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TIME WITHOUT CHANGE

IT is a widely held view that the passage of time necessarily involves change in such a way that there cannot be an interval of time in which no changes whatever occur. Aristotle spoke of time as "a kind of affection of motion," and said that, although time cannot be simply equated with motion or with change, "neither does time exist without change." [1] Hume claimed that "'tis impossible to conceive . . . a time when there was no succession or change in any real existence." [2] And McTaggart presented as something "universally admitted" the contention that "there could be no time if nothing changed" (from which, he claimed, it follows that everything is always changing, at least in its relational qualities).[3] Similar claims can be found in the works of contemporary writers.[4]

The claim that time involves change must of course be distinguished from the truism that change involves time. And, as it will be understood in this paper, it must also be distinguished from a truism that Aristotle expressed by saying "if the 'now' were not different but one and the same, there would not have been time," i.e., the truism that if at time t' some time has elapsed since time t, then t' is a different time than t.[5] I do not think that this truism is what Aristotle had in mind in asserting that time involves change,

[1] *Physics,* bk. IV, ch. 11, 218^b.

[2] *A Treatise of Human Nature,* L. A. Selby-Bigge, ed. (Oxford: University Press, 1888), p. 40.

[3] J. M. E. McTaggart, *The Nature of Existence* (Cambridge: University Press, 1927), II, p. 11.

[4] See, for example, Bruce Aune's "Fatalism and Professor Taylor," *Philosophical Review,* LXXI, 4 (October 1962): 512–519, p. 518, and, for a somewhat more qualified statement of the view, Jonathan Bennett's *Kant's Analytic* (New York: Cambridge, 1966), p. 175. Bennett makes the acute point that, because of multidimensionality of space and the unidimensionality of time, empty space is measurable in ways in which empty time necessarily is not.

[5] Aristotle, *loc. cit.*

but it, and certain related truisms, have seemed to some philosophers, e.g., to McTaggart, to imply that there are changes that occur with a logically necessary inevitability and relentlessness. Thus the date and time of day is constantly changing, it is constantly becoming later and later, whatever exists is constantly becoming older and older (whether or not it "shows its age"), and not a moment goes by without something that had been future becoming present and something that had been present becoming past. Such changes, if indeed they are changes, are bound to occur no matter how much things remain the same; whatever else happens or fails to happen in the next twenty-four hours, the death of Queen Anne (to use Broad's example) is bound to recede another day into the past.

I do not wish to become embroiled, in this paper, in the controversy as to whether these "McTaggartian" changes deserve to be regarded as genuine changes. My own view is that they do not. But my concern in this paper is with ordinary becoming, not "pure becoming"; my concern is with changes with respect to such properties as color, size, shape, weight, etc., i.e., properties with respect to which something *can* remain *un*changed for an infinite length of time. And though McTaggart may be an exception, I think that philosophers who have claimed that time involves change have generally meant, not of course that everything must always be changing with respect to every such non-McTaggartian property, but that during every interval of time, no matter how short, something or other must change with respect to some such property or other.

This view, unlike the truism that time involves McTaggartian change, has important cosmological consequences. It implies, for example, that the universe cannot have had a temporal beginning unless time itself had a beginning and that the universe cannot come to an end unless time itself can come to an end. The claim that time involves McTaggartian change is compatible with the universe having had a beginning preceded by an infinite span of empty time, for throughout such a span the beginning of the universe, and the various events in its history, would have been "moving" from the remote future toward the present, and this itself would be McTaggartian change. But the kinds of change I am here concerned with are changes of things or substances, not of events, and such a change can occur only while the subject of change exists; the occurrence of such changes involves the existence of a universe of things, and if time involves change then there can be no time during which the universe does not exist.

There is another sort of change, or ostensible change, which must be ruled out of consideration if the claim that time involves change is to assert more than a triviality. Consider Nelson Goodman's term 'grue', and suppose that this is given the following definition (which, though not Goodman's definition, is common in the literature): "*x* is grue at *t* if and only if *t* is earlier than 2000 A.D. and *x* is green at *t* or *t* is 2000 A.D. or later and *x* is blue at *t*." Anything that is green up to 2000 A.D. and remains green for some time after 2000 A.D. necessarily changes at 2000 A.D. from being grue to being nongrue. Clearly, for any interval during which something remains unchanged with respect to any property whatever, we can invent a "grue"-like predicate which that thing either comes to exemplify or ceases to exemplify during that interval. And if we take there to be a genuine property corresponding to every grue-like predicate and count the acquisition or loss of such properties as genuine change, it follows that whenever anything remains unchanged in any respect it changes in some other respect. Now it is notoriously difficult to justify or explicate the intuition that there is a distinction between greenness and grueness which justifies regarding the former but not the latter as a genuine property, and it is correspondingly difficult to justify or explicate the intuition that something does not undergo a genuine change when at the advent of the year 2000 A.D. it ceases to be grue by continuing to be green. But I shall assume in this paper that these intuitions are well founded and shall exclude from consideration "changes" that, intuitively, consist in the acquisition or loss of "positional," i.e., grue-like, qualities. If we do not do this, the view that time involves change becomes trivially and uninterestingly true, and the considerations usually advanced in its favor become irrelevant to it.

