Could Time be Change?

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Abstract
Sydney Shoemaker argues that time without change is possible, but begs the question by assuming an, in effect, Newtonian absolute time, that 'flows equably' in a region in which there is no change and in one in which there is. An equally possible, relativist, assumption, consistent, it seems, with relativity theory, is that where nothing changes there is no time flow, though there may be elsewhere, where there is change. Such an assumption would require some revision of uncritical common thought about time. Aristotle argues that there is no time without change but that time is not change. His arguments for the latter can be faulted both internally and again in terms of the same relativist assumption. From the *Physics* we can derive, though Aristotle himself did not, an argument that time is to change as geometrical space is to body: the thing itself in abstraction.

Could time be change? Not if Sydney Shoemaker's argument in 'Time without Change' holds. Shoemaker envisages a world in which there are three regions, each observable from each of the others, and in which each region in turn, at regular intervals, suffers a complete freeze, so that nothing, no change, occurs in it through an interval as observed from each of the other regions. The inhabitants of the frozen region will not, from their unchanging selves, know that time has passed, but may be informed later from the other regions that it has. The freezings are so regularly arranged in order that, as each region in turn freezes, two simultaneous freezes may, at regular intervals, be observed from the third region, A and B observable from C, A and C from B, and B and C from A. It follows that, at regular intervals, all three regions must expect to be frozen at once, though in such a case there could be no observer because no one and no thing would be unfrozen. If, for example, A freezes every third year, B every fourth and C every fifth, all freezes lasting one year, then A and B will freeze every twelfth, A and C every fifteenth, B and C every twentieth, and all three every sixtieth year. Shoemaker takes this thought experiment to show that time without change – absolute time, as we should certainly call it – although not directly observable, could be established inductively, from what is observable, as possible.[1]

[1] Sydney Shoemaker, 'Time without Change', *Identity, Cause, and Mind*, expanded edition (Oxford: Oxford University Press, 2003), 49-56. Originally published in *Journal of Philosophy* **66** (1969).

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Michael Scott, in 'Time and Change', argues against this view, upholding the contention, which he finds in *Wittgenstein's Lectures*, Cambridge 1932-1935, that changeless intervals of time make no sense. Scott argues that the freeze in one or even two regions, being always observed, gives us no ground for concluding that freezing can occur in all three regions, when observation is impossible.

> The image of a total freeze that is suggested by one or two areas freezing is of someone looking in on this world and seeing that it is frozen while [say] a year of real time passes. Such a perspective is, of course, unavailable [in a total freeze], because, as was stipulated, there is no change by which to measure the time elapsed.[2]

It might occur to one to say here, against Scott, that the point is not that there is no one or nothing to register the freeze but that, in Shoemaker's favour, such registering being reliably made where possible, and given the routine regularity of the freezes, it simply follows that the total freeze must be expected to occur, so that it seems the possibility of changeless – that is, absolute – time is established, though no such time can be directly observed. But Scott might reply that there would still be no way of establishing if, or for how long, a freeze occurred. There is, I think, beyond this a yet more fundamental objection to be made to Shoemaker's argument, and that is that he assumes changeless time to begin with – that is, that he begs the question.

It is usual enough for us to think that time must be relative, not absolute, precisely on the ground that absolute time is, even in principle, unobservable, which is why, of course, Shoemaker must try to establish the possibility of changeless time by this roundabout method of argument. But, though we may think that time must be relative to things happening, and it is not the case that it 'flows equably without relation to anything external', it is quite another thing to come to terms with the kind of thinking that that calls for, though Einstein's relativity of simultaneity and the slowing down of time in accelerated frames should nudge us in that direction – Shoemaker makes a point of noting that he is not particularly considering arguments that might be influenced by 'recent developments in

[2] Michael Scott, 'Time and Change', *The Philosophical Quarterly* **45** (1995), 216. In this paper Scott also opposes the contention of Roger Teichmann in 'Time and Change', *The Philosophical Quarterly* **41** (1991), 158-77, that 'statements about changeless duration can be shown to be intelligible given a Wittgensteinian account of meaning' – Scott, 213.

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physics, e.g. relativity theory'.[3] We tend to fall back on absolutist thinking, and suppose time to flow 'equably' in all systems, regardless of change or no change. And this, I think, is what Shoemaker has done.

