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The significance of time

THE CONCEPT OF TIME has never ceased to intrigue and puzzle those who think about it. We feel that, whatever happens, time must go on unceasingly and yet, when we come to analyse it, we find good reasons for rejecting the idea that time exists in its own right. We regard time as the order in which events happen. Consequently, if there were no succession of events, there could be no time. 'What did God do before He made Heaven and Earth?' asked St Augustine. He rejected the facetious answer that God was preparing hell for those who pry into mysteries! St Augustine's answer was that before God made heaven and earth he did not make anything. Time was made along with the heaven and the earth.

The intimate association of time and the universe can be traced back to Plato, the philosopher who exercised such a great influence on St Augustine. In Plato's cosmology, as set out in his dialogue the *Timaeus*, the universe was fashioned by a divine artificer who imposed order on primeval chaos by reducing it to the rule of what nowadays we call natural law. In Plato's view, the pattern of law was provided by ideal geometrical shapes in a state of absolute rest, and therefore essentially *timeless*. Whereas space was regarded by Plato as a pre-existing framework into which the universe is fitted, time was itself produced by the universe. For the universe, unlike the eternal ideal model on which it was based, is subject to change, and time is that aspect of change which bridges the gap between the two (the material universe and its ideal model), being, in his famous phrase, the 'moving image of eternity'.

Plato's antipathy to all research that involved the temporal material world led him to criticize people like the Pythagoreans who investigated problems of musical harmony and acoustics empirically. In an amusing passage in the *Republic* he pokes fun at them for wasting their time in measuring audible sounds and concords.

They lay their ears to the instrument as if they were trying to overhear the conversation from next door. One says he can still detect a note in between, giving the smallest possible interval, which ought to be taken as the unit of measurement, while another insists that there is now no difference between the notes. Both prefer their ears to their intelligence.

Plato was convinced that 'heard melodies are sweet, but those unheard are sweeter' – an attitude that was deeply influenced by the work of an earlier philosopher, Parmenides, the founding father of strict deductive argument and logical disputation. Parmenides submitted the ideas of becoming and perishing to acute criticism and concluded that time does not pertain to anything that is truly 'real', but only to the logically unsatisfactory world of appearance revealed to us by the senses.

Parmenides' belief that temporal flux is not an intrinsic feature of the *ultimate* nature of things has been tremendously influential. It is not only idealist philosophers who have claimed that the temporal mode of our perception has no ultimate significance. Even so empirically-minded a thinker as Bertrand Russell, although he rejected the arguments by which these philosophers have sought to justify this conclusion, made the following admission in his well-known essay on 'Mysticism and Logic': 'There is some sense – easier to feel than to state – in which time is an unimportant and superficial characteristic of reality. Past and future must be acknowledged to be as real as the present, and a certain emancipation from slavery to time is essential to philosophic thought.' Alas, even philosophers are men like the rest of us. An amusing story is told of the Russian philosopher Nicolas Berdyaev, who, after he had pleaded passionately for the insignificance and unreality of time, suddenly stopped

and looked at his watch with genuine anxiety, fearing that he was a few minutes late for taking his medicine!

It is notorious that most philosophers have regarded time as a thoroughly unsatisfactory concept. The French psychologist Pierre Janet remarked some forty years ago, in his book on time and memory, that, whenever stress is laid on logic and reason, time tends to be unpopular. Philosophers usually have a particular horror of the concept and have done all they can to suppress it. Nevertheless, it is only fair to point out that many mathematicians and physicists, too, have been sceptical about the ultimate significance of time and have been far more favourably inclined to spatial concepts. To some extent this may be because space seems to be presented to us all of a piece, whereas time comes to us bit by bit. The past must be recalled by dubious aid of memory, the future is unknown, and only the present is directly experienced. Even Einstein, who made the greatest contribution since the seventeenth century to the understanding of time when he formulated his special theory of relativity, later became decidedly wary of the concept, as we have seen, and came to the conclusion that physical reality should be regarded as a four-dimensional existence rather than as the *evolution* of a three-dimensional existence. In other words, the passage of time is to be regarded as merely a feature of our consciousness that has no objective physical significance. This sophisticated hypothesis makes the concept of time completely subordinate to that of space.

But time has certain important characteristics that clearly distinguish it from space. Apart from its one-dimensional nature, the two principal features peculiar to our conception of time are its arrow and its passage. Whereas time's arrow depicts the irreversible before-and-after succession of events, time's passage refers to the distinction that we make between past, present and future. These two closely associated properties must not be confused.