Aristotle's statement of his grounds for thinking that time involves change is unclear but suggestive. He says that "when the state of our own minds does not change at all, or we have not noticed its changing, we do not realize that time has elapsed, any more than those who are fabled to sleep among the heroes in Sardinia do when they are awakened; for they connect the earlier 'now' with the later and make them one, cutting out the interval because of their failure to notice it" (*ibid.*). It is not clear to me why Aristotle focuses here on change of "the state of our own minds," although later on I shall venture a suggestion about this. But if we leave this aside, the argument seems to be that time involves change because the awareness, or realization, that an interval of time has elapsed necessarily involves the awareness of changes occurring during the interval. It is not a serious objection to this that sometimes, e.g., when we have been asleep, we are prepared to allow that a good deal of time has elapsed since a given event occurred even though we were not ourselves aware of any changes during the interval, for in such cases it is plausible to hold that our belief that an interval of a certain duration has elapsed is founded on the inductively grounded belief that changes did occur that we could have been aware of had we been awake and suitably situated.

What Aristotle says here seems to be supported by the obvious and often mentioned fact that it is by observing certain sorts of changes, e.g., the movements of clock hands, pendulums, and the sun and stars, that we measure time. Even if what we are measuring is the length of time during which a given object remained *un*changed, it seems necessary that something, namely whatever we are using as our clock, should have changed during that interval. This is perhaps what Aristotle meant when he said that time is directly the measure of motion and only indirectly the measure of rest. At any rate, the fact that we measure time by observing changes lends plausibility to the view that there cannot be an interval of time in which no changes occur. The contrary view can seem to lead to total skepticism about the possibility of measuring time. If it is possible for there to be changeless intervals, 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. For if such intervals can occur there is apparently no way in which we can be assured of their nonoccurrence; as Aristotle put it, "the non-realization of the existence of time happens to us when we do not distinguish any change" (*ibid.*). And if this is so, we can never know how much time has elapsed since the occurrence of any given past event. But, it may be held, if the supposition that changeless intervals are possible leads to this sort of skepticism, this itself is proof that the supposition is false.

Of course, it is not only by measurement, i.e., by the use of clocks and the like, that we are aware of the existence and extent of intervals of time. We are all possessed of a "sense of time," an ability to judge fairly accurately the length of intervals of time, at least of short intervals, without using any observed change as a standard; one can tell whether the second hand of a clock is slowing down without comparing its movements with those of another clock, and if one hears three sounds in succession one can often tell without the aid of a clock or metronome how the length of the interval between the first and second compares with that of the interval between the second and third. But, although the exercise of this ability to judge the length of temporal intervals need not involve *observing* any change, it is plausible to suppose that as long as one is aware of the passage of time some change must be occurring, namely, at a minimum, a change in one's own cognitive state. Suppose that throughout an interval of five minutes I observe just one object, call it 0, which remains completely unchanged throughout the interval, and that at each point during the interval I know how long I have observed 0 to remain unchanged. Then the content of my knowledge will be different at different moments during the interval. For example, at one time I will know that I have been observing 0 for two minutes, and a minute later I will know that I have been observing 0 for three minutes. And this means that there will be a constant change in my cognitive state as the interval progresses.[6] Possibly it was considerations of this sort that led Aristotle to stress change "in the state of our own minds" in his discussion of the relationship between time and change—although it does not seem to be true to say, as he does, that one must *notice* a change

[6] Suppose, however, that what I am aware of, at each moment during the interval (after the first minute of it), is only that 0 has remained unchanged—has remained in a certain state which I will call "*S*"—during the immediately preceding minute. (I have, let us suppose, an incredibly short memory span, and after the first minute of the interval my memory does not extend back to the beginning of it). Would this continuous awareness of lack of change in 0 involve a continuous change in my own state of mind? One might argue that it does, on the grounds that at each instant I know something I did not previously know, namely that at *that* instant 0 is, and has been continuously for one minute, in state *S*. On the other hand, one could argue that my cognitive state at any instant during the interval (after the first minute) consists in a certain predicate's being true of me, namely the predicate "knows that 0 has remained in state *S* for the last minute," and that since the very *same* predicate is true of me throughout there is no change. I shall not here try to resolve the tricky issue of which of these ways of viewing the matter is correct. I shall only remark that the former, according to which awareness, even of changelessness, involves change on the part of the subject of awareness, seems to me essentially the same as C. D. Broad's view that as long as one is conscious there is a "steady movement of the quality of presentedness" along the series of one's experiences; see his *An examination of McTaggart's Philosophy*, vol.. II, pt. I (Cambridge: University Press, 1938), p. 308. My present inclination is to regard this kind of "change" as a species of McTaggartian pseudochange. The issues raised by this example are similar to those raised by a very interesting argument of Norman Kretzmann's, to the effect that God must always be changing if he always knows what time it is, and that there is therefore an incompatibility between the claim that God is omniscient and the claim that he is immutable. See Kretzmann's "Omniscience and Immutability," this JOURNAL, LXIII, 14 (July 14, 1966): 409–421.

