object cannot be situated in part only of its situation; it is a pervasive adjective. Nor can it be ingredient in part only of its causal field. If an object is ingredient here-now, and ingredient then-there, it must also be ingredient throughout the spatio-temporal interval. Also, the relationship between events must be expressed in terms of characters, or universals, so that the causal relation may be looked on as relating universal characters as they are ingredient in spatio-temporally continuous events. Since a character can only be manifested in a finite spatio-temporal interval, that is to say, since it must characterise an event, perception discloses not only the character of an event, but the mode in which the characters change. Thus the "immediate occasion of awareness" is capable of yielding to the trained eye, not only characters of events, but also laws of change relating to those characters, just as the rate and direction of motion of a particle during a short interval, is sufficient to determine its law of motion under similar sets of conditions. That is to say, we apprehend characters of



events, or rather characterised events, as revealing process under specific sets of conditions, and therefore as disclosing in nature, a rational ground of induction.

The story is often told of how James Watt, as a boy, watched the lid of the kettle jumping up and down as the water inside boiled, and how he thus conceived the idea of making use of steam to drive machinery. That is to say, within the given situation, he discerned a certain set of events, the movements of the kettle lid, as bearing a certain relationship to another set of events, the boiling of the water, a relationship which could be called briefly the relation of cause and effect. Furthermore, he abstracted from this concrete causal sequence, and visualized the possibility of many other causal sequences resembling the one present to his senses in important respects; that is to say, resembling the given causal sequence in the important characters of the cause events, and therefore in the characters of the resulting effect events. This "therefore" represents an assumption made by scientists and by common sense alike. James Watt may have doubted whether he could invent machinery of sufficient power to be of use in industry, and he may have doubted whether he could induce manufacturers to take up his invention. The one thing he never doubted was that water heated in his manner could behave in just the same way as water in his Grandmother's kettle. This assumption of a necessary relationship between certain of the characters of events in causal sequence, such

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to have as its basis, indubitable features of experience. We do, as a matter of fact, distinguish in experience certain series of events as causal, and others as non-causal, and within the causal sequence, certain respects as causally important and others as unimportant. Thus, James Watt could have made his observations just as well with a kettle on a gas stove as on an open grate: the important respect, causally, is that the kettle should be heated. Any view of causation, therefore, which denies that there is a real distinction between what common sense calls "causal" and "non-causal" series of events, must prove that common sense is mistaken in its assumption: the onus probandi lies on the philosopher who holds such a view, and not on the one who takes the assumption as an indication of a real distinction in nature, at any rate in the absence of proof to the contrary.

It seems that no philosopher has yet succeeded in proving that there is nothing in nature corresponding to the common sense notion of a causal connection. A causal connection between events is assumed by common sense, and so far, no one has succeeded in showing that this assumption is mistaken. The next question, then, which a philosophy of nature must discuss is: Assuming that events do bear a relation to one another which may be called a causal relation, does this relation possess the characters attributed to it by common sense? The common sense notion of a causal connection may be briefly expressed thus: The causal connection must be of such a nature

that of two events so related, one necessarily precedes the other. The precise statement of this condition was seen to involve the two following separate conditions:-

(i) That the cause events and the effect events must be in spatio-temporal continuity with one another.

(ii) That the characters of the cause events and of the effect events must be in some kind of essential connection with one another.

These two conditions require further discussion, but before entering upon this, it will be necessary to summarise the discussion in the first section, on the various kinds of change in nature.

Change is given within the present fact, and since all our knowledge of nature is based upon sense perception, the change which is given in perception, is of apparent characters of events. One important class of such natural changes was seen to be the interactions of moving bodies, and of such changes the following classification seems to be exhaustive.

(i) The communication of movement by a moving body to a body at rest.

(ii) The increase of velocity in movement communicated by a moving body to a body moving more slowly in the same direction as the first.

(iii) Change of structure in one or both bodies following on contact between a moving body and a body at rest.



(iv) Change in rate and direction of movement of two moving bodies in collision.

(v) Change in structure of one and in rate and direction of movement of the other, or change in structure of both of two moving bodies in collision.

(vi) Change of structure due to atmospheric influences.

In all these cases of natural change, the spatio-temporal continuity of cause and effect events is to be observed, except perhaps in the last; the only other kind of change recognised as taking place in nature is change in apparent or sense characters of events, and in such cases, spatio-temporal continuity is not obvious. It is required by science, in order to give a complete and adequate account of nature.

It was shown in the first section that change in sense qualities of events cannot be adequately represented as a linear series of events. By ignoring the percipient events, and the conditioning events, such as a source of light in visual perception, change in apparent qualities can be regarded as a linear series. That is to say, by taking sense objects as "pseudo-adjectives" of events, in Whitehead's sense, we can describe change in the sense qualities of objects as a single spatio-temporal series of events qualified by different "pseudo-adjectives" in succession; this may be compared with Mr Johnson's account of change as a series of occurrents inhering in one continuant. The two treatments of

The "really" seems to indicate the situation of visual is

change are only similar in the relationship which is conceived to hold between sense object and sense object on the one hand and between successive occurrents on the other. They differ in the kind of existence which is ascribed respectively to the sense object and to the occurrent. The former is an adjective of events, the latter has substantival existence. The two accounts also differ in that Professor Whitehead insists that such an account is necessarily partial - the sense object is only a pseudo-adjective of the series of events which it appears to qualify. Science forces us to regard change in sense qualities of events as a change involving a whole system of events, and in order to deal with such a system, analyses it into sets. Thus, change in any one of these sets of events, would appear as change in the sense qualities of one or other of the objects involved, but in order to account for this change, science has first to pass from the apparent to the causal characters of events, and thus to discover the source of the change. Thus, change in apparent characters of events, indicates a change in causal characters of events, but not necessarily in the causal characters of the events which the sense objects appear to qualify. A headache indicates disturbance in some part of the bodily organism: it is apparently located in the head, but it may be an indication of trouble in the digestive organs. Thus, in medical books, it is sometimes stated that most headaches are "really" stomach aches. The "really" seems to indicate the situation of causal in