The before-and-after series is a permanent series in the sense that, if the statement 'B occurs after A' is true, it is always true. For example, the statement that the Battle of Waterloo occurred after the Battle of Hastings is a permanent truth. The before-and-after series

is the way in which we normally *contemplate* a chain of events in time. It is a method of ordering analogous to numerical ordering and is compatible with the 'block universe' idea. On the other hand, the series of past, present and future characterizes the way in which we actually *experience* events. Unlike the before-and-after series, it is a changing series and gives meaning to the concept of occurrence. The fact that it is a changing series – that what happens now was once future and will be past – leads us to make statements that are not permanent truths. For philosophers this changing series has frequently been such a source of perplexity that many of them have concluded that it must be an illusion – a view that was held by the Cambridge philosopher M. J. E. McTaggart. The foundation of his argument was his contention that an event can never cease to be an event. 'Take any event,' he wrote, 'the death of Queen Anne, for example – and consider what changes can take place in its characteristics. That it is a death, that it is the death of Anne Stuart, that it has such causes, that it has such effects – every characteristic of this sort never changes.' McTaggart argued that from the dawn of time the event in question was the death of a Queen. He went on:

At the last moment of time – if time has a last moment – it will still be the death of a Queen. And in every respect but one, it is equally devoid of change. But in one respect it does change. It was once an event in the far future. It became every moment an event in the nearer future. At last it was present. Then it became past and will always remain past, though every moment it becomes further and further past.

McTaggart argued that, although past, present and future are incompatible, they must apply to every event. One might make the obvious retort that events do not have these characteristics simultaneously but successively, in which case McTaggart could easily counter with the argument that our statement that an event is present, will be past, and has been future, means that the event is present at a moment of present time, past at a moment of future time, and future at some moment of past time. But each of these moments is

itself an event in time and so is both past, present and future: in other words, the difficulty breaks out all over again and we are launched on a vicious infinite regress. McTaggart concluded that time is an illusion. This conclusion is, in my opinion, a non-sequitur. McTaggart's error was to treat the happening of events as if it were a form of qualitative change. But time is not itself a process in time.

Although in recent years few people have been influenced by McTaggart, a number of philosophers and others have argued that the transitional aspect of time is purely subjective. They do not regard it as a characteristic of physical time itself but only of our perception of time. In particular, they claim that our concept of 'present', which we signify by the word 'now', is merely the temporal mode of our personal experience, so that if there were no such experiences there would be no 'now'. This point of view is adequate for a great deal of physics and other sciences, so long as dates are irrelevant and the particular time at which an experiment is performed does not matter. In such cases, when classifying events temporally it is sufficient to concentrate on the relations of 'earlier than', 'later than', or 'simultaneous with'. On the other hand, for the meteorologist engaged in forecasting the weather, the precise distinctions between past, present and future are vital. Similarly, for the palaeontologist studying the fossil record in terrestrial rocks, not only are dates relevant but the distinction between past and present dominates his thoughts, since the overall effect of evolution appears to be irreversible.

Nevertheless, some philosophers have argued that one cannot define the present except by reference to itself. The present, they would argue, is simply our 'now', and as this is a circular definition there is no reason to suppose that what it defines has objective significance. They therefore conclude that we should restrict the concept 'now' to our mode of perception. Instead of accepting this view, can we establish the objectivity of past, present and future?

First, let us consider what we mean by simultaneity and the present. In the terminology introduced into relativity theory by Minkowski, two events on the respective world-lines of two distinct

individuals *A* and *B*, whether living or inanimate, are simultaneous if they are located at a point of intersection *O* of their world-lines. To establish the objectivity of a phenomenon, we usually try to show that it is not just a peculiarity of a particular person's experience. For example, one fine night in November 1572, the famous Danish astronomer Tycho Brahe, who knew the starry skies like the back of his hand, saw to his surprise a bright star (it was in fact what we now call a 'supernova') where no other star had ever been seen before. His doubts concerning its objective existence were resolved when he found that other people (his servants and some peasants driving by) saw it, too. Similarly, if the concept of the present is objective, any *A* and *B* when at the same *O* must have the same 'now'.

What would it mean if *A* and *B* had different 'nows' when they are simultaneously at *O*? Since, for this purpose we cannot usefully compare any purely internal feelings of presentness, because they are subjective and we are seeking to establish objectivity, we must concentrate on external physical events and the relation of the individual to the environment. An individual's 'present' can be defined as all that which interacts with him at a given instant. It is a relation between an individual and the rest of the universe, being all that which is happening to him at a given instant – all that which is in fact present for him. This definition does not necessarily imply self-awareness and can be applied to any individual, inanimate as well as animate, so long as it is capable of interacting with its environment.