in the state of one's own mind in order to be aware of the passage of time.

These considerations suggest that it is logically impossible for someone to know that nothing, including the state of his own mind, is changing, i.e., for someone to be aware of the existence of a changeless interval during that interval itself. But it does not of course follow from this that it is impossible for someone to be aware of the existence of such an interval before or after its occurrence. To take an analogous case, it is logically impossible that anyone should know, at any given time, that the then current state of the universe is such as to make impossible the existence in it of life and consciousness, yet most of us believe that we have very good reasons for thinking that the universe has been in the very remote past, and will again be in the very remote future, in just such a state. In what follows I shall try to show that it is conceivable that people should have very good reasons for thinking that there are changeless intervals, that they should have well-grounded beliefs about when in the past such intervals have occurred and when in the future they will occur again, and that they should be able to say how long such intervals have lasted or will last. Of course, the fact that people might have good reasons for thinking that something happens does not prove that it is logically possible for that thing to happen; people have had good reasons for thinking that the circle has been squared. But I think that the sorts of grounds there could conceivably be for believing in the existence of changeless intervals are such that no sound argument against the possibility of such intervals can be built on a consideration of how time is measured and of how we are aware of the passage of time.

To the best of my knowledge, it follows from well-established principles of physics that our universe is a perpetually changing one. But what is in question here is not whether it is physically possible for there to be time without change but whether this is logically or conceptually possible. Accordingly, I shall allow myself in what follows to consider "possible worlds" in which the physical laws differ drastically from those which obtain in the actual world. It may be objected that scientific progress brings conceptual change and that within modern physical theory it is not possible to make any sharp distinction between those propositions about time which express logical, or conceptual, claims and those which purport to express synthetic truths of physics. But I think that it is fair to say that those philosophers who have claimed that time involves change have not generally rested their case on recent developments in physics, e.g., relativity theory, and have thought that this claim holds for our ordinary, prescientific, concept of time as well as for the more sophisticated conceptions provided by the physicists. And in dealing with such a view it seems to me legitimate to consider possible worlds in which quite different physical theories would be called for. If someone wishes to maintain that the occupants of such a world would necessarily have a different concept of time than that which the physicists tell us is applicable to our world, I have no objection to make—as long as it is granted that their concept would have enough in common with our notion of time to make it legitimate to regard it as a concept of *time*. I should concede that in allowing myself to speak of worlds that are logically but not physically possible I am making the somewhat controversial assumption that there is a tenable distinction between logically contingent and logically necessary truths. But this assumption is one that I share with the philosophers against whom I am arguing, those who say that time involves change—for I think that this claim is philosophically interesting only if we understand the 'involves' in it as meaning "necessarily involves."

Consider, then, the following world. To the best of the knowledge of the inhabitants of this world all of its matter is contained in three relatively small regions, which I shall call A, B, and C. These regions are separated by natural boundaries, but it is possible, usually, for the inhabitants of this world to pass back and forth from one region to another, and it is possible for much of what occurs in any of the regions to be seen by observers situated in the other regions. Periodically there is observed to occur in this world a phenomenon which I shall call a "local freeze." During a local freeze all processes occurring in one of the three regions come to a complete halt; there is no motion, no growth, no decay, and so on. At least this is how it appears to observers in the other regions. During a local freeze it is impossible for people from other regions to pass into the region where the freeze exists, but when inhabitants of other regions enter it immediately following the end of a freeze they find that everything is as it would have been if the period of the freeze had not occurred. Eggs laid just prior to the beginning of a freeze lasting a year are found to be perfectly fresh; a glass of beer drawn just prior to the beginning of the freeze still has its head of foam, and so forth. And this remains so even when they make the finest measurements, and the most sophisticated tests, available to them; even radioactive decay, if such exists in this world, is found to be completely arrested during the period of a local freeze. Those people who were in the region during the freeze will initially be completely unaware that the period of the freeze has elapsed, unless at the beginning of the freeze they happened to be observing one of the other regions. A man who was stopped in the middle of a sentence by the onset of the freeze will resume the sentence at the end of it, and neither he nor his hearers will be aware that there has been any interruption. However, things will seem out of the ordinary to any inhabitant of a frozen region who at the beginning of the freeze was looking into one of the other regions. To such a person it will appear as if all sorts of major changes have occurred instantaneously in the other region: people and objects will appear to have moved in a discontinuous manner or to have vanished into thin air or to have materialized out of thin air; saplings will appear to have grown instantaneously into mature trees; and so on. Although people might initially refuse to believe that events that seem to them to have only just occurred in fact occurred a year before and that they have been unconscious for a full year, it would seem that they would eventually come to believe this after hearing the reports of observers from other regions and, more important, after they themselves have observed local freezes in other regions.