Figure I

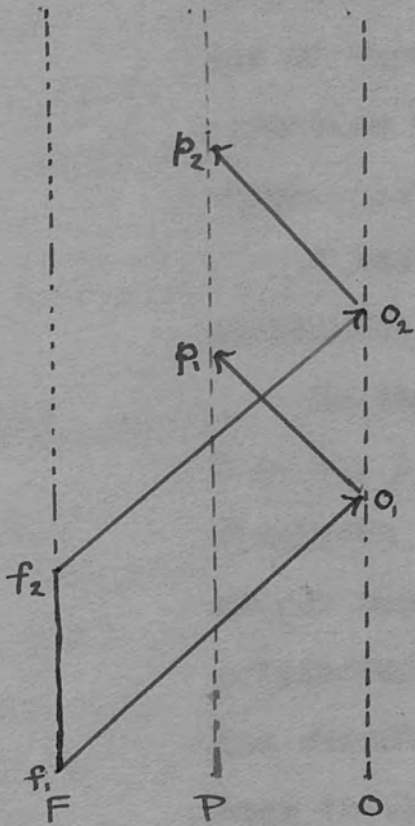


Figure II

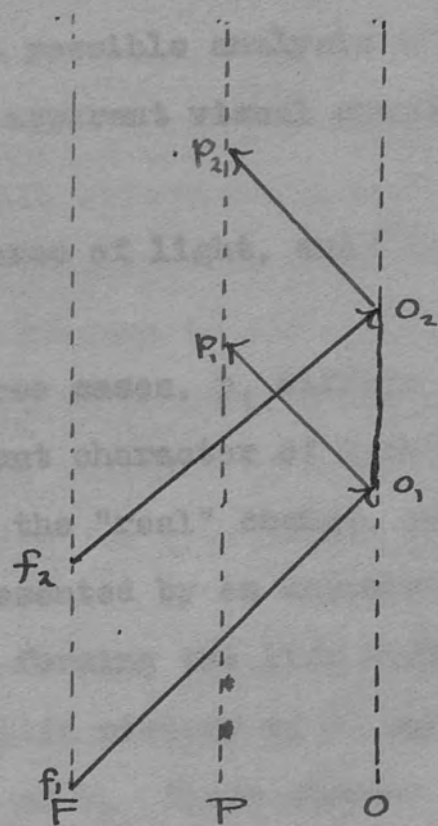
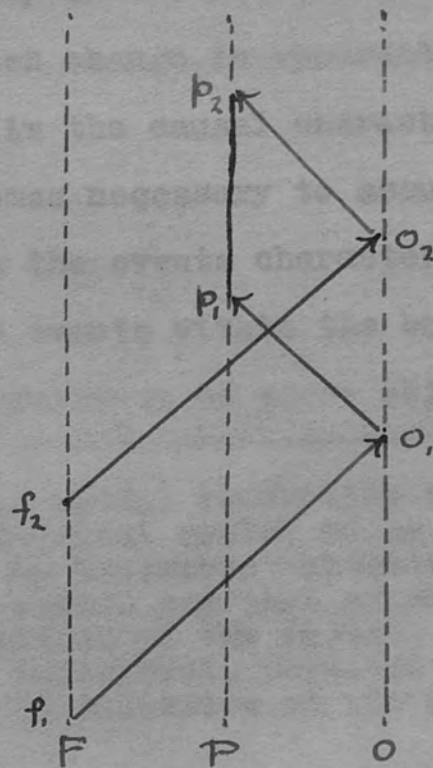


Figure III





distinction to the situation of apparent characters, or rather, the apparent situation of causal characters. This discussion might be illustrated by figures 1, 2 and 3, each one of which represents a possible analysis of the complex situation "Change in the apparent visual characters of an object, O."

F represents the source of light, and P the percipient organism.

In each of these three cases,  $p_1$  differs qualitatively from  $p_2$ , i.e., the apparent character of O has changed, though in the first case the "real" change, or change in causal characters, (represented by an unbroken line), has originated in the events forming the life history<sup>1</sup> of F, in the second case, in the life history of O, and in the third case in the life history of P. These changes may then fall under any of the six classes mentioned above.

When change in apparent characters is thus traced to change in the causal characters of some event or set of events it becomes necessary to assume spatio-temporal continuity between the events characterised by the causal characters, and the events within the body of the percipient which are the perceptions of sense objects. The causal characters of

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(1) This useful conception of the "life history", or of the "historical route" of an object, is used both by Dr Broad and by Professor Whitehead to indicate a continuous series of events, any part of which is distinguished by being the situation of the object. In Professor Whitehead's language the perceptual, physical or scientific object is a pervasive adjective of its historical route.



events are the objects of science, and it is necessary for the scientist to assume that scientific objects are ingredient in what is called "empty space", as well as in events characterised by apparent characters. Thus science has to conceive of something going on at every point between the source of light, a perceptual object and a percipient event, and it analyses this continuous process in terms of scientific objects. It is the aim of science to discover characters which bear a simple relation to events, such as scientific and perceptual objects. The relation of sense objects to events is far too complicated for precise scientific treatment.

The first condition of causal sequence, stated that events related as cause and effect must be in spatio-temporal continuity with one another. This condition is obvious in the first class of changes mentioned above, and necessitated by the scientific analysis of perception, photography, etc. The conception of continuity in space, or continuity in time is easily understood. Continuity in space-time is a more difficult conception, and necessitates some such notion as A.A. Robb's<sup>1</sup> view of space-time as displaying conical order. It will be best to begin by indicating what is meant by spatio-temporal continuity, in a very general kind of way, and then go on to make the notion more precise. In the first class of changes mentioned above which could be roughly summed up as

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(1) A.A. Robb, "A Theory of Space and Time". Introduction.

changes following on contact between material bodies, spatio-temporal continuity between cause and effect events was said to be observable. In any such case, common sense believes that the effect event begins at the moment of actual spatial contact between the bodies, and that any body which was not in spatial contact with the body of whose life history the effect event forms a part, cannot be directly causally connected with the change. In such cases as those falling into the sixth class, change in structure due to atmospheric conditions, heat, light, etc., spatio-temporal continuity is best expressed in terms of events. The causal events pass into the effect events in such a way that there is no spatio-temporal interval between cause and effect. If we take the case of James Watt's boiling kettle once more, the effect events form part of the life history of the kettle lid, and its environment is roughly, the kettle of water and the fire. Now the only way we can account for the effect, the movements of the kettle lid, is by viewing the process as a spatio-temporal whole, and it is then obvious that the cause and effect must be in spatio-temporal continuity with one another. The ordinary way of describing the process would be that the heat is generated in the stove, conducted through the atmosphere, through the metal lid of the stove, through the kettle to the water. The water then passes through a continuous series of degrees of heat till it boils and gives off steam, which moves

(1) Cf. St. Alexander's analysis between the three dimensions of space and time's three qualities. "Space, Time and Matter".

