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The Rate of Time's Passage

Eric T. Olson

abstract: Many philosophers say that time involves a kind of passage that distinguishes it from space. A traditional objection is that this passage would have to occur at some rate, yet we cannot say what the rate would be. The paper argues that the real problem with time's passage is different: time would have to pass at one second per second, yet this is not a rate of change. This appears to refute decisively not only the view that time passes, but any tensed theory of time.

1.

Many philosophers say that time has a kind of flow or passage that distinguishes it from space. Future times and events become less future; past ones become more past; persisting things grow older. The world is caught up in a process of purely chronological change. This is the dynamic view of time.

A traditional objection to the dynamic view says that if time passes in this way, it must pass at some rate, yet we cannot say what the rate would be. I claim that we can see easily enough what the rate of time's passage would have to be, but there can be no such rate. This objection appears to refute decisively not only the dynamic view, but any tensed theory of time.

2.

There are several ways of stating the dynamic view. We might say that each time or event has one or more tense properties, such as being present or being a year in the future. And times or events change in respect of these properties: your next birthday is now in the future, but it will one day be present. More precisely, times or events have tense properties simpliciter. The 21st century, and no other, is present. It is not just present for us, or present in the 21st century; nor does its presentness consist in its coinciding with the time of my writing this or your reading it. There is an absolute division of times or events into past, present, and future. And there is constant change in where times or events lie with respect to this division.

Dynamists who doubt the reality of the past or future can state the view by saying that certain times or events are absolutely present, and there is continual change in respect of which ones they are. Your reading of this sentence is present, but not for long; soon it will be your reading of the next sentence that is present.

Or we could say that each persisting thing has a chronological age: a property distinct from any of the physical or mental signs of age. And things change in respect of this property. Age, like presentness, cannot be relative to a temporal point of view: my being 100 years old must not be the mere fact that my birth occurs 100 years before the time of this utterance, in the way that it occurs a different number of years before other utterances about my age made at other times. Rather, I have an absolute and constantly increasing age.[1] All dynamists, unless they say that nothing persists, are committed to this.

3.

According to the dynamic view, the passage of time is a genuine process of change in the temporal properties of times, events, or persisting objects. Now if an event becomes more past, it must do so at a certain rate: by a certain number of hours in an hour. What is this rate? How fast, in other words, does time pass? This question is an old chestnut. Still, it seems to require an answer.

We needn't think of time's passage as a sort of movement for this question to arise. If something really does move, we can of course ask how fast it moves. But time's passage cannot literally be a kind of movement, for the simple reason that movement is change of spatial position, whereas the present would have to 'move' (relative to events or dates) in time. At best, the present can move from earlier events to later ones in a metaphorical sense, like that in which temperatures or prices move from lower values to higher ones.

Even so, time's passage would be a change in a scalar quantity. If people become older or events more past, they have to become older or more past by a certain amount--by a certain number of years or seconds--just as something that increases in temperature must increase by a certain number of degrees. And these changes take time. But if a change in a scalar quantity takes place during a period of time, it must take place at some rate. If the temperature increases by a certain amount during the afternoon, it must increase by a certain number of degrees per hour. Just so, if my age increases by a certain amount during the afternoon, it must increase by so many hours per hour.

[1] I ignore the fact that in special relativity age is relative to a frame of reference, in that the temporal separation between events is relative to how one is moving with respect to them. This has nothing to do with passage. The 'twins paradox' (in which someone returns from a round-trip journey chronologically younger than her twin sister) is also about temporal separation, and thus irrelevant.

4·

So how fast does time pass? Only one answer seems possible: time passes at one second per second--or some equivalent rate, such as sixty seconds per minute or twenty-four hours per day. If the boundary between past and future shifts forward, it must take exactly one second for it to shift by a second. I must get precisely one year older each year.

It is hard to feel entirely comfortable with the idea that time's passage, or for that matter any other process of change, takes place at a rate of one second per second. There have been plenty of complaints about it. Some object that the statement is tautologous or empty (Smart 1949: 485). Others say that although one second of 'ordinary' time might perhaps pass in a second of some kind of second-order 'supertime', it could not pass in one second of ordinary time (Broad 1968: 125f., Smart 1949: 484, Black 1959: 56f.). But why the rate of time's passage could not be tautologous, or why it could not be one second per ordinary second, is never made very clear. Dynamists typically reply that no supertime is needed, and that is indeed a tautology--an obvious conceptual truth--that time passes at one second per second (Prior 1958: 244, 1993: 36f., Craig 2000: 226; see also Markosian 1993: 843). If this sounds odd, we should remember that time's passage is unique and not like other changes. It is hard to see who is winning here.