He admits, in a sense anticipating Scott's criticism, that another possible way of accounting for the phenomena in this world 'is equally compatible with the generalization that freezes occur with these frequencies *with the exception* that all three regions skip a freeze every fifty-nine years' or that the freezes in each occur in cycles that have this same effect, so that it is not implied that 'there are ever freezes in all three regions at the same time'.[4] However, he rejects this possibility:

> Now it seems to be generally agreed that if two hypotheses are compatible with the same observed data, we should prefer the simpler of the hypotheses in the absence of a good reason for preferring the other. And the first generalization stated above seems clearly simpler than the second.[5]

But now we may ask why it seems clearly simpler – that is, on what assumption it seems simpler. It seems to be the assumption that if there is time in one place, there is the same time in another, distant, place, whether anything is happening in that other place or not – the same year as passing in B occurs in A, though everything in A is frozen – that is, it is the assumption of changeless or absolute time. But since it is the possibility of precisely this that Shoemaker is arguing for, it cannot be assumed in the argument without begging the question. The most that Shoemaker's argument can prove is that *if* time is changeless or absolute, some such situation as Shoemaker envisages is possible. But that is hardly of much consequence, since, if there is changeless time,

> then it may seem compatible with my total experience that any number of such intervals, each of them lasting billions of years, should have elapsed since I ate my last meal, despite the fact that the hour hand of my watch has made only one revolution and the fact that my lunch is still being digested'.[6]

[3] Shoemaker, op. cit., 54. In the same place he allows himself 'to consider "possible worlds" in which the physical laws differ drastically from those which obtain in the actual world'.

[4] Shoemaker, op. cit., 58.

[5] Shoemaker, op. cit., 59.

[6] Shoemaker, op. cit., 52.

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Shoemaker does not prove the possibility of changeless time; he assumes it. But another assumption is entirely possible: time is not absolute but relative to things happening, to change – and if no change occurs, there is no time. This would lead us to conclude that, instead of a year of changeless time passing, in say region A, there is no time there, or only an instant during which nothing happens – which is no time at least in the sense of no time passing, no interval of time – while a year passes in, let us say, B. If then there is some way for A and B to arrive at an agreed temporal measure, time in A will go consistently slower than time in B, since A has such an instant more often than B does. Now that time should go slower in one frame than in another is not such a strange thing for anyone acquainted, even cursorily, with relativity theory. And again, the relativity of simultaneity – what is simultaneous from one point of view is not from another – should suggest that an instant during which nothing happens in one region may correspond with an interval in another. We would have the relativity not only of simultaneity but of instantaneousness. Indeed, unless simultaneity is instantaneous there is no point in the relativity of simultaneity; what we would have instead is the non-existence of simultaneity – in which case no observer could clock anything besides the clock time itself.

My purpose here is not to develop these thoughts but simply to point out not only that we do not have to accept Shoemaker's argument about changeless time but that if we want to think in terms of relative time we have to be prepared to go outside ways of thinking that have become almost reflexive[7] – but also that we may be

[7] Even Leibniz, who, in *The Leibniz-Clarke Correspondence*, championed relative time (and space) as opposed to Newton's absolutes, seems to falter, when in effect challenged by Newton's proxy, Samuel Clarke, to show how relative time could produce the ideal mathematics of time. Leibniz falls back on the notion that time 'can only be an ideal thing' – which, if it means is an abstraction, is surely correct – but he provides an odd argument to show that ideality. Time cannot exist since it 'perishes eternally' (so that only the instant exists, which is itself, as durationless, not a part of time), and 'how can a thing exist, whereof no part does ever exist?' ... Whoever considers these observations, will easily apprehend that time can only be an ideal thing' – H. G. Alexander (ed), *The Leibniz-Clarke Correspondence* (Manchester: The Manchester University Press, 1956), 72. But it is surely a very equivocal argument to say that time cannot exist, therefore 'can only be an ideal thing', and therefore possesses the ideal mathematical properties. Leibniz has here an impossible *ens rationis*, the 'cannot exist' of which is not merely physical but logical.

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guided in that attempt by what seem to be generally accepted modern notions of relativity.