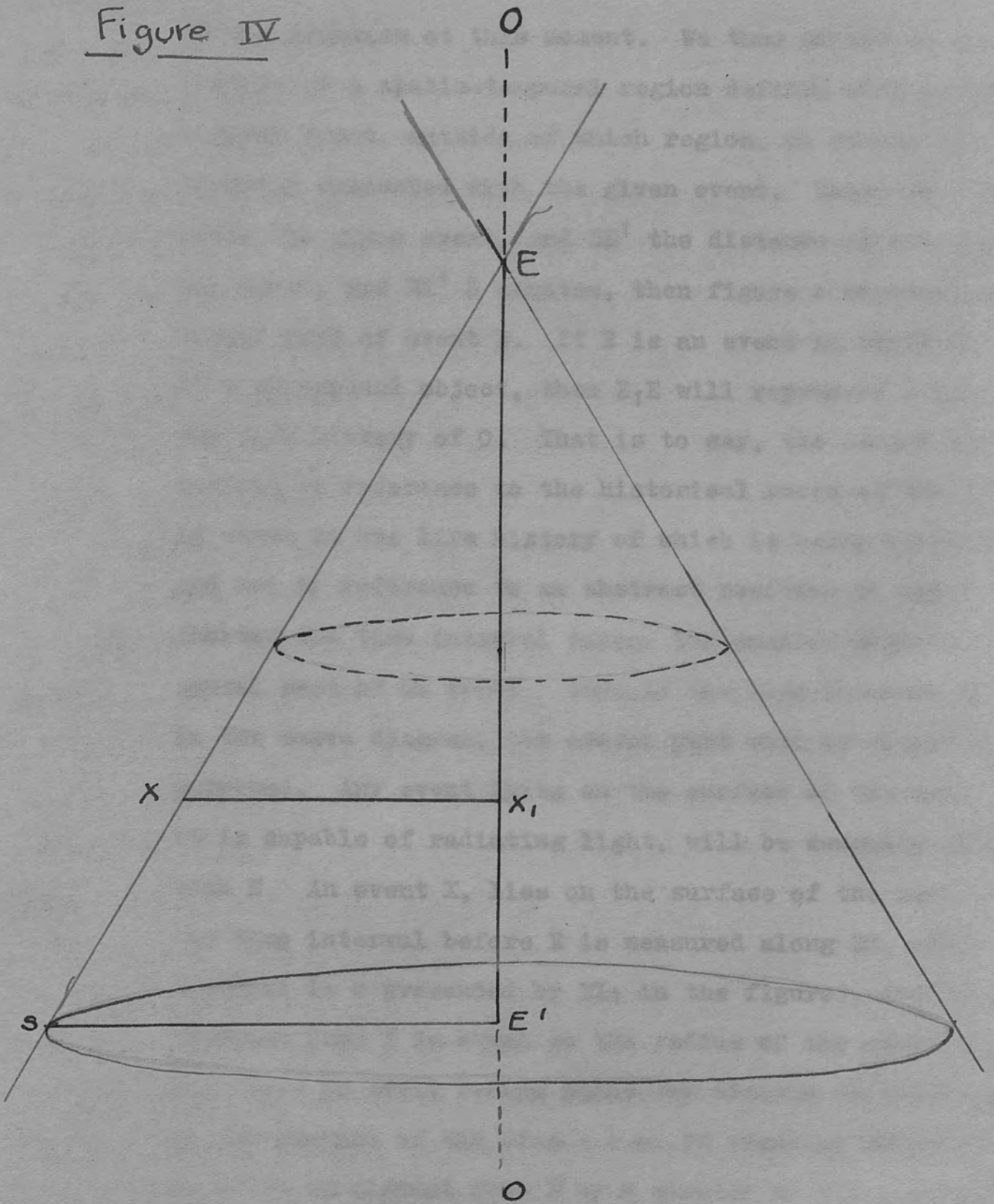
upward to the kettle lid and raises it. The important point of this description is that it postulates something "going on" at every moment in between the putting of the kettle on the fire - i.e., the putting of the lid into a suitable environment - and the effect, and also at every point in the spatial environment of the effect event. These things are, of course, essentially connected. Continuity in space has no meaning without time, and continuity in time has no meaning without space.<sup>1</sup> It might be expressed by saying that any spatio-temporal interval between the cause event and effect event will exhibit process relevant to the effect event.

The environment of the effect event was said to be the kettle of water and the fire. The fire, however, is impossible without the atmosphere, and the atmosphere cannot be confined to a definite region of space-time. Will the environment of the effect event then include wider and wider areas until it embraces the whole universe? Commonsense would answer emphatically no. What is happening in the outermost stars at this instant, or even in China, cannot possibly affect what is happening in this room at the same moment. Commonsense, however, would admit that the events in the outermost stars a reasonable interval ago may affect events here-present. Events which took place in the sun eight minutes ago are causally connected with the state of my

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(1) cf. S. Alexander's analogy between the three dimensions of space and time's three qualities. "Space, Time and Deity".

