CORRESPONDENCE

To the Editor of the *Journal of Philosophical Studies.*

The Psychological Import of Periodicity in the Conception of Time.

Sir,

There are few, if any, words in the English language which we use more frequently or in a greater variety of reference than Time. The same remark applies to its equivalent in other languages, and it is a notable fact that its use is very seldom, if ever, accompanied by any of the obscurity or ambiguity which attends the employment of many other general terms.

But although that is so, it is nevertheless practically impossible to find an explanatory definition of time. In most dictionaries its meaning is given as "duration," but that is merely the offer of an equivalent term, and supplies us with no information as to what time really is.

The reason of this somewhat remarkable paradox is to be found in the fact that time seems to describe an immediate datum of our conscious experience, and that accordingly it is difficult to find any more elementary concepts by means of which its real meaning can be explicated.

An interpretation of time can, therefore, only be reached by an analysis of the other fundamental concepts with which our minds are furnished and equipped by the experience of conscious life. The celebrated philosopher Kant, in his doctrine of the transcendental æsthetic, described space and time as the framework or mental furniture with which our conscious intelligence is equipped, and under which the data of sensation are apprehended by consciousness and thus co-ordinated into knowledge. But, after all, and with every respect for that remarkable man, he does not seem to have supplied us with any really useful information about space and time beyond what was already accessible to and generally apprehended by many of his predecessors. Few of those who have reflected on the problem of knowledge since Descartes have failed to discover that space and time are in a special and definite way the universal framework of our knowledge of the sensible external world of our experience. But they do not always, with Kant, consider these to be constituents of the recipient mind, and it can hardly be maintained that the most profound subsequent reflection has confirmed the view that space and time are to be regarded as subjective and *a priori* elements of cognition rather than as the universal and fundamental characters of our objective experience.

Space, as everyone knows, is composed of three dimensions. Time is generally held to consist of one dimension only. The spatial description of any physical object is completed when we are furnished with its length, breadth, and depth. It is possible to reason algebraically in regard to the conditions of space of four or five or *n*. dimensions. But whilst we can actually image space of one dimension—a line—or of two dimensions—a superficies—it is impossible for us to frame any image of a space of more than three dimensions.

The position of a stationary point in space is given when three co-ordinates are supplied. But if the point is in motion a further fourth one is necessary, and such one is temporal.

Lagrange, who introduced the idea of the fourth dimension, employed the notation x.y.z.t. This led mathematicians to treat time as in their calculations equivalent to a fourth dimension. Recently this has led a number of psychologists to imagine that time can properly be regarded philosophically as a fourth dimension of space of the same nature as the three Cartesian co-ordinates. Any such idea is, however, quite unwarranted, and in no way justified by the mathematical method of determining the position or path of a point in motion.

These considerations, however, enable us to procure some useful light as to the nature of time.

In the first place, it becomes clear that time is in some way or other closely related to motion, and indeed if a conscious intelligence could be imagined as placed in an absolutely motionless universe, it is certain that it could never acquire any idea or any knowledge of time.

In the second place, it is evident that time is something quantifiable and measurable. Now before anything can be measured a unit of computation must be found and fixed on. In the case of time, such unit must be a motion. The motion of the sand in an hour-glass, so called, is an example; the swing of a pendulum is another; the rotation of the earth on its axis is a third.

In order to effect measurement it must be possible for the unit to be repeated. Having fixed upon an inch as a unit of length, it must be possible to ascertain the number of inches in the object to be measured if we are to accomplish its measurement. In like manner as to time, the unit motion must be one which is repeated, and the length of time is ascertained in one way only, namely, *by counting the repetitions of a repeated motion.*

Throughout nature there is no scarcity of such repeated motions—indeed, the whole universe is full of them.

In astronomy this phenomenon is named the law of periodicity. It is exemplified in the rotation of the earth on its axis in its revolution round the sun and in all the other curvilinear motions of the heavenly bodies.

