

## ON TIME

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### 0. *Introduction*

My subject is time — a topic that many philosophers have found enigmatic. My aim is to suggest resolutions to some of the enigmas.<sup>1</sup> The particular enigmas I have in mind are time's flow, its direction, and its duration. There is, it seems to me, one key which unlocks all these problems. I will attempt to explain this in section 2. But first, I need some background explanation; for the key is made of a material that will be somewhat unfamiliar.

### 1. *The Spread Hypothesis and the Hegelean Definition of Change*

The first thing I must explain is the *spread hypothesis*. Let us start with a rough statement of this; I will give a more precise formulation in a moment:

A physical magnitude cannot be localised to its value at an instant of time, but only to those values it has in a small neighbourhood of that time.<sup>2</sup>

I do not wish to defend the spread hypothesis here. I am content for it to remain an hypothesis, to be supported by the solutions its applications provide. Let me just paint a picture which goes with the hypothesis. We suppose that over small neighbourhoods of time it is impossible to pin down states of affairs. The impossibility is not merely epistemological, but ontological: nature itself is such that it is unable to localise precisely its doings. Each instant is so intimately connected with those around it that their contents cannot but encroach.

Though I do not argue for the spread hypothesis here, I note that it is not an hypothesis produced solely to solve the problems of time that I shall discuss. It was proposed initially in the context of an analysis of motion: its application solves a number of the puzzling aspects of that subject too.<sup>3</sup> Only one part of that discussion is presently relevant: an explanation of the Hegelean account of change. According to this, for a quantity to be in a state of change is for it to be in a certain contradictory state. *Merely* being in different states at different times is not enough. How this idea works we can see at the same time as making the spread hypothesis more precise.

Let us take a quantity (such as the spatial location of a body),  $q$ .  $q$  may take any of a set of distinct values (say, real numbers),  $V$ . To avoid talking in terms of satisfaction we will make the harmless assumption that every member,  $r$ , of  $V$  has a name,  $r$ . Let  $q$  be a function,  $v$ , of time; let  $Q(x)$  be the predicate ' $q$  has the value  $x$ '; and let

$$S_t = \{Q(v(t))\} \cup \{\sim Q(r); r \neq v(t)\}.$$

Then the fact that  $q = v(t)$  implies that all the members of  $S_t$  are true at  $t$ . The spread hypothesis can be interpreted as saying that for any time,  $t$ , there is an interval containing  $t$ ,  $\theta_t$ , such that the diagram (i.e., complete description of the atomic states) at  $t$  is just the "superposition", that is, set theoretic union, of every  $S_{t'}$  for  $t'$  in  $\theta_t$ . Let us call this union the *state description* at time  $t$ .<sup>4</sup>

Now, suppose that  $q$  is changing in a neighbourhood of  $t$ . Then within  $\theta_t$  there is a time  $t'$  such that  $v(t) \neq v(t')$ . The state description at  $t$  is therefore inconsistent. Conversely, if  $q$  is constant in a neighbourhood of  $t$  then, provided  $\theta_t$  is small enough to lie within this neighbourhood (which it will be if it is proportional to  $dv/dt$ ), the state description at  $t$  is consistent. Thus is the Hegelean account of change illustrated. To be in a state of change is to have an inconsistent state description. So much for a state of change. What of the direction of change? A contradictory state is an intrinsic state of change, such as motion. And just as a state of change, when it occurs, is intrinsic, so the direction of change, if there is one, must be. The intrinsic nature of the direction of change at  $t$  corresponds to a certain asymmetry in the state at  $t$ . 'Which asymmetry?' is a question that might be answered in several ways. One which is not *ad hoc* is as follows.  $\theta_t$  will not necessarily be distributed symmetrically about  $t$ . In fact, there is reason to suppose that  $t$  is the leading edge of  $\theta_t$ , so that the interval is skewed all to the past of  $t$ , at least normally. (Es-

entially, the reason is that if the interval projects to the future of  $t$ , this would seem to permit backwards causation.<sup>5</sup>) Now let us call  $\{v(t'): t' \in \theta_t\}$  the *spread* of  $q$  at  $t$ . Then  $q$  is intrinsically increasing at  $t$  if  $v(t)$  is the upper bound of the spread at  $t$ , intrinsically decreasing if it is the lower bound, and intrinsically neither otherwise. (Drawing a few diagrams will quickly convince the reader of this.) Thus, the direction of change at  $t$ , if it exists and is not indeterminate, is from the interior of the spread to the exterior, through  $v(t)$ . So much for preliminaries.