The possibility of what I have described so far is compatible with the claim that there can be no time without change. That claim is that *something or other* must change during any interval of time and not that everything must change during every interval, and all that I have so far described is a case in which a fairly large percentage of the things in my imaginary world remain unchanged (or apparently unchanged) throughout an interval of time. But now the following seems possible. We can imagine, first, that the inhabitants of this world discover, by the use of clocks located in unfrozen regions, that local freezes always last the same amount of time—let us suppose that the length of freezes is always exactly one year. We can also imagine that they keep records of local freezes and find that they occur at regular intervals—let us suppose that it is found that in region A local freezes have occurred every third year, that in region B local freezes have occurred every fourth year, and that in region C local freezes have occurred every fifth year. Having noticed this they could easily calculate that, given these frequencies, there should be simultaneous local freezes in regions A and B every twelfth year, in regions A and C every fifteenth year, in regions B and C every twentieth year, and in all three regions every sixtieth year. Since these three regions exhaust their universe, to say that there will be simultaneous local freezes in all three regions every sixtieth year is to say that every sixtieth year there will be a *total* freeze lasting one year. Let us suppose that the predicted simultaneous two-region freezes are observed to occur as scheduled (the observers being, in each case, the inhabitants of whichever region remains unfrozen), that no freeze is observed to begin by anyone at the time at which local freezes are scheduled to begin simultaneously in all three regions, and that the subsequent pattern of freezes is found to be in accord with the original generalization about the frequency of freezes. If all of this happened, I submit, the inhabitants of this world would have grounds for believing that there are intervals during which no changes occur anywhere.[7]

The objections that might be made to this (and they are many) can be divided into two sorts. Objections of the first sort maintain, on various grounds, that the inhabitants of my imaginary world could not really have good reasons for believing that no changes whatever occur in a region during an ostensible local freeze in that region. For example, it might be held that, even if the hypothesis that no changes occur in such regions has survived a large number of refinements of their instruments and techniques of measurement, they could never be entitled to believe that further refinements of their instruments and techniques would not show that very slight changes occur during such intervals. Or it might be held that visual observation of an ostensibly frozen region would itself involve the occurrence of changes in that region, namely the transmission of light rays or photons. Objections of the second sort do not question the possibility of there being good reasons for believing in the occurrence of local freezes, but do question the legitimacy of extrapolating from these to the periodic occurrence of total freezes. Later on two objections of this sort will be considered in detail.

I shall not in this paper consider, except in a very general way, objections of the first sort. For though I am inclined to think that all such objections can be met, I think that such objections have limited force even if correct.[8] Even if the inhabitants of this world

[7] It is obvious that during a local freeze objects in the frozen region will undergo changes of a kind; they will undergo changes in their relational properties in virtue of the changes that are still going on in the unfrozen regions. But during a total freeze there are no unfrozen regions, and so no changes occur even with respect to relational properties.

[8] Of the two objections of this sort I have mentioned, I think that the first can be met by supposing that the scientific investigations of these people support a "quantum" theory of change which rules out the possibility of changes so slight that they are undetectable by certain instruments. The second could be met by supposing that visual observation in this world does not involve the occurrence of processes in the vicinity of the thing perceived, does not involve

could not have good grounds for thinking there are intervals in which no changes at all occur, it seems clear that they could have good grounds for thinking there are intervals in which no changes occur that are detectable by available techniques and instruments. And this goes against the view, suggested by Aristotle's remarks, that when we have the well-grounded belief that two events are separated by an interval of time this belief is always grounded, ultimately, on evidence that changes occurred between these events, i.e., is grounded either on observations of such changes or on inductive evidence that such changes occurred. Moreover, if one thinks that the possibility of time without change can be ruled out on verificationist grounds and if it is only objections of the first sort that enable one to maintain that it is impossible to verify the existence of changeless intervals, then one seems to be committed to a view which is much stronger, and intuitively less plausible, than the view that *something or other* must change during every interval of time; one seems committed to the view that *everything* must change during every interval of time. Now there is of course a sense in which a change in any given thing involves a change in the relational properties of everything else. But it now appears that the verificationist must rest his case on the (alleged) impossibility of verifying that anything has remained wholly unchanged even with respect to its *non*relational properties and that he ought to conclude that it is logically impossible for anything to remain unchanged with respect to its nonrelational properties. But this seems no more plausible than the argument from the fact (if it is one) that it is impossible to verify that two things are exactly equal in length to the conclusion that any two things necessarily differ in length.