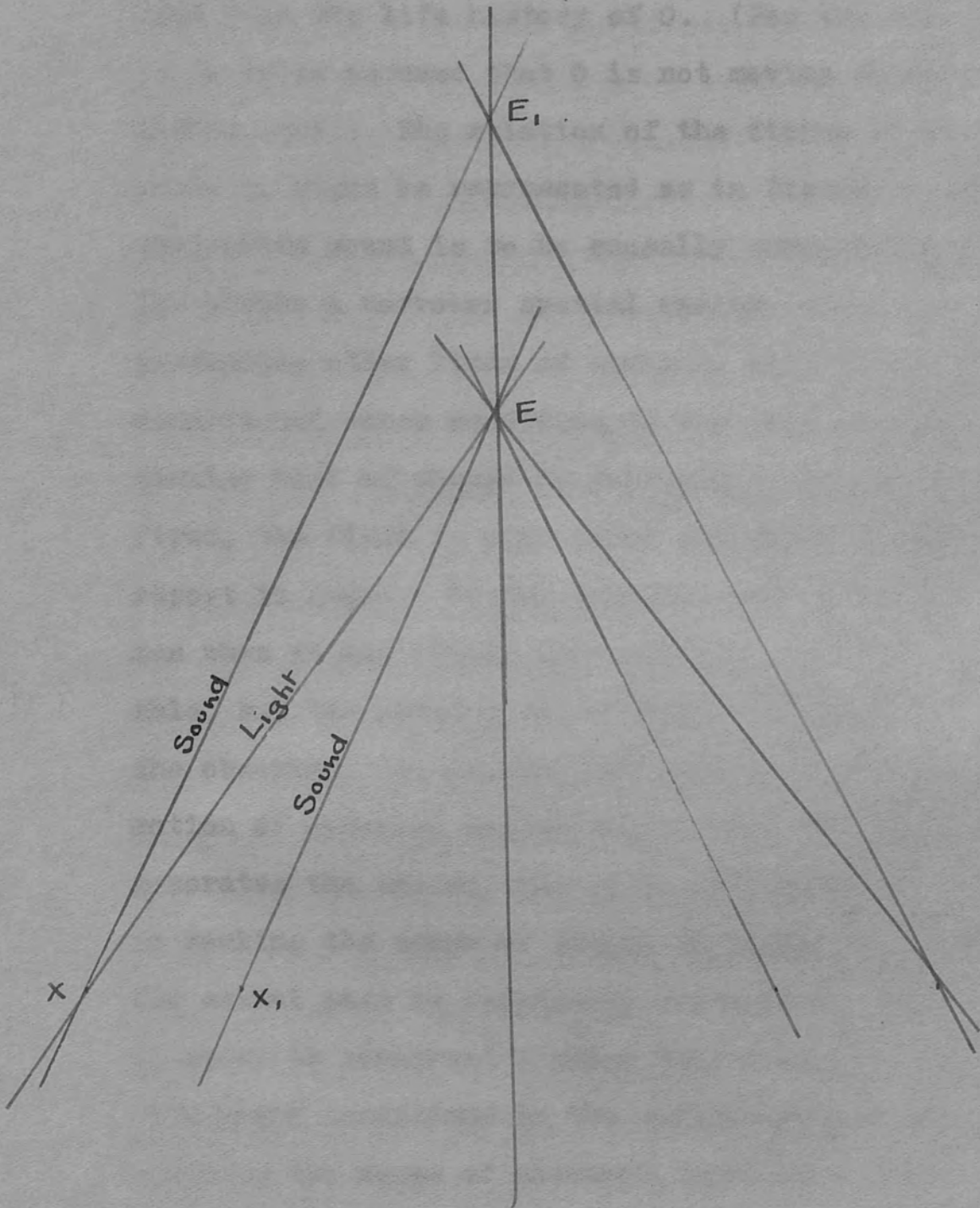
Figure IV





bodily organism at this moment. We thus arrive at the conception of a spatio-temporal region defined with reference to a given event, outside of which region, no events can be causally connected with the given event. Thus, if  $E$  represents the given event, and  $SE^1$  the distance of the sun from the earth, and  $EE^1$  8 minutes, then figure 4 represents the causal past of event  $E$ . If  $E$  is an event in the life history of a perceptual object, then  $E_1E$  will represent a part of the life history of  $O$ . That is to say, the causal past is defined by reference to the historical route of the object an event in the life history of which is being considered, and not by reference to an abstract position in space. The shorter the time interval taken, the smaller will be the causal past of an event. Thus, if the time interval be halved in the ~~above~~ diagram, the causal past will be considerably narrowed. Any event lying on the surface of the cone, if it is capable of radiating light, will be causally connected with  $E$ . An event  $X$ , lies on the surface of the cone if, when its time interval before  $E$  is measured along  $EE_1$  (this time interval is represented by  $EK_1$  in the figure), its spatial distance from  $E$  is equal to the radius of the cone from point  $X_1$ . Thus an event taking place two minutes before  $E$ , lies on the surface of the cone - i.e., is causally connected with  $E$ , if it is distant from  $E$  by a quarter of  $E_1S$ . If  $X$  is such an event as the firing of a cannon, the light generated will reach  $E$ , but since sound travels more slowly, the sound

Figure V



generated by X will not reach E. To travel the same distance  $XX_1$ , it will require a longer time interval than the light waves, so that it will coincide with a later event than E in the life history of O. (For the sake of simplicity it is being assumed that O is not moving relatively to its environment.) The relation of the firing of the cannon to event E, might be represented as in figure 5. If an event generating sound is to be causally connected with E, it must lie within a narrower spatial radius, e.g.,  $X_1$ . Events generating other kinds of changes, will lie on differently constructed cones according to the rate at which the particular kind of change is generated. Thus when a cannon is fired, the flash is seen first and after an interval the report is heard. If the observer were very near to the cannon when it was fired, this interval would be barely perceptible, but the greater the distance between the cannon and the observer, the greater will be the interval. The rate of motion of material bodies varies with the kind of event which generates the motion, but it is comparatively small, so that in seeking the cause of change in motion of a material body, the causal past is relatively restricted. Thus James Watt, in order to construct a steam driven engine, need not study widespread conditions in the environment of the kettle. In studying the cause of movement, such conditions as light radiation, propagation of sound, etc. is irrelevant. The only kind of change which might interfere with such a sequence of

from the fact that nature is not a bare event.

events as the boiling of the water and consequent movement of the lid, would be movement of material bodies in the immediate neighbourhood. For instance, pressure on the lid of the kettle would prevent the effect from taking place. More accurately, the two sequences of events, the boiling of the water in the kettle and the pressure of some material body on the lid, or very dense atmospheric pressure, would conjointly produce a total effect different from the effect of the boiling water alone. The total effect might be the bursting of the kettle. In constructing a machine upon similar principles then, only such conditions as these need be studied in order to make sure that the "same cause will produce the same effect". This assumption was seen to be justified when