The periodicity of these motions determines the character of the living organisms affected by them. There can be no doubt that the vegetable world exhibits life as affected principally by the earth's annual revolution; the animal world life as affected more closely by the diurnal rotation.

Periodicity characterizes all living organisms. Very evident in plants, it still more dominates animals. Breathing, walking, the heart's pulsation, waking and sleeping, doing and resting, rhythm in song and dance, attest its prevalence. The artificial systems of time-measurement, which spread like a network over every department of civilized life, are composed entirely of instruments for thus counting and enumerating repeated motions.

Now how is this periodicity to be accounted for? It is a consequence, we have seen, of the curvilinear motion of the heavenly bodies, and that curvilinear motion is due to the action of what we—following Newton—call "the force of gravitation," acting on material masses endowed with kinetic energy. Had these bodies not been acted on by this force, we know that, in accordance with Newton's law, those material masses being endowed with kinetic energy, would have continued to move on uniformly in a straight line. On the other hand, had the force of gravitation acted on bodies not endowed with kinetic energy, it would have drawn them speedily to a centre where their motions would have ceased.

(1) Material bodies endowed with kinetic energy; and (2) the force of gravitation: these two phenomena are both necessary in order to give us the fundamental conditions under which our whole solar system is maintained, and the primary conditions of the life of all living things are determined.

https://doi.org/10.1017/S0031819100028400 Published online by Cambridge University Press

Fundamentally, every individual endowed with life, whether a plant or an animal, is, if we might so say, a unit of periodicity, without which life and knowledge are impossible.

ALEX. PHILIP.

THE MARY ACRE,
BRECHIN, N.B.

NOTE IN REPLY BY MR. WALLIS CHAPMAN

The first impression on reading this communication is, "This is no use, we knew it all before!" but such a view is unjust. It is true that Mr. Philip's writing is not that of a man who gives consideration to recent work on this subject, but he has clearly given much thought to the older writers, and the newer ideas are by no means so complete or so conclusive that there is no gain in putting the older point of view afresh for reconsideration.

The chief criticism that I should make on Mr. Philip's paper is that his analysis is insufficient. The word time has more ambiguity than he is willing to allow it. It covers several conceptions, closely connected, it is true, so that the use of the word time to cover all of them is justifiable, but distinguishable, so that it is necessary to separate them to consider the nature of the connection.

I will consider three passages in his notes: "time seems to describe an immediate datum of our conscious experience"; "if a conscious intelligence could be placed in an absolutely motionless universe, it is certain that it could never acquire any idea or any knowledge of time"; and "it is evident that time is something quantifiable and measurable." Now it may fairly be asked, Can the time which is "an immediate datum" of our conscious experience be identified with the time which is "quantifiable and measurable?" and can "an immediate datum of conscious experience" be derived from a knowledge of motion?

There is a preliminary criticism to be made on the second quotation. What is essential to time is not so much motion as change. An intelligence situated in a world showing, for example, changes in colour, could construct a time-order without the idea of motion, *i.e.* of the successive appearance of groups of events showing a particular type of continuity in different parts of space.[1]

Now the perception of change seems to be not so much an immediate datum as the recognition of the connection of four such data. These may be roughly described as simultaneity, succession, memory, and expectation. Simultaneity and succession are relations immediately perceived in the "specious present." It is much harder to give an account of memory and expectation, which involve some of the most difficult of philosophical questions, but this much is clear, that they imply relations continuing the order given by succession, and that in this way we obtain an order within our own experience, which we call the time-order. So far we have only considered individual experience, and it was formerly held that in order to correlate these experiences and avoid solipsism this order must be the same for all observers. With such a theory the conception of time as a fourth dimension added to the three dimensions of space was useless. The essence of the theory of relativity, in so far as it concerns time, consists in the idea that this correlation can be effected by supposing that the time-orders of different observers, though not necessarily the same, are so connected that,

[1] It is true that we assign motions as the cause of changes in colour, but this is a different and subsequent question.

given the time-order for one observer and the relation between him and a second, the time-order of the second observer is determinate. The study of the relations of these different time-orders is the study of the geometry of the space-time manifold. In this way the treatment of time as a fourth dimension becomes consistent with the recognition of the specific nature of the feelings on which our conception of time-order is based.