I turn now to objections of the second sort, and to the first objection that I shall consider in any detail. I have imagined that the inhabitants of my imaginary world come to accept the generalization that local freezes occur in region A every three years, in region B every four years, and in region C every five years, from which it follows that there is a total freeze every sixty years. But why should they accept this generalization? What they observe is equally compatible with the generalization that freezes occur with these fre-

the transmission at finite velocities of waves or particles. Alternatively, we can avoid the objection by supposing that while a local freeze exists in a region it is as if the region were divided from the rest of the world by an opaque (and impenetrable) curtain, and that what serves as evidence that no change occurs in regions thus insulated is the fact that when such a region again becomes observable everything appears to be just as it was immediately before the region became insulated.

quencies *with the exception* that all three regions skip a freeze every fifty-nine years; or in other words (to put this in a way that makes it sound less ad hoc): one-year local freezes occur in A in cycles in which nineteen freezes occur at the rate of one every third year, with four "freezeless" years between the last freeze of one cycle and the first freeze of the next; they occur in B in cycles in which fourteen freezes occur at the rate of one every fourth year, with six years between cycles; and they occur in C in cycles in which eleven freezes occur at the rate of one every fifth year, with eight years between cycles. This generalization does not imply that there are ever freezes in all three regions at the same time, and it may be held that for just this reason it should be preferred to the generalization that does imply this.

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. One reason for preferring the second is the belief that total freezes, i.e., changeless intervals, are impossible. And the most common basis for this belief is the conviction that the existence of changeless intervals is unverifiable. But, on the assumption that the simpler hypothesis is a possible one, the existence of total freezes is verifiable by standard inductive procedures; so one cannot claim that the existence of changeless intervals is unverifiable without begging the question against the possibility of the simpler hypothesis. Of course, the existence of total freezes is not "directly" verifiable, if direct verification of the occurrence of something involves knowing of its occurrence while it is actually occurring. But there are all sorts of things whose occurrence is not directly verifiable in this sense and yet is perfectly possible and knowable; it would be impossible to verify directly, in this sense, that the rotation of the earth would continue if everyone in the universe were sound asleep, yet it is clearly possible that everyone in the universe should at some time be sound asleep, and we all have excellent reasons for believing that if this ever happens the rotation of the earth will continue. I conclude that considerations of verification give no reason for preferring the second hypothesis to the first, and that the first, being simpler, should be preferred unless some other reason for preferring the second can be found.

If one does not find this wholly convincing, this is probably because the generalization that implies the existence of total freezes does not strike one as significantly simpler than its competitor, and because one views the latter not really as an "hypothesis" at all, but rather as a straightforward description of what would actually be observed over a long period of time by the inhabitants of my imaginary world. But I think that this way of viewing the matter becomes less plausible if we introduce some modifications into the example.

So far I have supposed that local freezes are always of the same length, and that whenever local freezes in different regions coincide they do so completely, i.e., begin and end at the same times. Let us now suppose instead that freezes vary in length and that sometimes freezes in two different regions overlap, so that the inhabitants of each region can observe part of the freeze in the other region, namely the part that does not coincide with a freeze in their own region. Let us further suppose that the length of local freezes is found to be correlated with other features of the world. For example, we can suppose that immediately prior to the beginning of a local freeze there is a period of "sluggishness" during which the inhabitants of the region find that it takes more than the usual amount of effort for them to move the limbs of their bodies, and we can suppose that the length of this period of sluggishness is found to be correlated with the length of the freeze. Finally, let us replace the supposition that observed freezes always last one year with the supposition that they always last longer than six months.

It now becomes possible to decide empirically between the two hypotheses stated earlier. First, it is compatible with the first and simpler hypothesis, but not with the second, that during the sixtieth year after the beginning of a cycle some periods of freeze should be observed. For now we are allowing local freezes to overlap and to last for less than a full year, and this allows freezes to be observed even in a year in which there are freezes in all three regions. Perhaps the second hypothesis could be modified in such a way as to allow there to be local freezes during the sixtieth year, as long as there is no interval during which all three regions are simultaneously frozen. This would of course involve asserting that there are exceptions to the rule that freezes always last longer than six months. Moreover, it obviously could turn out that on occasions on which the local freezes in the sixtieth year could not have lasted longer than, say, four months without there having been a period of total freeze, the periods of sluggishness preceding them were observed to be of a length that had been found in other cases to be correlated with freezes lasting, say, seven months. We can of course modify the second hypothesis still further, so that it will assert that there are exceptions to the rule that the length of the freeze is always proportional to the length of the adjacent period of sluggishness, and that these exceptions occur every fifty-nine or sixty years. But this does seem to me to make the hypothesis patently ad hoc. By positing these sorts of exceptions to observed regularities one can of course make the second hypothesis compatible with the observed facts, but it seems to me that this is no more intellectually respectable than the use of the same procedure to protect from empirical falsification the quasi-Berkelian hypothesis that objects disappear when no one is looking at them, or, to take a case closer to home, the hypothesis that it is impossible for there to be an interval of time during which everyone in the world is sound asleep.