The cause of a given event E, might then, be defined as the only change or changes in relevant respects, taking place within the causal past of E, the causal past being defined quite definitely in reference to the kind of change which is being considered as the effect event. The business of induction would then be to discover the respects relevant to effects of different types. In discovering the aspects relevant to effect E, we are considering E as possessing a given character. That is to say, we are seeking the cause of E's possessing a certain character; we are not seeking the cause of E's existence. It follows from the nature of events that they are continually passing into new events. It also follows from the conception of nature as an interconnected system of events, and from the fact that nature is not a bare event,



that each event should possess some character. What this character or characters shall be, does not follow from the nature of events merely as events. Causation, then, is not concerned with the occurrence of new events, it is concerned with the kind of character which the new event will possess. In seeking the cause of an event's possessing a certain character, it is seeking to exhibit the characters of the new events as in some kind of connection with the characters of the events out of which the new events passed. The common-sense idea of cause involves the assumption that the events "immediately preceding" the effect events are such that their characters alone will account for the characters of the effect event. This assumption was seen to be justified when "immediately preceding" is interpreted as "in spatio-temporal continuity with", for then the immediately preceding events form the causal past of the event, and ex hypothesi, it is impossible that any event outside this region should be causally connected with the event.

The notion of "causally relevant respects" is familiar in psychology, and an example taken from the psychological field will illustrate the point well, even though the two uses are not precisely analogous. The human organism reacts to many different kinds of influences, but it would be admitted that causally, the most important of these reactions are those of the eye to light, and the ear to sound. The organism of a dog reacts chiefly to scents, so that the causal

region of a man is very much wider than that of a dog. Thus, if a man and a dog go for a walk together, the man stands and gazes at the landscape around him and listens to the singing of the lark up in the sky, while the dog is busy in his own little causal region, attending to smells in the immediate neighbourhood and apparently uninfluenced by anything beyond.

The two cases are not exactly analogous because the distinction between the causal region of the man and the dog respectively, is based on the psychological quality of selection displayed by all sentient organisms, while the causal past of an event, as the phrase was used above, is defined by reference to one aspect of the event abstracted from the concrete situation. From this latter point of view, we might abstract one similar aspect from each series of events, the life history of the dog and of the man, for which aspect the causal past would also be similar. For instance, if we consider the eyes of the dog merely as radiators of reflected light, the causal past for this event, i.e., the radiation of light, would be defined in just the same way as the causal past of the event, the radiation of light from the eyes of the man.

Thus the region within which the cause of an event must be sought, has been defined; the characters also of the events within the region have been distinguished into two classes, those which are causally relevant, and those which are causally irrelevant. For instance, if the radiation of

reflected light is being considered as the effect event, its causal past will be defined by reference to the velocity of light. Any event lying on the surface of the cone thus derived, will be relevant to the effect, but only in its aspect as a radiator or absorber of light. Just as a certain aspect is abstracted from the total effect event, so the same aspect is abstracted throughout the causal past of the event. All other aspects are negligible. In order then, to define a cause precisely, the state of the causal past as regards the respects relevant to the effect must be stated. In this connection it is important to point out that if an event forms part of the life history of a perceptual or scientific object, its historical route is always the centre of its causal past. From this it follows that a very important part of the causal past of an event E, is constituted by the past history of the object in whose historical route E lies. Here again though, the past history of the object will only be relevant in certain defined respects, just like the rest of the causally relevant environment.

The position may be summed up as follows. The environment of a causal sequence must fulfil briefly the condition of non-interference. In order to ensure this, it is necessary to study just that aspect of the surrounding events in which they are relevant to the aspect of the effect event which is being considered. Change in this aspect alone could be causally connected with the change of aspect in the effect

event. Induction then, aims at discovering which aspects are relevant to particular kinds of change. Thus, in trying to discover the reason that the hop and the bean climb round their poles in different directions, it is necessary to discover which aspects of their environment, including the past history of each plant, is relevant to such an effect. Evidently it is not the aspect of the environment which might be summed up as "atmospheric conditions" which is relevant to the effect, nor the soil conditions, for the two plants can grow side by side in what is, practically, the same environment in these respects. It must, then, be some aspect of the past history of each plant which has caused the later events of its life to possess this character. Their past history must then be compared, in order to discover in which aspect they differ; this comparison discloses the fact that the past history of the plants through several generations has been passed in different hemispheres, and that each plant climbs in the direction of the sun's orbit in its own native hemisphere. The causally relevant aspect of the total state of affairs is then the growth of a habit in the plant through several generations of exposure to the relevant conditions - i.e., the movement of the sun in a certain direction. Many of the other factors in the environment are causally connected with the other aspects of the plant's growth, but this particular characteristic is connected in a peculiar way with a particular factor in the environment. In some



cases, the causally relevant respects are obvious. When anything has been smashed, it is obvious that the aspect of the environment relevant to the change is the movement of material bodies in the immediate neighbourhood. Only material bodies which were within a narrow spatial area immediately before the smash - i.e., within the causal past of the event defined with reference to the rate of motion of material bodies - could be suspected of being involved in events in causal connection with such an effect. The events in the sun could be in causal connection with the event considered in its aspect of receiving and reflecting (or absorbing) light rays, but in its aspect as a change in structure of a material object, only the movements of other material bodies in the neighbourhood are causally relevant.

The precise statement of a causal relation, then, should point out the respect in which two events are causally connected. Instead of seeking the cause of event E, we are seeking the cause of E's possessing a certain character, and the cause will have to be similarly stated. Thus, the cause of E's possessing a certain character C, is the possession by E<sub>1</sub> of a certain character C<sub>1</sub>. ~~Thus~~ E possesses many other characteristics as well as its effect character C, and E<sub>1</sub> possesses many other characters as well as its causal character C<sub>1</sub>, just as a woman possesses many other characteristics besides the characteristic "being a daughter". This comparison throws light on the question of the necessity of the causal relation. It is sometimes argued that because each

event is unique, and therefore each causal sequence is unique, necessary connection between events can have no meaning. It is true that each instance of causal sequence is unique, just as each instance of "being a daughter" is unique, but the instance is in each case an instance of a universal relation; each instance of a causal law resembles other instances in the causally important respects, so that the uniqueness of instances has no bearing on the question of a necessary connection between events. The character of this necessary connection, will, however, be considered in the next and concluding section, with reference to the more general topics of induction.