I want to set aside this traditional debate. The real problem with saying that time passes at one second per second is not that this is a funny sort of rate, but that it is no rate of change at all (van Inwagen 2002: 59). One second per second is one second divided by one second. And when you divide one second by one second, you get one. Not one of anything, just one. Dividing anything by itself, unless it is zero, gives you one. Sixty seconds per minute and twenty-four hours per day are also one, because sixty seconds is equal to one minute and twenty-four hours is one day. And one is not a rate of change. A thing can change at a rate of one mile per hour or one degree per minute, but not at a rate of one. 'One' cannot answer a question of the form 'How fast...?' or 'At what rate...?'. It can only answer a question of the form, 'How many...?', or more generally a question asking for a number. If we ask how many pigs are in the sty, the answer may well be 'one'. But if we ask at what rate something is changing--whether how fast the temperature is rising or at what rate things grow older--'one' is not even a potential answer, right or wrong.

We should not let the existence of a rate given in metres per second per second lead us, as it did Prior (1993: 36f.), to suppose that there could be a rate given in seconds per second. A runaway train might accelerate at one metre per second per second: for every second it rolls, its velocity increases by one metre per second. This is perfectly legitimate, because one metre per second per second is not equal to one, or any other

number. It is a genuine rate of change. But one second per second is not.

So the problem with the rate of time's passage is that time would have to pass at one second per second--at a rate of one--and there is no such rate. (I suppose this may be what the traditional critics of time's passage were trying to say. But if it is, they didn't say it plainly.)

5.

Dynamists appear to have two ways of defending their view against this argument. They can say that time <u>can</u> pass at one second per second: somehow one second per second is a rate of change, despite the fact that it is equal to one. Call this the <u>direct reply</u>. Or they can say that time can pass without passing at one second per second: it can pass at some other rate, or at no rate at all. Call this the <u>indirect reply</u>.

Neat as these categories may be, here is a reply that doesn't fit easily into either. You might think that dynamists can avoid the problem by careful rephrasing. To ask at what rate time passes is to ask how many seconds change from future to past per second. And this question seems to have a perfectly good answer: it simply asks for a number. So perhaps we can say how fast time passes by saying that the number of seconds that change from future to past in a second is one, even if we cannot say that time passes at one second per second.

This reply is sophistical. Suppose we ask how fast the temperature is rising. We can rephrase this question too so that it asks for a number: 'By how many degrees does the temperature rise in an hour?' Even so, if the answer to the second question is 'one', then the answer to the first must be 'one degree per hour': if one is the number of degrees by which the temperature rises in an hour, it follows that the temperature rises by one degree per hour. In the same way, if the answer to the question 'How many seconds pass in a second?' is 'one', then the answer to the question 'How fast does time pass?' must be 'one second per second'. If one is the number of seconds that pass in a second, then time passes at one second per second, which is impossible. Clever rephrasing can make the problem less obvious, but it won't make it go away.

Here is a direct reply. Part of my argument has been that 'one second per second' cannot answer the question 'At what rate does time pass?', because one second per second is one, and 'one' cannot answer it. But maybe 'one second per second' <u>can</u> tell us how fast time passes, even if 'one', owing to its grammatical form, cannot. 'One second per second' appears to have precisely the right form to tell us how fast a certain process of change takes place: the form 'so-and-so many units of whatever it is that changes per unit of time'. It has the same form as 'one degree per hour' or 'one metre per second', which clearly do express rates of change. Could the rate of time's passage be one second per second, even if it can't be one?

Surely not. The reason 'one' cannot tell us how fast time passes is not merely that it has the wrong grammatical form, but that it does not express a rate of change. So the proposal must be that 'one second per second' expresses a rate of change, even though 'one' does not. But one second per second is one. Thus, if one is not a rate of change, one second per second cannot be a rate of change either. It is true that 'one second per second' has the right grammatical form to express a rate of change. But appearances can be misleading: the phrase 'one divided by zero' has the right grammatical form to express a number--the same form as 'one divided by two'--yet it does not express a number.

One more direct reply: I said that time could not pass at one second per second because one second per second is a number, and no rate of change can be a number. (The fact that that number is one plays no role in the argument.) But suppose Georgi runs a race of the same distance every month, and her performance, measured by the clock, steadily improves. Her race time might improve by one second per month. Yet one second per month is equal to a number. (I leave it as an exercise for the reader to work out what number it is.) Doesn't this show that a rate of change can be a number?

No. Although we can understand the claim that Georgi's race time decreases by one second per month, it is hardly the most accurate description of things. It isn't really a period of time that changes. What changes is Georgi--or her running, or the speed of her running. Georgi changes by running faster; her running changes by speeding up; the speed of her running changes by increasing. The rate of this increase in speed is a certain number of miles per hour per month. And that rate, like the rate at which our runaway train accelerates, is not equal to any number. Were this more perspicuous description not available, talk of Georgi's race time decreasing by one second per month would be nonsense. The claim that time passes at one second per second, by contrast, admits of no such harmless redescription. So the story does not show that a change could take place at a rate measured in seconds per month, or seconds per second.

6.