This brings me to the last objection that I shall consider. Suppose for the moment that it is correct to describe my imaginary world as one in which there are intervals during which no changes, and hence no events or processes, occur. A question arises as to how, in such a world, processes could get started again after the end of such an interval, i.e., how a total freeze could come to an end. What could *cause* the first changes that occur after there has been a total freeze? In the case of local freezes we might initially suppose that the end of a freeze, i.e., the changes that mark its termination, are caused by immediately preceding events (changes) in regions adjoining the region in which the freeze existed. But we cannot suppose that local freezes are terminated in this way if we want to defend the legitimacy of extrapolating from the frequency of their occurrence to the periodic occurrence of total freezes. For such an extrapolation to be legitimate, we must think of a total freeze as consisting in the simultaneous occurrence of a number of local freezes, the beginnings and endings of which are caused in the same way as are those of the local freezes from which the extrapolation is made. And if a freeze is total, there is no "unfrozen" region adjoining any frozen region, and hence there is no possibility that the end of the freeze in any such region is caused by an immediately preceding event in an adjoining region. If there were evidence that the changes that terminate local freezes are always caused by immediately preceding events in adjoining regions, this would be a reason for rejecting the extrapolation to the existence of total freezes of fixed and finite durations. Nor does it seem open to a defender of the possibility of total freezes to hold that the changes that terminate freezes are uncaused events. For if that were so, it would apparently have to be sheer coincidence that observed freezes always last exactly one year (or, in the modified version of the example, that their length is proportional to that of the temporally adjoining intervals of sluggishness)—and it is illegitimate to extrapolate from an observed uniformity that one admits to be coincidental. So we are faced with the question: by what, if not by an immediately preceding event in an adjoining unfrozen region, could the end of any freeze be caused? And a special case of this is the question of how the end of a total freeze could be caused.

If we make the simplifying assumption that time is discrete, i.e., that for any instant there is a next instant and an immediately preceding instant, it is clear that the cause of the change that ends a total freeze cannot be, and cannot be part of, the state of the world in the immediately preceding instant. For the immediately preceding instant will have occurred during the freeze (will have been the last instant of the freeze), and since no change occurs during a total freeze the state of the world at that instant will be the same as its state at any other instant during the freeze, including the first one. If the state of the world at that instant were causally sufficient to produce a generically different world state in the immediately following instant, then the freeze would not have occurred at all, for then the change that ends the freeze would have begun immediately after the first instant of the freeze—and a freeze "lasting" only an instant would be no freeze at all.

If time is dense or continuous, of course, we cannot in any case speak of a change as being caused by the state of the world at the immediately preceding instant, for in that case there is no immediately preceding instant. But I think that it is rather commonly supposed that if an event E occurs at time t and is caused, then, for any interval i, no matter how short, that begins at some time prior to t and includes all the instants between that time and t, the sequence of world states that exist during i contains a sufficient cause of E. If this is so, however, the first change that occurs after a total freeze could not have a cause. For let i be an interval with a duration of one second. If the freeze lasted more than one second, then the sequence of states that occurred during i was part of the freeze, and consequently the very same sequence of states occurred during the first second of the freeze. If the occurrence of that sequence of states had been sufficient to initiate the change that ended the freeze, the freeze could not have lasted more than one second. But since we can let i be as small an interval as we like, we can show that if the change that ends the freeze was caused, then the duration of the freeze was shorter than any assignable length, and this is to say that no freeze occurred at all.

It would seem that the only alternative to the view that the termination of a total freeze cannot be caused is the view that there can be a kind of causality that might be called "action at a temporal distance" and that the mere passage of time itself can have causal efficacy. To hold this is to deny the principle, stated above, that if an event is caused then any temporal interval immediately preceding it, no matter how short, contains a sufficient cause of its occurrence. I shall refer to this principle as "P." To suppose P false is to suppose that an event might be caused directly, and not via a mediating causal chain, by an event that occurred a year earlier, or that an event might be caused by such and such's having been the case for a period of one year, where this does not mean that it was caused by the final stage of a process lasting one year. Now I think that we are in fact unwilling to accept the existence of this sort of causality in our dealings with the actual world. If we found that a flash is always followed, after an interval of ten minutes, by a bang, we would never be willing to say that the flashes were the immediate causes of the bangs; we would look for some kind of spatiotemporally continuous causal chain connecting flashes and bangs, and would not be content until we had found one. And if we found that things always explode after having been red for an hour, we would never suppose that what causes the explosion is simply a thing's having been red for an hour; we would assume that there must be some process occurring in something that is red, e.g., the burning of a fuse or the uncoiling of a spring or the building up of an electric charge, and that the explosion occurs as the culmination of this process.