Having defined the present in this way, can we show that it is an objective concept? Clearly, the only point in claiming the opposite would be if two individuals (animate or inanimate) could simultaneously have different 'nows'. This would happen if when *A* and *B* are together at *O* they were to have incompatible interactions with their environments. Suppose *A* is a mirror capable of reflecting light that falls on it and *B* is a human being. If *A* were to present a view of trees in winter without foliage when *B* sees the same trees in full leaf, we could interpret the discrepancy as evidence that *B*'s 'now' is out of phase with *A*'s.

In practice, we do not normally¹ encounter this kind of discrepancy, and the physical world would be much more complicated if we did. We have therefore no reason for rejecting the commonsense assumption that *A* and *B* have a common 'now', and from this it follows that the distinctions we make between past, present and future are not merely subjective.

It has already been shown that acceptance of the theory of relativity does not compel us to regard the order of events in time as wholly dependent on the observer. For, as we have seen, the theory actually allows an objective time-order for a wide class of events: namely those which can interact with or influence each other. Consequently, in defining the concept of the present for any observer in terms of his interaction with his environment we are not in conflict with relativity. Moreover, if the universe admits a common cosmic time for observers fixed in the galaxies, then in terms of this cosmic time all events have a unique time-order. From the point of view of the fundamental observers there is a common linear world-time time-order and a clear-cut distinction between past, present and future. We come back to Plato's idea that time and the universe are intimately associated.

Atoms of time

The concept of time that has prevailed in the last few centuries is based on the idea of linear advancement, but it also assumes that time is homogeneous and continuous. The plausibility of these assumptions was not only greatly strengthened by the development of precise methods and machines for the measurement of time, but also more subtly by the general decline of belief in traditional temporal associations of a magical rather than a scientific nature. It is true that the notions of lucky and unlucky days and of climacteric

1. Hallucinations, optical illusions, etc. being ruled out as fake evidence, and allegedly paranormal phenomena rejected.

years – those periodic dates in a man's life which were potential turning-points in his health and fortune and were based on the doctrine that a man's body changed its character every seven years – were all rejected by the medieval Church. But the ecclesiastical calendar also tended to encourage belief in the uneven nature of time.

In the seventeenth century many of the traditional practices enshrined in this calendar, such as the observance of Lent and the celebration of saints' days, were attacked by the Puritans, who advocated instead strict adherence to a regular routine of six days of work followed by a day of rest. By the end of the seventeenth century this routine had become generally accepted in this country. According to Keith Thomas, who has made a thorough investigation of popular beliefs in sixteenth- and seventeenth-century England in his book *Religion and the Decline of Magic*, this change in working habits was 'an important step towards the social acceptance of the modern notion of time as even in quality, as opposed to the primitive sense of time's unevenness and irregularity'. Nevertheless, a relic of this more primitive conception of time survived in the strict observance of Sunday as a day of rest that was still rigorously enforced in many households within living memory.

Belief in the unevenness of time was more natural in the past when society was essentially agrarian and dependent on the seasons for its pattern of living. The medieval Christian almanac, with its emphasis on the *year*, was based on the needs of this type of society, whereas the Puritan insistence on a rhythm of living based on the *week* was more natural to those who worked in towns instead of being tied to the soil. During the latter part of the seventeenth century developments in economic life began to prevail over the traditional seasonal routine and this made for general acceptance of the scientific idea of homogeneous and continuous time.

Nowadays most of us tend to accept automatically the idea that time is continuous because we believe in the continuity of our existence. Until the present century it was also possible to believe in the continuity of matter and energy, but with the establishment of the atomic theory of matter and of the quantum theory we have been

compelled to abandon these beliefs. In recent years the continuity of time has occasionally been called in question, although in this case it is too soon to say what the ultimate decision will be. Instead of time being infinitely divisible it has been suggested that, like matter and energy, it may be atomic or granular in structure. This speculation is linked with a similar idea concerning the nature of space. It has been claimed that a minimum spatial displacement may be about a million millionth part of a millimetre (corresponding to the effective diameter of a proton or electron). If this is so, then a corresponding minimum time – the *chronon* – might be the time required for light (the fastest moving thing) to cross such a distance. This would be about the million millionth part of the million millionth part of a second (10^{-24} sec). Of course, if the chronon exists it would be a minimum value of proper time and owing to time dilatation would appear relatively shorter to a moving observer.