## 2. *The Flow of Time*

Let me now explain the application I wish to make of these ideas. The paradigm of a physical magnitude,  $q$ , is spatial location, in which case, the change is motion. But it could equally well be momentum, charge or wot not. The suggestion I wish to make is that it can also be time itself. We would not normally, perhaps, think of time as a physical magnitude in the same sense that velocity and charge are. I suggest that for the purposes of the application of the spread principle, it is. Whether this commits me to an absolute, as opposed to relative, view of time, I shall not discuss here. Henceforth, I shall use  $q$  for the state of time.  $V$  is the set of reals, and the function  $v$  simply the identity function. Applying the above: by the spread principle, for every time,  $t$ , there is an interval containing  $t$ ,  $\theta_t$ , such that for all  $t' \in \theta_t$ ,  $Q(t')$  is true at  $t$ . So, for example, at twelve noon, it is every time in the interval around 12 noon. This much is trivial. What is not so trivial is its application to the enigmas concerning time.

The first enigma I have in mind, and perhaps the most fundamental one, is the flow of time. We commonly think that time somehow flows or changes, so that events in the distant future become less future till they become present, recently past and then remotely past. But, of course, as many have observed,<sup>6</sup> as soon as one tries to make sense of this idea one winds up in, if not absurdities then at least grave difficulties. If time flows then it would seem that it must change *with respect* to something else, but there is nothing else for it to change with respect to. Some have bitten the bullet and postulated hyper-times,<sup>7</sup> and, pushed on by the obvious regress, even hyper-times of higher orders. But few have given this idea serious credence.

A more orthodox response<sup>8</sup> is simply to deny the objective reality of the flow. This, however one puts it, amounts to the claim that the flow is an illusion produced by some psychological mechanism: the flow is merely the way that a manifold of befores and afters appears to conscious beings of a certain kind. The view is implausible. What credibility it has is due to the fact that no one, so far, has come up with a workable way of understanding the flux of time. But the present machinery can provide just that.

Given the above application of the spread principle, the state of  $q$  at any time is inconsistent, since the identity function is nowhere constant. This, according to the Hegelean account of change, is exactly what it is to be in a state of change. Thus, the reality of the flux of time does not have to be denied; neither does it have to be accommodated by the postulation of hyper-times. There is only one time, and that, being in a constantly inconsistent state, is in a state of flux.

This account of the flux of time can also be applied to solve another problem, which is particularly acute for those who have wished to deny the reality of the flow of time. This is to account for the apparent lack of symmetry between space and time. Why is it that time appears to flow and space does not? The present account suggests a simple answer to this: there is no analogue of the spread principle for space. Or, to put it another way, there is, but the interval of non-localisation about a spatial point,  $s$ , is just  $\{s\}$ . Why this is, one might debate; I shall return to the issue briefly in section 4. It suffices here to note that because of this the analogous contradictions for space do not arise. State descriptions indexed by spatial locations, rather than by temporal ones are consistent. Space, unlike time, is not in a state of flux.

### 3. *The Direction and Duration of Time*

So much for the flow of time. What of its direction? What accounts for the anisotropy of time? This, again, has been a thorny problem, particularly for those who have denied the reality of the flow of time. They have had to locate the anisotropy of time not in time itself, but in processes in time,<sup>9</sup> a tall order since apparently all causal laws are time-symmetric. Again, the solution to the problem on the present approach is obvious. Since the identity function is monotonically increasing,  $v(t)$

is always the upper bound of the spread of  $q$  at  $t$ . Thus, the direction of the flow of time is perpetually from past to future — which seems about right.

We might note also that on this account of the direction of time, it makes perfectly good sense to ask what a world would be like in which all processes went backwards in time. This makes little sense on more orthodox accounts of the direction of time. For if all physical processes go backwards, then if the direction of time is defined by these, so, too, does time itself.<sup>10</sup> According to the Hegelean account of change, the direction of change of a quantity at  $t$  is a function of the skew in its interval of non-localisation about  $t$ . As I noted, there are reasons to believe that the skew is normally to the past. But the direction of time, we now suppose, is determined by the skew in time itself. Thus, as long as the interval of non-localisation of time is skewed in the same direction as the intervals of other quantities, they all have the same direction. If, however, time were skewed in the *opposite* direction to all (other) quantities their direction (relative to time) would be reversed. All processes would therefore go backwards in time, as, therefore, would causation.