In the *Treatise* (though not in the *Inquiry*) Hume made it part of his definition of "cause" that causes are "contiguous" with their effects. And I think that there is some temptation to think that principle P, which could be thought of as expressing (among other things) the requirement that causes and their effects be temporally contiguous, is an analytic or conceptual truth. Establishing that this is so would not show directly that it is not logically possible for there to be changeless intervals, but it would undermine my strategy for arguing that this is logically possible. For, as we have seen, this would make it illegitimate for the inhabitants of my imaginary world to argue for the existence of total freezes on the basis of the observed frequency of local freezes.

But is P analytically or conceptually true? Here it is useful to distinguish two ostensible sorts of "action at a temporal distance," both of which are ruled out by P. The first might be called "delayed-action causality," and would be possible if the following were possible: X's happening at t is causally sufficient for Y's happening at a subsequent time t', and is compatible with t and t' being separated by an interval during which nothing happens that is sufficient for the occurrence of Y at t'. If in my earlier example we deny that the flash can be the "direct" cause of the bang, we are denying that this sort of causality is operating. I think that it is commonly believed that this sort of causality is logically impossible, and I am inclined to believe this myself. But in order to save the intelligibility of my freeze example we do not need to assume the possibility of this extreme sort of causality at a temporal distance. All that we need to assume is the possibility of the following: X's happening at t is a necessary but not sufficient part of an actually obtaining sufficient condition for Y's happening at t', and t and t' are separated by an interval during which nothing happens that is sufficient for Y's happening at t'. To posit this sort of causality is not necessarily to deny the principle that causes must be temporally contiguous with their effects. If we take something's exploding at t to be the result of its having been red for the preceding hour, there is a sense in which the cause (the thing's having been red for an hour) is temporally contiguous with the effect (the explosion); yet here the thing's having been red at t-minus-one-half-hour is taken to be a necessary though insufficient part of a sufficient condition of its exploding at t, and it is assumed that nothing that happens during the intervening half hour is sufficient to bring about the explosion. Likewise, if S is the state the world is in at every instant during a given total freeze and if E is the event (the change) that terminates the freeze, we can suppose that E is caused by the world's having been in state S for one year without violating the principle that causes are temporally contiguous with their effects, although not without violating principle P. Now we are, as I have already said, quite unwilling to believe that this sort of causality ever occurs in our world. But I am unable to see any conceptual reason why it could not be reasonable for the inhabitants of a world very different from ours to believe that such causality does occur in their world, and so to reject any principle, such as P, which excludes the possibility of such causality. And if this is possible, then in such a world there could, I think, be strong reasons for believing in the existence of changeless intervals.[9]

[9] It may be objected that allowing for this sort of causality would complicate the scientific theories of these people so much that it would always be simpler for them to avoid the need of allowing for it by adopting an hypothesis according to which total freezes never occur. But this supposes that they *can* avoid the need for allowing it by adopting such an hypothesis. It seems entirely possible to me that they might find that in order to subsume even *local* freezes

But here an important reservation must be made. Early in this paper I ruled out of consideration what I called "McTaggartian changes," and in doing so I was implicitly refusing to count certain predicates, e.g., "present" and "ten-years old," as designating genuine properties—these (which I will call "McTaggartian predicates") are predicates something comes to exemplify or ceases to exemplify simply in virtue of the passage of time. In ruling such predicates, and also grue-like predicates, out of consideration, I relied on what seem to be widely shared intuitions as to what are and what are not "genuine" changes and properties. But these intuitions become somewhat cloudy if we try to apply them to a world in which there is action (or causal efficacy) at a temporal distance. Supposing "F" to be a non-McTaggartian predicate, let us define the predicate "F'" as follows: "x is F' at t" $=_{\mathrm{df}}$ "at t x is F and has been F for exactly six months." It follows from this definition that if something is F' at t it ceases to be F' immediately thereafter, simply in virtue of the "passage" of t into the past. "F'" seems clearly to be a McTaggartian predicate, like "ten-years old," and one is inclined to say that something does not undergo genuine change in coming or ceasing to be F'. But now suppose that the basic causal laws governing the world are such that the following is true: something's having been F for a period of one year is a causally sufficient condition of its becoming G at the end of that year (where "G" is another non-McTaggartian predicate), and it is not the case that something's having been F for any interval of less than a year is a causally sufficient condition of its becoming G at the end of that interval. Given this, the causal implications of something's being F' at t are different from those of its being F at t; from the fact that something is F' at t, but not from the fact that it is F at t, we can infer that if it continues to be F for another six months it will then become G. And if we introduce another predicate "F''," defining it like "F'" except that "exactly six months" is replaced by "more than six months," we see that "F'" and "F''" are incompatible predicates having different causal implications. Now we are accustomed to regarding the causal properties of things, their "powers," as intrinsic to them, and it is thus plausible to say that, when predicates differ as "F'" and "F''" do in their causal implications, then something does undergo genuine change in ceasing to exemplify one