Hume analysed the necessity of the causal relation as a habit of the mind following on the constant conjunction of the cause and effect events in experience. Whether he would look on this experience of constant conjunction as the cause of the formation of the habit is not clear. It seems plain, however, that if the two are causally connected, it must be in some sense other than that which Hume gives to the phrase "necessary connection between events". However this may be, the next point to be discussed is: How far does Hume's account of a necessary connection give an adequate explanation of our conviction that if a man is shot through the heart he must die? Few of us have seen a man shot through the heart, so that our conviction is not based on personal experience of the sequence of events "shooting of a man through

VI. The Necessity of the Causal Relation.

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"If a man is shot through the heart, he dies." This proposition would be accepted by all rational men as the statement of a necessary connection between events, in some quite clear and definite sense of the word "necessary". As we have seen before, this connection must be regarded as a necessary connection between the characters of events, but this point is not important here. What is important is to discover what can be the meaning of the word "necessary" in this context.

Hume analysed the necessity of the causal relation as a habit of the mind following on the constant conjunction of the cause and effect events in experience. Whether he would look on this experience of constant conjunction as the cause of the formation of the habit is not clear. It seems plain, however, that if the two are causally connected, it must be in some sense other than that which Hume gives to the phrase "necessary connection between events". However this may be, the next point to be discussed is: How far does Hume's account of a necessary connection give an adequate explanation of our conviction that if a man is shot through the heart he must die? Few of us have seen a man shot through the heart, so that our conviction is not based on personal experience of the sequence of events "shooting of a man through

the heart" - "death". It must then be based on the testimony of others who have experienced the constant conjunction of the two events, but can a "habit of mind" be thus communicated? Can X's experience of two events in constant conjunction cause in Y a habit of the mind to pass from an idea of the one event to an idea of the other event, i.e., cause Y to look on the two events as causally connected? It might be said that even if this is impossible, X erroneously interprets his experience of constant conjunction between the two events, as a sign of a real connection in nature, and communicates this false belief to Y, who henceforward, on experience of the one event, will expect the occurrence of the other. This would account for our belief in causal connection which we have not experienced; it will not account for the fact that we discriminate between the beliefs which others attempt to communicate to us, and for the fact that discrimination is on the basis of rational grounds for the belief, not on the number of people who have experienced the constant conjunction. On Hume's grounds this latter should be the only rational basis for belief in a necessary connection.

Belief in a necessary connection between "being shot through the heart" and "dying", cannot then be based on our own experience, but on the testimony of a very few men, and this testimony is not of the nature of bearing witness to the actual occurrence of the sequence of events "X shot through the heart", "X's death". It would take the form of an analysis



of the whole situation, and this analysis of the situation would be a description of the human organism, with a description of the sequence of events following on the introduction of a foreign body into a certain part of the human organism. Thus, we accept the surgeon's account of necessary connections between events in the human organism, and death, not because he has had more experience of death, from this point of view, any soldier who went through the European War would be more qualified to give an opinion than a doctor with a civilian practice - but because, from his greater knowledge of the structure of the human body, he is more likely to recognise within the given concrete situation, the aspects which are causally relevant to any given state of affairs. In other words, he is capable of recognising necessary connections between certain aspects of the concrete situation. To the unprofessional eye, all aspects of the causal sequence are interconnected; it is the business of science to unravel these intertwined connections, and show how the various aspects of the cause event are connected with the aspects of the effect event. Thus, science has to discover within the given concrete situation, aspects of the event in necessary connections with one another. If it fails to do so, then Hume's conclusion inevitably follows; if the necessary connection is not discoverable within the single instance, it will not be discoverable anywhere.

It will probably be objected at this point, that as a matter of fact the scientist hardly ever discovers a necessary connection without the examination of many instances. That is to say, he never does, as a matter of fact, establish a necessary connection by examination of the single instance. This is undeniable, but it is not to the point. It is an empirical fact about the way in which the human mind works, and sets about gaining its knowledge; it does not imply any quality of nature, which the mind thus comes to know. Not only does the mind need to examine many instances before it can clearly perceive a causal connection in nature; it also needs to view a geometrical figure from many different aspects, before the universal connections among its various properties are clearly recognised. Thus, the beginner in mathematics has to become familiar with triangles of all kinds, scalene, etc., before the universal connection between the form of the triangle and the lengths of its three sides emerges. He learns by experience of drawing triangles, and of handling wooden triangular shapes, that, given the lengths of the three sides, the triangle is fixed. Once this fact has emerged from the mass of irrelevant detail, it is obvious to the beginner. In any given instance, he can discover this universal connection - but it was discoverable before. The way in which he has learned to recognise it, is irrelevant to the connection itself. It is there to be discovered in each concrete instance, and the examination of many instances was only important

in so far as it aided the mind in detecting universal aspects of each situation by multiplying the unimportant aspects.

Similarly, the recognition of a necessary connection among the characters of events does not logically involve the examination of many instances. The function of multiplication of instances in induction is to accentuate the causally relevant respects of a given situation by as much variation as possible among the irrelevant respects, while the aspects which are suspected to be causally relevant are reproduced as far as possible in each instance. J.M.Keynes<sup>1</sup> expresses this by saying that the function of the multiplication of instances, is to increase the negative analogy among the class of events which is being investigated. Thus, the way in which scientists set about discovering a universal connection, is to take one instance of the connection as typical, and regard all other instances as throwing light on the given concrete situation. By means of comparing and contrasting the aspects in which the instances resemble and differ from one another, they are enabled to discern within the given typical instance, relations which were there before, but which are only apparent to the practised eye. The true aim of induction then, is not to establish general propositions, but to gain greater insight into the given concrete situation. It is true that the more precise and detailed our knowledge of a given situation, the more highly probable will be generalisations based on this instance, but increased knowledge of

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(1) J.M. Keynes, "A Treatise on Probability".



the given instance must come first.