If time does consist of a sequence of 'atoms' as short as this, it would, for all practical purposes, be virtually continuous. Nevertheless, from the theoretical point of view, however small its magnitude may be, the possible existence of the chronon is a revolutionary idea that calls into question a fundamental feature both of the scientific idea of time that has prevailed in recent centuries and of the popular conception of time that most people accept intuitively.²

Precognition and the nature of time

Another of the traditional properties of time that has also occasionally been called in question in recent years is its unidimensionality. Some investigators of extrasensory perception have argued that

2. Many people have difficulty in imagining time to be 'atomic' in structure because they believe that this would imply the existence of temporal gaps which must themselves be a part of time in contradiction of the hypothesis. On the contrary, however, the 'atomicity' of time refers only to the *indivisibility* of the chronon. In principle, chronons could be imagined as being like a row of pebbles which touch each other, so that there would be no gaps between them.

linear time is inadequate to account for all events in our world. In particular, the idea that time may have more than one dimension has been invoked by J. W. Dunne, in his well-known book *An Experiment with Time*, to justify his claim that occasionally in dreams future events in our waking life are experienced as pre-presentations. An event *P* might precede an event *Q* in the familiar time-dimension and yet *Q* might precede *P* in another time-dimension. Consequently, if *P* were the precognitive impression of event *Q* – for example, a dream concerning the occurrence of *Q* before *Q* actually occurs – it would be intelligible to say that *Q* determines *P* if it occurred before *P* in the second dimension of time.

Any hypothesis of this kind involving a second dimension of time is difficult to accept because it means that we should have to cope with the puzzling notion of a double 'now', for what is 'now' in one respect, or dimension, could be 'past' or 'not yet' in the other. Worse still, it would lead to the following curious situation.

Suppose I precognize an event which is to occur next Sunday. In one respect – that is to say, in one dimension of time – this event has not yet come into being: it is still future and does not yet exist. But in another respect, or second dimension of time, it is past and so has already come into being. It is, so to speak, half-real, since it has partially come into existence but not entirely. Not until next Sunday will it receive its second instalment of being, and then be completely real. But will it? For these two parts of its being are in fact out of step, because what begins to be in one dimension of time will already be long past in the other.

The possibility of precognition has been rejected by the Cambridge philosopher C. D. Broad who argued that the phrase 'future event' does not describe an event of some special kind, as the phrase 'sudden event' or 'historic event' does. Instead, a future event is nothing but an unrealized possibility until it comes to pass and therefore can itself influence nothing, although the present *knowledge* that there will be such an event can influence our actions when it is called to mind. An event which seems to 'fulfil' an earlier experience and make it appear precognitive cannot possibly help to determine the

actual occurrence of that experience. Consequently although there may be cases of apparent precognition, they cannot be genuine perceptions, and the hypothesis of two-dimensional time is certainly not required to explain them.

The transitional nature of time

Genuine precognition, in the sense of our being able, in certain circumstances, to perceive future events before they actually happen, might perhaps be possible if we inhabited a block universe in which, as I said before, physical events do not suddenly occur but are there waiting for us to experience them. This idea has already been rejected on the grounds that past, present and future are in fact objective characteristics of physical events. But the block-universe hypothesis has strange implications for mental events, such as our conscious perceptions and our decisions to perform physical actions. In a block universe, as we have seen, past, present and future do not apply to physical events, and so they neither come into existence nor cease to exist – they just are. But whatever kind of universe we inhabit, mental events certainly come to be and cease to be in our personal experience. Therefore, if we inhabited a block universe, mental events would have a completely different kind of existence from physical events. This would have the most peculiar consequences for cause and effect. In purely physical causation, an effect would not actually be produced by its cause, it would merely be further on in time. But mental causation of a physical event – such as deciding to drop a stone into a pond – would mean that a cause (in this case, the decision to drop the stone) suddenly comes into being, but the effect (the splash when the stone strikes the water) would not: it would just be. Such a strange difference between cause and effect would be completely incomprehensible.

If physical events are there eternally, how could we get the illusion that they are not? Surely, we have the faculty for temporal awareness of successive phases of sensory experience because our minds are

adapted to the world we live in and this is a constantly changing world. The objections that are brought against the transitional nature of physical time are a rearguard action in favour of the age-old belief in the essentially unchanging character of the universe and the ultimate insignificance of its temporal aspect. So far from the transience of time being an inessential, because purely subjective, characteristic, the ultimate significance of time is to be found in its transitional nature. For, just as the reason for the existence of evil in a moral universe must be that without evil there could be no good – since there would then be nothing to contrast good with and thereby give meaning to the concept – so without the fact of transience there could be no significance in permanence.

To conclude: although our perception of time has many subjective and even sociological features, it is based on an objective factor that provides an external control for the timing of our physiological processes. This objective factor is what we call physical time. It is an ultimate feature of the universe and its relationship with observers, particularly fundamental observers, which cannot be reduced to anything else. But this does not mean that it exists in its own right: it is an aspect of phenomena. The essence of time is its transitional nature. That this has given rise to so much argument down the centuries is not surprising, for, in the words of Whitehead, 'it is impossible to meditate on time and the mystery of the creative passage of nature without an overwhelming emotion at the limitations of human intelligence'.