What I want to go on to argue is that, *pace* Shoemaker, time may well indeed be change. The question whether time is change, despite its suggesting a facetious translation for '*Zeit ist Geld*', is serious, and one well worth asking, though now seldom if ever asked. The authority of Aristotle, of Newton, of McTaggart, Russell and others, though any such authority of course does not constitute a philosophical argument, motivates us to accept as unquestioned the assertion that time is to be distinguished from change. We may, however, lift, so to speak, from Aristotle an argument to the effect that time is indeed change, or at least that time is to change as geometric space is to physical body: namely, the thing itself in abstraction. But let us approach the question in an orthodox Aristotelian fashion, noting the difficulties, and seeing how they may be resolved.

In *Physics* IV.10 Aristotle himself 'first criticizes the view that time is a certain particular change: the rotation of the universe (218a33-b5). He then goes on to argue more generally that time cannot be any kind of change'.[8] I shall not dwell on the first criticism, of the view that time is the rotation of the universe, of which Ursula Coope gives a good account, pointing out that Aristotle assumes 'that there can be only one time series'.[9] The more general claim that 'time cannot be any kind of change' will have more interest for us here.

Aristotle has two such arguments that time is not change (which includes motion), neither of which is, I think, convincing in itself. The first is that change is in or where the changing thing is, whereas time is 'alike everywhere and with all things' (218b9-13). The second is that change is faster or slower, whereas time is not, for 'faster' and 'slower' are defined by time, but time cannot be defined by itself (218b13-18). In the first argument, I take it, change in the thing is accidental or attributional change, such as the change of size in the cat; change where the thing is is substantial change, as when the cat dies, so ceasing to be a cat and becoming something else: a corpse where the cat was.

To accept the first argument we should have to accept the Aristotelian ontology of substance and attribute, which seems not entirely sufficient to explain the world as it is dealt with from a more modern perspective. It is of course true that the precise change that is in something is not, as such, in something else, but

[8] Ursula Coope, *Time for Aristotle* (Oxford: Clarendon Press, 2005), 32.
[9] Ibid.

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any physical change has repercussions elsewhere, so that it is not true that the change is confined as regards every aspect to the thing that changes or the place where it changes. As the cat changes size, for example, so does its visual aspect, at whatever distance – its mirror image, for example, which is not in the cat or where the cat is. When the cat dies its last breath makes a sound which travels off at the velocity of sound; the exhaled breath contains subatomic particles which may travel off at a high velocity through whatever medium, so that the death of the cat makes all sorts of changes throughout the world, changes which are not confined to the space occupied by the cat or the corpse. There is some reason there to think that physical change reaches anywhere, in its effects, to everywhere reachable. Besides, if time is everywhere, whereas change is not, it then follows that there can be time without change, which, as we shall see, is denied by Aristotle. It is true of course that time cannot be wholly identified with change in or from, let us say, the cat, but what is there to prevent time from being change in the most general sense, so that changes in the cat will be instances of time? There is no reason therefore for us, if we are looking to find out about time rather than trying to defend Aristotle on his own terms, to accept his first argument that time is not change.

The second argument is that change, unlike time, is faster or slower. To accept that we should have to accept that time moves equably, in rather Newtonian fashion, all by itself, without relation to anything external, or at least without relation to any change, which seems to amount to the same thing. And the notorious trouble with that is our entire inability to detect it or the absolute equable rate in terms of which changes are faster or slower. 'Fast' and 'slow', even without the comparative suffix, are not absolute but relative terms. There is no detectable absolute standard. We ordinarily decide all such matters by comparison. When Galileo came to the decision that the candelabra in the Cathedral of Milan moved as pendulums (something not in the Aristotelian ontology) – that is, moved regularly – he judged that regularity by comparison with his own resting pulse, for want of any better clock. Similarly, changes are fast or slow by comparison. It should be physically possible to construct two clocks one of which counted a second, by the second hand, say, twice as fast as the other. By the one clock changes in the world would happen twice as slow as by the other – and there is an element of arbitrariness in our deciding which clock is to be standard. Indeed, according to the theory of special relativity, and getting rid at some level of the arbitrariness, at least by the postulate 'that light [and any similar electro-magnetic disturbance] is

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always propagated in empty space with a definite velocity *c* which is independent of the state of motion of the emitting [or receiving] body', and assuming also the traditional, Galilean, postulate, modified to admit also the electro-magnetic and optical, that the laws of physics are the same in any inertial frame,[10] time in a moving system, as judged from a system regarded as at rest, actually slows down, along with all its physical, including biological, clocks. Again, it has actually been demonstrated that where one frame is accelerated, as in circular motion around the earth, coming back to the same point, the accelerated clock actually does slow down in comparison to a clock stationary at that point and originally synchronized with the accelerated clock.[11] Aristotle's changes, therefore, could be faster or slower by comparison with each other, and there is no detectable regular time, except by comparison with our own or other physical regularities – that is, physical changes – by which they are faster or slower.