under causal laws they have to accept the existence of this sort of causality (e.g., they never succeed in explaining the termination of local freezes in terms of immediately preceding events in adjacent unfrozen regions), and that they might find other phenomena in their world that they are unable to explain except on the assumption that such causality exists.

and coming to exemplify the other. But if we say this, then we will have to allow that, in remaining *F* for a year and not undergoing change with respect to any other non-McTaggartian property, a thing nevertheless undergoes genuine change. And this of course goes counter to the intuition that McTaggartian change is not genuine change. It remains true, I think, that the inhabitants of my imaginary world could have good reasons for thinking that there are intervals during which no non-McTaggartian changes occur—but given the sorts of causal laws they would have to accept in order for it to be reasonable for them to believe this, it is not so clear whether they would be justified, as I think we are in our world, in dismissing McTaggartian changes as not being genuine changes. The determination of whether this is so must wait on a closer examination of the considerations that underlie our intuitions as to the genuineness, or otherwise, of ostensible changes and properties.[10]

Supposing that it is possible for there to be time without change, how are we to answer the skeptical argument mentioned at the beginning of this paper—the argument that we can never be justified in believing that a given amount of time has elapsed since the occurrence of a certain event, since there is no way in which we can know that the interval between that event and the present does not contain one or more changeless intervals, perhaps lasting billions of years? I think the answer to this is that the logical possibility of such intervals, and the fact that such intervals would necessarily be unnoticed while they were occurring, do not prevent us from knowing that such intervals do not in fact occur. Given the nature of our experience of the world, the simplest theories and hypotheses that do justice to the observed facts are ones according to which changeless intervals do not occur. We do not indeed have a set of hypotheses that explain all observed phenomena, but none of the unexplained phenomena are such that there is any reason to think that positing changeless intervals would help to explain them. If our experience of the world were different in describable ways, e.g., if it were like that of the inhabitants of my imaginary world, then, so I have argued, it would be reasonable to believe in the existence of changeless intervals. But even then there would be no basis for skepticism about the measurement of time. The simplest set of hypotheses that did justice to the observed facts would then be one according to which changeless intervals occur only at specified inter-

10 The need for this reservation was impressed on me by Ruth Barcan Marcus, who observed in a discussion of this paper that, if the "mere" passage of time can itself have causal efficacy, it is not clear that it can be dismissed as not being genuine change.

vals, or under certain specified conditions, where their existence and extent could be known (although not while they were occurring). If anything leads to skepticism it is not the claim that changeless intervals can occur but the claim that they might occur in such a way that their existence could never be detected. But it is not clear to me that even this is a *logical* impossibility, or at any rate that we must assert that it is in order to avoid skepticism. The claim that changeless intervals *do* occur in such a way that their existence cannot in any way be detected could not—and this is a logical "could not"—constitute part of the theory that provides the simplest and most coherent explanation of the observed facts, and this seems to me a sufficient reason to reject it. It is "senseless" in the sense that it could never be sensible to believe it; but it seems to me unnecessary to maintain, in order to avoid skepticism, that it is also senseless in the sense of being meaningless or self-contradictory. This is, in any case, irrelevant to what I have been arguing in this paper, for what I have suggested is that there are conceivable circumstances in which the existence of changeless intervals *could* be detected.

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COMMENTS AND CRITICISM

IDENTITY IN INDIRECT DISCOURSE

PETER GEACH has it that there is a case for recognizing intentional identities.* His evidence consists of sentences such as

(1) Hob thinks a witch has blighted Bob's mare, and Nob wonders whether she (the same witch) killed Cob's sow.

In asserting (1) a speaker asserts an identity of reference for expressions ('a witch' and 'she') which occur in distinct clauses of indirect discourse. According to Geach such an identity cannot rightly be construed in Quine's transparent way as

(2) As regards somebody, Hob thinks she is a witch and has blighted Bob's mare, and Nob wonders whether she killed Cob's sow.

Geach claims that (2) fails as a construal of (1) because (2) "would imply"

(3) Hob and Nob had some one person in mind as a suspected witch,

* "Intentional Identity," this JOURNAL, LXIV, 20 (Oct. 26, 1967): 627–632.