But the time relations thus constructed cannot be considered as identical with those of our individual experience. Whitehead says[1]: "There are certain objections to the acceptance of Einstein's definition of simultaneity, the signal-theory as we will call it. In the first place, light-signals are very important elements in our lives, but still we cannot but feel that the signal-theory somewhat exaggerates their position. The very meaning of simultaneity is made to depend on them. There are blind people, and dark cloudy nights, and neither blind people nor people in the dark are deficient in a sense of simultaneity. They know quite well what it means to bark both of their shins at the same instant." In other words, the simultaneity of direct perception is not the same relation as the simultaneity of physics.

But, given time as an order, is it necessarily "quantifiable and measurable"? To terms arranged in one dimensional order, the real numbers, or a suitable selection of them, can always be so correlated that to the later of two terms in the order there corresponds the larger of the two corresponding numbers, but this, though necessary for measurement, is not sufficient. For measurement we need a unique correspondence of the type described, but there are always an infinite number possible. As a rule the appropriate relation is easily determined by practical, *i.e.* empirical, reasons, but this is not always the case, and difficulties may ensue.[2] In the case of time, the further conditions necessary to determine the correspondence we require are, as Mr. Philip truly says, given by the repetitions of a repeated motion, but this conception requires more examination than he has given to it. As he says, the whole universe is full of such motions; which of them is to be chosen? By what right do we invent a "mean sun," which no one ever saw, and say that the intervals between its crossings of the meridian are equal, whereas those given by the real sun are not? Why indeed should we take our time from the sun at all, and not from, say, successive earthquakes? Or why should the beating of the heart be considered regular and the intervals between sneezes irregular? The answer is, of course, that we find that a large number of types of repeated motions give us fairly concordant measurements of time.

Mr. Philip's reduction of repetitions of this type to gravitational motions appears a little too summary. He leaves out of account such mechanical motions as the vibration of springs. Many repetitions occurring in living organisms would appear to be more closely connected with these than with the length of the day; the pulsations of the heart, for example, would appear to depend on the time the blood takes to traverse the tissues, which is controlled by a variety of mechanical and biochemical causes. We can, however, find a characteristic of such concordant motions. Each is connected with a system which is apparently more or less isolated, and returns to its original state when the period is complete. In so far as the isolation is defective, we have to correct the time reckoning as given by the system. The earth as a rotating body is a rough approximation to isolation,[3] so the

[1] *Principles of Natural Knowledge*, p. 53.

[2] Cf. Keynes, *Treatise on Probability*, p. 45.

[3] That is, if the sun is considered only as an external index not affecting the earth's motion.

days are roughly equal. The earth-sun system is more nearly isolated, so the mean sun gives us a better measure, but this has to be corrected for tidal retardation and planetary perturbations. The human body, as a self-protecting organism, is comparatively isolated, so heart-beats and breathing give concordant results, but they can be upset by external influences. In the case of a sneeze, on the other hand, the isolation has broken down, and we can find no suitable isolated system. Earthquakes do not give a measure of time, because after an earthquake the rocks are not in their previous state.

We thus have a common character of sets of motions giving time-measurements concordant with each other, but this does not explain why they should do so. Perhaps the answer lies somewhere in the region of Weyl's theory, connecting gravitation with electro-magnetism, and thus with atomic and molecular structure, but such a theory cannot be developed at present. In the meantime it is worth remembering that, according to the theory of relativity, the time-measurements of different systems are not identical, only interconnected.

After all that has been said, there remains the fundamental epistemological question, How can we connect our private experience with an external physical world? I am not prepared to answer this, but perhaps these notes may help to show the relation of this question in the case of time to the form which it takes for other aspects of our experience and of nature.

H. WALLIS CHAPMAN.

CAWTHORNE, JORDANS,
BEACONSFIELD.

https://doi.org/10.1017/S0031819100028400 Published online by Cambridge University Press