There is, of course, an obvious logical sense in which it is true to say, as Aristotle does, that time is not defined by time. It is the same sense in which it is true to say of any class of things that it is not, under pain of circularity, defined by itself. It does not follow, though, that some rate of time, or change, is not defined by some other rate, arbitrarily, as the case may be. Our first clock, above, is defined as fast by our second clock, our second as slow by our first. You cannot take the comparison out of 'fast' and 'slow', and, once the comparison is in them, there is no need of an absolute standard to judge them by. A relative, even arbitrary, one will do, even if we

[10] These two postulates are the foundation of the special theory, as expressed in Einstein's famous June 1905 paper 'Zur Elektrodynamik bewegter Kőrper' in *Annalen der Physik*, and may be found (37-38) in A. Einstein, H.A. Lorentz, H. Weyl and H. Minkowski, *The Principle of Relativity*: A Collection of Original Papers on the Special and General Theory of Relativity, with notes by A. Sommerfeld, translated by W. Perrett and G. B. Jeffery (New York: Dover Publications – an unaltered republication of the 1923 translation first published by Methuen), 37-38.

[11] 'In the early 1970s scientists at the U. S. Naval Observatory in Washington carried out a simple experiment in which a physicist flew with a scheduled airline once around the globe. He traveled with several atomic clocks... After his return to Washington, his clocks were compared with similar clocks that had remained in Washington. And true enough, the traveling clocks lagged slightly behind the stationary clocks. The result was in perfect agreement with Einstein's theory', Harald Fritzsch, *An Equation that Changed the World*, translated by Karin Heusch (Chicago and London: University of Chicago Press, 1994), 135.

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do have, by a postulate of relativity, a constant velocity, containing a relation between time and space. Given that that velocity is, by a by now well-supported postulate, always constant – whether I am moving towards or away from the source of, say, light, the light itself comes to me at that constant rate – then, no matter what else speeds up or slows down, the components of that speeding up or slowing down, time and space, must be modified accordingly, to preserve, so to speak, the velocity of light as constant. So time may slow down in an inertial frame as the sub-c speed of that frame increases.

And so there is no obvious need for us to accept Aristotle's second argument that time is not change.

But Aristotle goes on to say, in the first sentence of *Physics* IV.11, that neither is there time without change (218b21).[12] This conflicts with the assertion that time is everywhere, whereas change is not. If time is everywhere and there is no time without change, then it appears that change must be everywhere too, and Aristotle's first argument that time is not change collapses. So, all told, there is no compelling reason to accept Aristotle's arguments that time is not change.

But, given that he believes that there is no time without change, Aristotle then goes on to link time to a very particular kind of change, namely motion through space, finding the before and after of time to be ordered by the before and after of space and the before and after of motion through space, the Greek *proteron*, 'before', and *husteron*, 'after' being usable in Greek, as in English, for both space and time. This approach requires the before-after order of space to be primary (219a14-15), ordering in turn the before-after of motion and of time (219a15-19). The before and after become temporal when each is recognized as a now and counted as such (219a22-30). This then leads to the definition of time as 'the number of motion according to before and after (219b1-2).

Oddly enough, in English, and it seems in Greek too, as we shall see, the recognizing that the concepts of before and after apply to space, motion and time, all three, leads to an inverse, and not direct, correspondence between the 'before' of space and the 'before' of time when motion is in question. If, for example, we

[12] The term for 'change' here is *metabolē*. For the definition of time as the number of motion, later, Aristotle uses *kinēsis* for 'motion'. The terms *metabolē* and *kinēsis* seem often synonymous for Aristotle. So, for example, at *Physics* IV.14.223a29-223b1, he gives as examples of *kinēsis*, as numbered by time: generation and perishing, growing, altering, as well as moving locally.