The question of whether time itself could go backwards on this account is less clear. Of course, we can let  $t$  be the *trailing* edge of  $\theta_t$ . But unless there is some other significance to the direction of the  $t$  axis, this would be nothing but a change of notation. One thing that would provide this significance is if tense were real (as “A theorists” maintain). Then the future and past would be independent of the direction of skew, and it would make sense to talk of  $\theta t$  as being skewed towards the future. Since I do not wish to discuss the reality of tense here, I shall not pursue this possibility further.

What it would be like to *experience* any of these changes, I am not sure. However, experience brings me to the last of the enigmas of time I would discuss. The present is a durationless instant. But this fact seems to do no justice to the phenomenology of time: we experience the present not as a durationless point, but as having some little duration. This sort of present has been called by the unfortunate name of the specious present by some philosophers.<sup>11</sup> I prefer to call it the extended present. A graphic way of focussing attention on the extended present is by concentrating on our experience of certain sorts of motion. For example, before the hegemony of the digital timepiece, clocks were often found with hands for the hour, the minute and the second. One could not see

the minute hand (and *a fortiori* the hour hand) move, unless it was of the kind that jumped occasionally. One saw it in a certain position and inferred that it had moved, since one remembered it as being elsewhere. The second hand, by contrast, could actually be seen to move. One did not infer its motion by comparing present position with remembered position. Its motion was part of the phenomenological furniture. It was as if one could see the whole of a short stretch of motion at once. But of course, every point of the motion occurred at a different instantaneous time. The conclusion that we experience a present extended through a certain period of time seems mandatory.

Despite this, the theory of the extended present has not found favour among the orthodox. It seems to end quickly in absurdity. How can we possibly experience two different times at the same time? By the time we experience the latter the former must be over. This leaves, of course, an awkward problem of what to say about the phenomenology of our experience of the present. Let us not go into what has been said. That is unnecessary; for it is clear that the extended present is accommodated very happily by the assumption that time itself satisfies the spread hypothesis.

For every  $t'$  in the spread of  $q$  at  $t$ ,  $Q(t')$  is true at  $t$ . There is, to put it picturesquely, some past occurring at the present.

The extended present just is the spread of time around the present (or perhaps just some part of it if we do not experience it all). The third enigma of time is therefore solved.

#### 4. *Some Variations and Extensions*

The main aim of the paper, to explain a solution to some puzzles of time, has now been fulfilled. However, it will be clear that it has been fulfilled only in outline. The solution has numerous ramifications. While I cannot hope to treat them all in this paper, I want, at least, to pursue some of them. I will do this by considering a possible objection, which may well have occurred to the reader already. The objection can be put in several different ways, but one reasonably perspicuous way is as a sorites.

Let us suppose, for the sake of perspicuity, that the duration of  $\theta_i$  is one minute. Then at twelve noon it is every time in the interval around twelve noon; thus it is also one minute to 12. But at one minute to 12 it

is every time in the interval around one minute to twelve. It is therefore two minutes to twelve. But at two minutes to twelve, it is... Hence at twelve noon it is every past time; and similarly for every other time.

Certainly, this conclusion is unacceptable: it is not all past times now. The objection may be met in a number of different ways which modify, or fill out, the basic theory very differently. I will consider three.

### *Solution 1:*

The argument exploits the fact that we have applied the spread hypothesis to time itself. Refrain from doing this, and apply it only to quantities in time. Result: the flow of time itself can now no longer be explained in terms of the inconsistency of the state description of time. As in orthodox accounts, time does not flow. And as in orthodox accounts, the direction of time has to be explained by the anisotropy of processes in time. However, this is neither the direction of causation, nor of increase of entropy, but is the skew of the intervals of non-localisation of physical states of affairs. The extended present may still be accounted for in much the same way: it makes little difference to the explanation whether the past itself persists into the present, or just past states of affairs. This solution is perhaps the least enticing. The modified theory, whilst still offering *some* advantages over more orthodox accounts, reneges on the prime advantage of the original theory: the explanation of the flow of time itself.

### *Solution 2:*

Maintain that the spread hypothesis applies to time itself, but now suppose that time is correctly represented by the non-standard real line, and that  $\theta_i$  is infinitesimal. It then follows that at twelve noon it is every time infinitesimally before 12; but since adding infinitesimal to infinitesimal never gives a non-infinitesimal, the regress never gets beyond an infinitesimal distance from 12. Result: the flow and direction of time may be accounted for as before. The extended present cannot, since this is not, presumably, infinitesimal.