Turn now to the indirect reply. Must time really pass at one second per second? Might it not pass at some less problematic rate instead? Some dynamists say that the question of how fast time passes admits of other answers than 'one second per second'. Markosian says we could give the rate of time's passage in terms of physical changes: by saying, for instance, that time passes at a rate of one hour for each circuit of the big hand round the clock (1993: 841f.). And there is nothing wrong with a rate of one hour per circuit. (It is not equal to a number.)

But this reply is directed at the traditional objection that there is no nontrivial or informative way of stating the rate of time's passage. It does nothing to explain how time

might pass without passing at one second per second or an equivalent rate. Even if time were to pass at a rate of one hour per circuit of the big hand, it would have to pass at one hour per hour as well. The passage of time has to be something that takes place in time--in ordinary time, and not, or not merely, in a second-order supertime. One circuit of the big hand takes an hour: that's why Markosian proposes that time passes at a rate of one hour per circuit. But if time passes at one hour per circuit of the big hand, and the time it takes the big hand to go round is one hour, does it not follow that time passes at one hour per hour? Doesn't time have to pass at one hour per hour if it passes at all, even if there are other ways of expressing its rate of passage?[2]

Or maybe time could pass without passing at any rate at all. In that case it would not have to pass at one second per second, and the fact that there is no such rate would be neither here nor there.

I argued in §3 that the passage of time would have to have a rate because it would be a change over time in a scalar quantity: if my age increases by a year in the course of a year, how could it fail to increase by one year per year? How could something change by a certain quantity in a certain period time without changing at some rate?

Markosian (1993: 843) suggests that it might make no sense to ask for the rate of time's passage because of its special status as the standard by which we measure all changes. He compares this to Wittgenstein's remark that we can say neither that the standard metre in Paris is one metre long, nor that it is more or less than one metre long, because it is the standard by which we measure all length. Yet this would not mean that time does not pass, any more than Wittgenstein's claim implies that the standard metre is unextended.

How could the standard metre fail to be one metre long? Well, what makes it the standard metre is that the phrase 'one metre long' is defined as 'as long as the standard metre'. Thus, to say that the standard metre is one metre long is to say that it is as long as the standard metre. Now most of us would say that it is true, if trivial, that the standard metre is as long as the standard metre. Wittgenstein thought it wasn't true, because he thought tautologies were not genuine statements; and what isn't a genuine statement can't be true.

Markosian's suggestion is that 'one second' is defined as 'the time it takes for one second to pass'. Thus, to say that one second passes in one second is to say that one second passes in the time it takes one second to pass. If he is to avoid the conclusion that time passes at one second per second, he will have to say that despite appearances it is not true that one second passes in the time it takes for one second to pass--even though time does pass. Why isn't it true? Apparently because it is a tautology, and

[2] Similar remarks apply to Schlesinger's proposal (1983: 115f.) that we could give the rate of time's passage in our cosmos in terms of its passage in another.

tautologies are never true.

Few now accept Wittgenstein's view of tautologies. It may of course be possible to give a more attractive 'no-rate' reply. But this doesn't look like a promising dynamistic research project: any semantic theory tough enough to prevent us from stating the rate of time's passage is likely to make the dynamic view itself unstatable.

7.

If the dynamic view really does imply that time must pass at a rate of one second per second, and there is no such rate, then that view is false. Time's passage is a myth. But then no tensed or 'A-theory' of time can be true either, for tensed theories entail the dynamic view. Tensed theories say that tense is a real feature of the world, and not merely part of the content of our thought and talk: certain times or events are absolutely present, and each persisting thing has an absolute age. And of course these tense properties are evanescent: anything that has them is bound to change in respect of them. No present event is always present, and I can't remain 100 years old forever. The reality of tense brings with it purely temporal change: the dynamic view. If there were no change in which times or events are absolutely present, nothing could be absolutely present. Were there no change in the absolute age of things, nothing would have any absolute age.

Any tensed theory of time must therefore entail the dynamic view. I have argued that the dynamic view cannot be true. If that is right, then neither can any tensed theory of time.[3]

University of Sheffield
S10 2TN, UK
e.olson@shef.ac.uk

References

Black, M. 1959. The "direction" of time. Analysis 19: 54-63.

Broad, C. D. 1968. Ostensible temporality. In R. Gale, ed., The Philosophy of Time. London: Macmillan. (Original work 1938.)

Craig, W. L. 2000. The Tensed Theory of Time. Dordrecht: Kluwer.

Markosian, N. 1993. How fast does time pass? Philosophy and Phenomenological Research 53: 829-844.

Prior, A. N. 1958. Time after time. Mind 67: 244-246.

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---. 1993. Changes in events and changes in things. In R. Le Poidevin and M. MacBeath, eds., The Philosophy of Time. Oxford: Oxford University Press. (Original work 1968.)

Schlesinger, G. N. 1983. Metaphysics. Oxford: Blackwell.

Smart, J. J. C. 1949. The river of time. Mind 58: 483-494.

van Inwagen, P. 2002. Metaphysics, 2nd ed. Boulder: Westview.