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were to fly from Boston to Washington, our flight path taking us over New York and Philadelphia, in that order, I could at some point say: 'We have left Philadelphia behind us, and New York was before that again'. This, obviously, causes no confusion, and yet I have just used 'behind' and 'before' to indicate the same spatial direction (north, let us say), and the same direction in time (past or earlier). The reason why it causes us no confusion is that we implicitly take it in that the behind in space, in terms of motion, corresponds to the before in time, the before in space, in that context, to the after in time. In that sentence about Philadelphia and New York the 'behind' is spatial, the 'before' temporal, and the one corresponds to the other when motion is in question. If that is also true in Greek, Aristotle might be expected to explain why he seems to want to make the spatial 'before-after' prior and derive the before and after of time from those of space via those of motion, it seems in the most direct, rather than inverse, fashion.

And that it is true in Greek that the temporal before corresponds, via motion, to the spatial after or behind is sufficiently attested by some expressions of Plato's in the *Parmenides* (151a) about 'time moving' (*poreuomenou tou chronou*), and to the effect that the one gets older (than itself – but we shall not be considering that paradox here) 'if indeed it moves forward according to time' (*eiper proerchetai kata chronon*) This latter expression uses, in effect, a spatial metaphor for time and considers the future as though it were a spatial region to move forward into.[13] But in purely temporal terms the future is later, that is, after, not before – which, as I say, would cause us to expect from Aristotle some explanation of why he seems to want to derive the temporal order rather directly from the spatial.[14] I suspect that he does not notice the inversion, and that in considering the spatial order to be prior he is indulging in a Greek bias towards space over time. But it seems somewhat odd anyway that Aristotle, having at one point (218b19-20) said we need not distinguish between movement and change, 'change' (*metabolē*), it seems, being here rather broader than, and including 'motion'

[13] In English, Andrew Marvell says to his coy mistress: 'But at my back I always hear/ Time's wingèd chariot hurrying near, / And yonder all before us lie/ Deserts of vast eternity', similarly using a spatial metaphor for time.

[14] There is one situation, in English and Greek, in which 'after', say, may indicate both behind in space and afterwards in time, as in 'You came after us to Washington'. What is indicated there is not so much the going from one point to the other as the maintaining the same distance, both spatial and temporal, from someone so going.

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(*kinēsis*), goes on almost immediately (219a10-219b1) to tie time to local motion, with its before and after, as related to space, rather than to change in general, so attempting to derive the before-after order of time from that of space, considered as prior.[15]

There is not, I think, an ultimately satisfying account of time as related to change/motion to be found in Aristotle – not very surprising perhaps in the first real, extended treatise on time – and it may be because he is too tied, for both change and time, to his substance-attribute ontology and the corresponding subject-predicate logic, where what seems to be required is rather a logic of relations, as it was developed in modern terms. By it time is a simply ordered class or series according to a dyadic relation (earlier-later) which is connected, irreflexive, transitive and asymmetrical.[16]

But there might seem a more direct way of noting that time and change are different: one based on common usage – and it may be that Aristotle, especially in saying that time is everywhere but change not, was influenced by that, assuming, as seems justifiable enough, that the usage was similar in ancient Greece. If I hear the sentence 'Time passed', that seems in some sense to give sufficient information, so that I am not moved to ask how time passed or what kind of time it was. But if I hear the sentence 'A change occurred', I am not given sufficient information and am moved to ask what kind of change. So, it seems, a simple sentence about time gives more satisfying information than a somewhat similar simple sentence about change, and therefore time and change must at least be different things. But now, taking the view of time as relative rather than absolute, that time passed does mean that some sort of change occurred, and that change occurred does mean at least that

[15] It has been argued, by G. E. L. Owen and others, that Aristotle, in trying to derive the temporal from the spatial before-after order begs the question by considering motion temporal in the first place, before trying to derive the before-after order of time from it. See, for example, Julia Annas, 'Aristotle, Number, and Time', *The Philosophical Quarterly* **25** (April, 1975), 97-113; G. E. L. Owen, 'Aristotle on Time' in P. Machamer and R Turnbull (eds.), *Motion and Time, Space and Matter* (Columbus, Ohio: Ohio State University Press, 1976), 3-27; Denis Corish, 'Aristotle's Attempted Derivation of Temporal Order from that of Movement and Space', *Phronesis* **21** (1976), 241-251.