At the cost of endorsing the thought that physical continua have the structure of the non-standard real line (which has some independent advantages), this is a more enticing solution. Of the three aspects of time discussed, the extended present is the one which most plausibly might be expected to have an explanation in terms of the psychology of observers.

*Solution 3:*

Maintain that the spread hypothesis applies to time itself and that  $\theta_t$  is not infinitesimal, but draw a distinction; or rather, enforce a distinction explicit in the representation. The distinction is that between ‘The time is  $t$  ( $Q(t)$ )’ being true, and  $t$  being the index of the state description. Then the sorites is broken. For when the index of the state description is 12 noon ‘It is one minute to 12’ is true; but it does not follow that the index of the state description is one minute to 12, and so the argument goes no further.

This is, perhaps, the most obvious response, and the most attractive since it sacrifices none of the explanatory power of the account. But one may be less than satisfied with it. For it would appear that we are now operating with a two-time system after all. Intuitively, we have only one way of specifying the time: we say ‘It is 12 noon’. Now is this to be interpreted as ‘It is 12 noon’ is currently true’ or as ‘The index of the state description is currently 12 noon’? And whichever it means, what exactly are we to make of the other notion, which appears to have been smuggled in under the guise of being our familiar talk of time?

There is, however, a possible answer to this point: We do have two ways of specifying time: by “A series” tensed locutions and by “B series” non-tensed locutions. Could it not be the case that these two ways correspond to the distinction we have observed? The equations in the state description give the (inconsistent) B-series descriptions of time holding; whereas the index of the state description marks the point, representing the present, dividing the temporal continuum into the past and the future.

This reply is a tempting one. It allows us to make sense of the dual temporal scales; it sits well with the thought that  $\theta_t$  marks the extended present: the real present is a punctual now, located within an extended present of clock times. Finally, it also explains why a similar construction is not to be expected for space. (See section 2.) Spatial “A-series” terms, like ‘here’, have no independent reference in the same way that tensed terms do.

On the negative side, a disadvantage of this solution is its loss of neutrality on the A-series/B-series issue, that is, on the question of the reality of tense. Everything in this paper until now could be accepted equally by someone who denied the objective reality of tense, and by someone who endorsed it. Obviously, buying this interpretation of solution 3 commits us to a realist view of tense. But, on the other hand, and



because of its engagement, this construction may shed new light on this issue.

## 5. Conclusion

It is clear that the ramifications of this approach to time spread a great deal further than I have pursued them here. But it is also clear that the application of the spread hypothesis and the Hegelean account of change provides at least *prima facie* solutions to a number of problems in the philosophy of time. And that is sufficient for the present.<sup>12</sup>

## NOTES

1. I have little of novelty to say on the problems faced by extant proposed solutions. I will therefore say little.
2. The spread hypothesis was formulated in Priest (1985) and Priest (1987) ch 12. It was formulated there for the special case where the magnitude concerned is the spatial location of an object. (The spread hypothesis then amounts to the claim that at an instant an object may be spread over a neighbourhood of locations. Hence the name.) However, as I indicated in those places, there is nothing particularly special about this special case, and the present statement is just the generalisation. It is worth pointing out that the hypothesis is non-committal about the extent of the non-localisation. A natural assumption, however, is that its length is proportional to the derivative of the magnitude with respect to time.
3. This is discussed in the places cited in fn 2.
4. This is essentially the formulation given in Priest (1987). A slightly different formulation is given in Priest (1985), but the difference is not important here. A discussion of the formal semantics underpinning this idea can be found in those places and also in Priest (1982).
5. The point is discussed in Priest (1987), ch 12.
6. See, for example, Williams (1951), Smart (1949).
7. E.g., Dunn (1927).
8. See, for example, Grünbaum (1968), Mellor (1984).
9. Common solutions are to attribute it to either the increase of entropy,

or the direction of causation. See, e.g., Grünbaum (1967), Gold (1966), Reichenbach (1956), Mellor (1984).

10. See, e.g., Gold (1966).

11. See Mabbott (1951) for a discussion of the specious present.

12. A draft of this paper was read at a meeting of the Australasian Association of Philosophy at the University of New South Wales, August 1985. I am grateful for comments made there by David Lewis, Hugh Mellor and Chris Mortensen. I am also grateful to Peter Forrest and Jean Paul Van Bendegem for their written comments.

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