The difficulty of dealing with scientific method lies in the fact that no investigator ever attacks his problem with a perfectly "empty" mind, so that the first step in any investigation presupposes a good deal of vague knowledge on the part of the investigator. Thus, in order to select "instances" of a causal connexion, he must have partly discerned the causal connexion within his key instance. After an examination of each added instance, he goes back to his given situation and reads it more clearly, though he may never attain his ideal, which is to discern within it universal connection among its characters. By way of illustration, we will suppose that an educationist wishes to discover if the direct method of teaching Latin is successful. The natural way in which such a problem would arise, is that the investigator has observed a total situation, a school, in which certain aspects, the teaching of Latin, interest him. He observes within the total situation, certain factors which he vaguely apprehends as being in causal connection, the use of the direct method in teaching Latin, and an unusual degree of proficiency in Latin in the scholars. He wishes to exhibit this causal connection clearly to himself and others, and to do this, he must show that the other factors which belong to it as a concrete state of affairs, are causally irrelevant to the particular aspect of the total situation, which interests him. This then, is his key



instance, and he first examines it carefully, to guide him in his selection of instances. His examination of the key instance shows him plainly that there are many other factors in causal connection with the total situation, "The teaching of Latin in this school". To pick out two only; there are the teachers, of a certain degree of proficiency, and there are the scholars, of a certain degree of intelligence. These aspects are certainly in causal connection with the total situation, but are they connected with the aspect under consideration, the unusual proficiency in Latin? Each instance which he selects will be compared with the key instance from this point of view. How does it compare with the given instance in these three aspects, the proficiency of the teachers, the intelligence of the scholars, and the method by which Latin is taught? Each instance examined will aid him in his analysis of the key instance. A school in which the teaching is good and the scholars intelligent, as in his key instance, but in which the direct method is not used, will show success in the teaching of Latin, but success of a different kind. The scholars will be well grounded in the grammatical constructions, and in their set books, but they will lack that lively interest in Latin as a means of expressing everyday wants and interests, <sup>therefore</sup> and they will lack knowledge of it as the speech of an active and intelligent race. He will thus learn to discern in his key instance, hitherto unanalysed aspects in

his total situation "successful teaching of Latin", and to discern the relations between its various aspects.

We have spoken of "discerning" universal connections among events, but how is it possible thus to perceive universal relations within experience? Hume analysed the experiences of the human mind, and could discover no perceptual correlate or "corresponding impression" to the idea of necessity, and we must admit that Hume was so far right. There is no perceptual correlate to any relation, spatial, temporal, causal or any other relation. We see "the book on the table" - we see the book, we see the table, but we do not see "on". What is perceived, is the total situation, which may be analysed into factors in relationship with one another. It might here be objected that in any instance of causal connection, what is experienced is spatio-temporal sequence, and that there is no further relation discoverable, such as a necessary relation. This is true. The recognition of necessary relations within experience is the work of the mind. What is perceived, is a sequence of events in spatio-temporal continuity, but within this concrete sequence, the intellect recognises certain universal aspects as in necessary connection with one another. Mr C.J. Ducasse, in his work on causation,<sup>1</sup> insists that the causal relation is observable. He defines the cause of a given event as the only change in relevant respects taking place in the environment, and in observing this change followed

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(1) C.J. Ducasse, "Causation and the Types of Necessity".

by the effect change, we are actually observing a necessary relationship. This is correct if observation includes abstraction and intellectual recognition of universal aspects within the given situation. Just as an equation contains all its implications for the mathematical mind, so a concrete situation displays its universal connections to an observer who possesses a good deal of knowledge of the characters of such a situation.

It was said earlier that our knowledge of relations between ideas, as in mathematics, was analogous to our knowledge of relations between matters of fact, in that knowledge of both kinds is to be attained empirically. There is one important distinction however, which must not be overlooked. In dealing with relations between ideas, we are dealing with characters which have no essential reference to events, and which may therefore be called "timeless". In dealing with causal relationships on the other hand, our characters which are in connection with one another bear essential reference to events. Our knowledge of triangularity is derived from events which are more or less triangular, but the idea itself can be understood and its implications deduced without reference to these events. On the other hand, such characters as "redness", "being a piece of iron", "being shot through the heart", have no meaning apart from some event which manifests them. It has always been recognised that such characters require space in which to manifest themselves, but Professor Whitehead points

out that they also require time. "There is no such thing as iron at an instant." These characters require essential reference to space-time in the sense that, though they can be contemplated without reference to a particular date and place, they cannot be contemplated without reference to space-time in general. Any character of events requires a certain region of space-time in which to manifest itself, so that it must be regarded as in some sense, a process, or rather, as the character of a process. What bearing has this distinction upon the necessity of the relations among such characters? With increase of scientific knowledge, our knowledge of these processes becomes more precise and accurate, so that our knowledge of the character "being a piece of iron" must be stated in terms of scientific objects, which by their regular or rhythmical ingression in events, make up the life of a piece of iron throughout a given region of space-time. Knowledge of characters of events, then, is of the nature of knowledge of laws of change, but laws of change which involve a more or less permanent factor. Thus, the character "being a human organism" can only be adequately described in terms of cycles of events, the cycle known as the "circulation of the blood", the breathing cycle, etc. The life of such an organism is not completely expressed in an instant - it requires a minimum of time in order to show the rate and direction of the movements which make up its life history. Complete knowledge of the human organism then, involves knowledge of it as a process,



but also of the process as recurring, so that at any given time, we know that the organism is at some stage in its cycle of events. If then, some other process of events comes into spatio-temporal contact with such an organism, the surgeon knows more or less completely which part of the cycle has been interrupted, and he can therefore deduce what will be the sequence of events following on the interruption. The fact then, that our knowledge of nature shows nature as fundamentally a process, seems to have no bearing on the question of the necessity of the causal relation, and the fact further remains that process must always be stated in terms of objects of some sort. At present, the ultimate objects are electrons, and for the physicist, process is stated in terms of electrons and protons. It remains to be seen if it will be discovered that these themselves are more accurately to be described as processes involving yet more ultimate types of entity.