[16] For an account of such series see, for example, Edward V. Huntington, *The Continuum* and Other Types of Serial Order (Cambridge, MA: Harvard University Press, 1917). An example of such a simply ordered class is, according to Huntington, 'The class of all instants of time, arranged in order of priority' (16).

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time passed, this may suggest that the difference between them is merely one of abstraction, the more abstract giving, in some sense, more satisfying information – or at least information satisfying the point of interest. In this sense 'A change occurred' does tell us that time passed, but that goes without saying and is not the point of interest. Something above and beyond that, something less abstract, is hinted at, and so we want to know what it is. In somewhat similar fashion, if we think more abstractly even than time itself, that something precedes and something succeeds, we know immediately that if A precedes B and B precedes C, then A precedes C, without having to know whether 'precedes' means 'is earlier than' rather than 'is smaller than' or 'is to the left of', and without having to know what A, B and C are. There are levels of abstraction, and as we abstract more we require less particular information. This may well be the situation as regards change and time.

Aristotle had in fact earlier in the *Physics* than his treatise on time provided a basis which would have been suitable for a dyadic earlier-later logic, had such a logic been possible to envisage then. For before defining change (*kinēsis*) rather elaborately in terms of potentiality and actuality – the ultimate metaphysical system of explanation of his ontology of substance and attribute – as 'the fulfilling of the potential being, as such' (*hē tou dunamei ontos entelechia, hē toiouton*), (*Physics* IV.1.201a11-12), he had provided, to put it as a relatively simple depiction, the notion 'that change always involves an underlying thing and two contraries. The underlying thing persists through the change, losing one contrary and gaining the other.'[17] Kant, who is not yet entirely free of the Aristotelian subject-predicate way of thinking, has nevertheless a more amenable account of change. He calls it, under the concept of alteration (*Veränderung*), 'a combination of contradictorily opposed predicates in one and the same object', and adds 'Only in time can two contradictorily opposed predicates meet in one and the same object, namely, *one after the other*'.[18] Dispensing, as unnecessary for our purposes, with Kant's, or Aristotle's, rather elaborate notion of some permanence underlying alteration, we may rather simply express this notion of change as 'both A and not-A'. This again, of course, can be true only in time sequence. 'Both A and not-A' cannot be true as of the same time, but it can be true. The non-existence and existence, or existence

[17] This is a summary of the rather elaborate discussion in *Physics* I.7-9, quoted from Ursula Coope, op. cit., 6.

[18] *Immanuel Kant's Critique of Pure Reason*, translated by Norman Kemp Smith (New York: St. Martin's Press, 1965), 76.

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and non-existence, of the same thing, provided that each obtains, give a fundamental, perhaps not further reducible, meaning to 'earlier-later', that is, to time sequence itself, and then the various logical properties of the relation – transitivity, etc. – evolve naturally.[19]

Change requires time sequence, as both Kant and Aristotle recognize, but does time sequence require change? Aristotle, as we have seen, thinks so. And we at least are not prevented from thinking so, if what I have said above against Shoemaker holds. If time is relative rather than absolute, then time requires something to happen, some change to take place, and where no such thing happens or takes place, there is no time, no A and not-A. But if something does happen, there is change, there is both A and not-A; there is time, however the subsequent logic of all that may have to be worked out.[20]

But now we can also take a hint from Aristotle – though Aristotle could very probably not himself have taken it, given his position in the evolution of scientific thought and of logic – as to how time may be considered change. The hint comes not from the discussion of either change or time but from that of the mathematicians' attitude in respect to natural bodies. 'For natural bodies', he says, 'have surfaces and volumes, and lines and points, with which the mathematician deals'. And he explains:

> The mathematician [like the astronomer] is concerned with [things such as shape], but not as the limits of the natural body. Nor does he regard their properties as going with such bodies. On that account he separates them; for by thought they are capable of being separated from motion [*kinēseōs*], and it makes no difference, nor does anything false come from their being separated (*Physics* II.2. 193B31-35).

Now this is as good a depiction of abstraction as may be, even if we still need an account, such as that of *Posterior Analytics* II.19, of how such abstraction can occur, and even if we, like Aristotle there, must say that the mind somehow can do this kind of thing

[19] I have tried to give some ontological account of all this in Denis Corish, 'Time Reconsidered', *Philosophy* **81** (2006).