Mr Ducasse is very insistent that a causal theory must be concerned with the single instance of causal connection, and not with causal laws, but what he does not recognise, is that a complete and accurate statement of any single instance of causal connection is itself a causal law, that is, if we regard the causal relation as connecting aspects of events, or rather, as connecting events regarded as possessors of the particular aspect we are abstracting. Mr Russell says: "But in order to ensure that the effect will recur, we must take

in more and more of the environment, until we have included the whole universe."<sup>1</sup> This is obviously assuming that if it were possible to duplicate the characters of the whole universe, the characters of the succeeding state of the universe must also be the same. This is so obviously impossible, that it may seem absurd to discuss it, but it seems to point to the fact that the contingency of the conclusions of inductive reasoning is not logically necessary but only follows from the immense complexity of the material with which induction deals. In this thesis, I have attempted to reduce this complexity in two ways: firstly by limiting the environment of an event to its spatio-temporal past, and secondly by limiting the characters of this past which must be considered, to the characters which are causally relevant to the effect character. Now to return to Ducasse's single instance. We are considering one single aspect of the concrete effect event, and have defined its causal past with reference to this aspect. The events lying within this causal past - i.e., on the surface of the cone as explained in the last section - are the only ones which need to be considered, and then only that aspect of them which is causally relevant to the effect aspect. In the precise statement of these aspects, we are stating a causal law, for we are stating the conditions which are necessary and sufficient to produce the effect aspect. That is to say, in

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(1) Proceedings of the Aristotelian Society, 1912-13.  
Presidential Address.

the precise statement of the single instance, the single instance is universalised, for all irrelevant aspects of both effect and cause events are left out of account, and the important aspects considered in abstraction. Thus, precise statement of a single instance of "shooting through the heart" followed by "death", is a universal causal law, for it would include only the character of the man's organism as it was relevant to such an effect, and the only causally relevant events in the environment would be physical objects moving at such a rate and in such a direction that they would reach the man at the moment that the change culminating in the man's death was originated. In this conception of the generalisation of the single instance, Mr Johnson's conception of "property" is valuable. The single instance possesses some quality in virtue of which it is an instance of a general law. Thus each single instance of arsenic, prussic acid, etc., possesses some quality in common, and it is the causally relevant property in a certain state of affairs, introduction into a living organism, and the events following after. The conception of the property of a continuant then, represents the most complete abstraction. "Being poisonous" is the only causally relevant aspect of one of the continuants involved in each single instance of poisoning.

It would seem then, that it is not logically necessary that reasoning from cause to effect should be contingent, and if this is so, it seems probable that if we could



discover a class of cases in which the causally relevant aspects are clearly distinguishable, then the precise statement of each instance will be the statement of a universal and necessary connection. Such a class of cases is to be discovered in the relative movements of material bodies. The causally relevant aspects are clearly distinguishable in such cases, and they are moreover measurable, so that they can be stated with almost complete precision. Given the mass of a material body, and the force with which it is sent out, the rate and direction of its motion can be deduced. Given two such material bodies, if they are moving towards one another, and knowledge of the material of which they are made is given, then the effect of a collision between the two could be calculated.

Any statement of causal law is, of course, elliptical. There are certain widespread conditions which have been discovered by experience to reign throughout nature, such as the law of gravitation, the atmospheric conditions belonging to each planet, etc. Any causal law, then, has implicit reference to these conditions, and if stated fully, would be hypothetical. "If the conditions shortly summed up as the law of gravitation remain constant, then a material body of mass  $m$  etc." These conditions could be included in the statement of each instance, but it is simpler to state them as one generalisation or universal law to which all material bodies are subject.



The conclusion from this discussion of the necessity of the causal relation seems to be that within the given instance of causal sequence, is to be discerned a necessary connection between the characters of the events in sequence; that increased knowledge of the instance results in a clearer perception of the universal connections between aspects within the situation, and that this increased knowledge is to be obtained through examination of many similar instances. The nature of the necessary connections is not, however, affected by the empirical way in which knowledge of them is obtained.

In accordance with these positions, Section I. is devoted to an analysis of the kind of sequence which commensurate as-  
 ments to be causal, and to a precise statement of the plain-  
 man's view of the causal relation. This leads to the conclusion  
 that any sequence, in order to satisfy the conditions implicit  
 in the commensurate notion of cause, must be spatio-temporal in  
 character, and must show some kind of necessary connection  
 between the characters of events in sequence.

### VII. Summary.

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The general attitude adopted throughout this thesis may be expressed briefly in the following propositions:-

- I. That the conceptions current in the commonsense view of nature must receive some meaning in a philosophy of nature, and that distinctions which are drawn among its conceptions by commonsense, must also be drawn by the philosopher, even though it may be on different grounds in the two systems.
- II. That the causal relation must be discoverable in the single instance.
- III. That the data for science, and therefore for the philosophy of nature, are revealed in perception as being of the nature of events or processes - i.e., they are spatio-temporal.

In accordance with these positions, Section I. is devoted to an analysis of the kind of sequence which commonsense assumes to be causal, and to a precise statement of the plain man's view of the causal relation. This leads to the conclusion that any sequence, in order to satisfy the conditions implicit in the commonsense notion of cause, must be spatio-temporal in character, and must show some kind of necessary connection between the characters of events in sequence.

Section II. deals with Mr Russell's treatment of causality, chiefly as departing from positions I and III as laid down above. I do not wish to assert that Mr Russell in his general philosophical position does not accept the third proposition, but that his rejection of what he calls the "philosophical notion of causation", depends to a large extent upon the separation of time from space.

In Section III, Mr Johnson's otherwise valuable treatment of causality, is seen to suffer from the fact that it was not worked out from the point of view of the modern assimilation of space and time. He recognises the importance of this step in science, but does not see that it necessitates a fundamental revision of concepts.

This necessity is recognised to its full extent by Professor Whitehead; Section IV.A. is an examination of his philosophy of nature as providing rational grounds for induction. IV.B. is an elaboration of the causal theory implicit in his system, according to which, causation is seen to be a mode of ingression of objects into events. Thus Professor Whitehead's causal theory is in intimate connection with his theory of objects.

In Section V. is an elaboration of the notion of spatio-temporal continuity, which is shown to be an essential condition of causal sequence. In this section, also, the "causal past" of an event in respect of certain characters is defined.

In Section VI. the necessity of the causal relation is discussed, and found to be a relation between characters as they are manifested in events.

In agreement with the foregoing discussions, the conditions under which the propositional function "A causes B", yields a true proposition, may be precisely stated. First, the function itself must be stated more accurately thus:- "In virtue of possessing character  $\alpha$ , A is the cause of B's possessing  $\beta$ ". This will yield a true proposition when:-

I. A is an event lying on the surface of the cone representing B's causal past in respect of  $\beta$ .

This might be called the " $\beta$ -causal past" of B.

II.  $\alpha$  and  $\beta$  are related in such a way that whenever an event possesses  $\alpha$  it will pass into, or be in spatio-temporal continuity with an event possessing  $\beta$ .

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