[20] Leibniz, despite his odd grounding for the ideal in time, gave, in *The Leibniz-Clarke Correspondence*, at least a hint of what should be required. Suggesting that 'time [is not] any thing distinct from things existing in time', he goes on: 'instants, consider'd without the things, are nothing at all; and . . . they consist only in the successive order of things', 27. The challenge, of course, would be to show just how – rather than merely assume that – time, as such a relation between things, can produce the mathematically necessary notion of the durationless instant.

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(100a13-14), a remark which is undoubtedly true, even if the account of so-called active mind in *De Anima* III.5 does little enough to explain it. In the *Physics* Aristotle goes on immediately to indicate that the Platonists also, without realizing quite what they are doing, abstract from the purely physical conditions. But he recognizes levels of abstraction when he remarks that

> Odd and even, straight and curved, and again number and line and point are without motion [*aneu kinēseōs*], but flesh and bone and man not so; these are predicated like 'snub nose' and not like 'curved' (194a3-7).

A snub nose, even in the abstract, as defined, is understood as something abiding in the physical, and so similarly the flesh, the bone, the man, whereas the mathematical properties inhabit a yet more abstract level – as abstracted from everything physical. It seems clear here that 'motion' or 'change', *kinēsis*, is used to indicate such physical conditions.

We could, though Aristotle does not, apply this kind of consideration to time as well as to space. So, if the edge of a body may give us the concept of the straight line, and a corner that of the point, the noticing of passing time, that is, the noticing of change, may give us the concept of a temporal interval in the abstract and the noticing of no change in something give us the concept of the instant. Both the interval and the instant are abstractions, each an 'ideal thing', but 'it makes no difference, nor does anything false come from their separation' into this ideal state. The abstractions have a perfectly sound foundation in reality.

But now, what are they separated from? Evidently, from the perception of mere physical change, or the perceived lack of it. If there is change, of any kind, there is time; to the extent to which something does not change, to that extent alone there is no time, even if in some other respect there may be time – the observation through an interval in Shoemaker's region B of no change in region A, for example. Time is change – and the durationless no change – in the abstract. In the penultimate abstract, we should say, for if we proceed to the ultimate abstraction, we get not the earlier-later of time but merely the more skeletal precedes-succeeds, in which change, time, or for that matter space or number is reduced to the logic of serial order.

But perhaps in the last analysis this whole question becomes: Is time absolute or relative? If it is absolute, then Shoemaker is at least right in thinking that some, however indirect, means must be provided to show that it can exist – but his assuming that it does exist in the frozen because it exists in an unfrozen region cannot

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provide that showing. If time is relative, then we must be prepared to abandon almost reflexive ways of traditional thought and become comfortable with such notions as that time does not always proceed 'equably', at every place, whether anything is happening at some such place or not – or even that what may be a durationless instant of no change from one point of view, a simultaneity, for example, may be an interval, reflecting change, from another. This last thought would at least have the advantage of treating instants too as relational entities, rather than as the impossible, logical anomalies of being so *small* as to have no size that they have tended to become as a result of traditional thought that tends towards the 'simpler hypothesis' of absolutism. It is likely, perhaps, that instants – and points – have in that approach succumbed to the practical attitude of 'little or none' rather than conforming to the strictly logical requirement that no size cannot be small any more than big.

This notion of time as change in the abstract seems, so far, to be consistent not only with something of Aristotle's reasoning, and with the approach suggested, if not satisfactorily developed, by Leibniz in the last period of his life, that of the *Leibniz-Clarke Correspondence* – which correspondence was brought to an end by the death of Leibniz – but also, as we have seen, with the theory of relativity.

Finally, with such a relativist notion of time as change we can give a satisfactory definition of a clock: a clock is any recurrent change the periods of which are assumed or stipulated to be equal. With such a definition, however, the human pulse, for example, whether in the body's resting or non-resting state could be considered a clock. We need further then the notion of a useful clock: a useful clock is one which is synchronous with one or more others. That is, some constant number of its repetitions occurs simultaneously, or almost simultaneously, with some constant number of those of the other clock, as, for example, the periods of the resting pulse of Galileo with the swings of the pendulums. This example will also suffice to show that we have often, in practical situations, to be content with near simultaneity rather than the ideal actual simultaneity.

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