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Time Is Change

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Abstract

What is time? In this paper, I defend the view that time is change. In Section 1, I introduce the view that time is change and contrast it with an alternative view. In Section 2, I draw on recent developments in higher-order metaphysics to defend a particular theory of change, and therefore, of time. Finally, in Section 3, I respond to several objections to the view that time is change.

Keywords: time; change; temporal ontology; higher-order metaphysics

1. Theories of Time

What is time[1]? As Fiocco [1] points out, this question has received surprisingly little attention in contemporary philosophy of time, where debate has largely focussed on questions of temporal ontology and persistence through time[2]. Why is that? I think there are several plausible reasons. First, the question is extremely general, and it is usually easier to make philosophical progress on more narrowly focussed questions. For example, philosophers of time have focussed on questions such as whether there is a metaphysical distinction between the present and non-present; whether the past and future exist; and how things persist through change. Second, the expression 'time' might reasonably be thought to be ambiguous between various objective, scientific, instrumental, 'common-sense', and phenomenological notions. If that is right, there is more than one reasonable way to interpret the question of what time is, making the question both harder to pose and harder to answer. Third, the expression 'time' as it appears in the question 'What is time?' appears to be a mass noun like 'water' and 'gravity', so the question itself can seem to presuppose that time is a *thing* or *object*—that there is, as Prior ([3], p. 75) memorably puts it, 'some monstrous object called Time'. However, many philosophers are rightly suspicious the idea that time is an object[3]. That might reasonably deter them from addressing the question of what time is directly, rather than indirectly through more familiar questions of temporal ontology and persistence.

Despite these understandable reasons for avoiding it, I think it is worth addressing the question of what time is[4]. Moreover, I think a strong case can be made for the view that time is change. Call this the 'Change Thesis':

Change Thesis: Time is change.

The Change Thesis has a long history in the philosophy of time. In *Physics* Book IV, Aristotle describes it as a 'prevalent idea' ([5], 10.218b9-10), and assumes without argument that necessarily, time either is change or 'something of' change ([5], 11.219a.9-10) However, Aristotle does not accept the Change Thesis: he rejects it in favour of the view that time is 'a number of change in respect of before and after' ([5], IV.11.219a37)[5]. I discuss Aristotle's arguments against the Change Thesis in Section 3 below. The Change Thesis is also closely

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associated with Henri Bergson, who identifies time with 'duration' (*la durée*). In his early work *Time and Free Will* ([9], p. 226), Bergson characterizes duration as

> [. . .] nothing but a succession of qualitative changes, which melt into and permeate one another, without precise outlines, without any tendency to externalize themselves in relation to one another, without any affiliation with number . . . [it is] pure heterogeneity"

Later, in *The Creative Mind* [10], Bergson writes that 'real duration is what we have always called time, but time perceived as indivisible', and that 'the more or less lengthy changes we witness within us and in the external world take place in a single identical time'. Although there is room for disagreement as to Bergson's exact meaning here, it seems reasonable to characterise him as holding that time (as duration) is identical to change[6].

An important question raised by the Change Thesis is what is meant by 'change'. There are two distinct theories of change in contemporary philosophy of time, the Russellian view and the Priorian view[7]. According to the Russellian view, for there to be change is for there to be variation along the temporal dimension of the spacetime manifold; or in other words, for something to be one way at one time and some other way at some other time (where a 'time' is a maximal region of simultaneity or *hypersurface*). Call this view 'Russellian Change':

> **Russellian Change**: Necessarily, there is change if and only if for some x and some times (i.e., hypersurfaces) t and t', x is F at t and x is not F at t'.

Russellian Change is intended by its defenders to be compatible with 'Propositional Eternalism', the view that (always) every true proposition is always true[8]:

> **Propositional Eternalism**: Always, every true proposition is always true[9].

Crucially, Propositional Eternalism is compatible with there being Russellian Change, since propositions expressing instances of Russellian Change—for example, that there is a time at which I am under four feet tall and another time at which I am over four feet tall—are always true if true.

In contrast, according to the Priorian view, for there to be change is for it to be the case that sometimes, some proposition is sometimes but not always true; i.e., for there to be at least one 'temporary' proposition. Call this view 'Priorian Change'[10]:

> **Priorian Change**: Necessarily, there is change if and only if sometimes, some proposition is sometimes but not always true.

Given that there *is* change, Priorian Change entails 'Propositional Temporalism', the view that there is at least one temporary proposition:

> **Propositional Temporalism**: Sometimes, some proposition is sometimes but not always true[11].

From now on, when I discuss the Change Thesis, I mean the view that time is identical to Priorian Change rather than Russellian Change. The reason is that I accept Propositional Temporalism, and therefore find it natural to accept Priorian Change as well[12].

What is the alternative to the Change Thesis? In other words, what could time be if it is not change? I suspect some philosophers are attracted to the view that time is a dimension of spacetime[13]. Call this the 'Dimensional Thesis':

> **Dimensional Thesis**: Time is a dimension of spacetime.

According to Thomas ([17], p. 89), the Dimensional Thesis can be traced to the 'linear model of time' which emerged in the late nineteenth century, and found its clearest expression in Hinton's [18] view that physical reality is an unchanging four-dimensional space in which 'all that has ever come into being or will come co-exists' ([18], p. 23). Hinton's view

clearly anticipates the contemporary 'B' theory of time, according to which physical reality is a four-dimensional manifold of spacetime points and regions in which the distinction between present and non-present events is merely relative. According to Markosian ([19], p. 2), just as we typically conceive of space as a unified three-dimensional manifold of spatial points and regions, it is natural for B-theorists to conceive of time as a dimension of the unified four-dimensional Minkowskian manifold[14].

An important question raised by the Dimensional Thesis is what makes one of the dimensions of spacetime temporal rather than spatial. In particular, since spacetime physics eliminates distinct spatial and temporal relations between events in favour of *spatiotemporal* relations, it is natural to wonder what distinguishes the allegedly temporal dimension of spacetime from the spatial dimensions[15]. This question is especially pressing for B-theorists, since according to the special theory of relativity, there is no non-relative—i.e., frame-independent—way of identifying hyperplanes with times.

In reply to this question, Skow [21] argues that what it is for a spacetime direction to be temporal is for it to be a direction in which the fundamental physical laws govern the evolution of the world. However, there is an alternative response which is not available to B-theorists like Skow, but is available to those who defend 'A' theories of time (such as the Growing Block and Moving Spotlight theories) according to which there is an absolute distinction between present and non-present times: namely, that what it is for a spacetime direction to be temporal is for it to be the direction in which times are successively (absolutely) present[16].

My aim in this paper is to defend the Change Thesis. My strategy is not to defend it by pitting it against the Dimensional Thesis, but by developing an interpretation of the Change Thesis on which the main objections to it can be answered. The key to this strategy, as I argue in the next section, is to interpret 'change' in the context of the Change Thesis in irreducibly higher-order terms, according to which for there to be change is for there to be something (in an irreducibly higher-order sense) which is sometimes but not always the case. As I argue in Section 3, this higher-order interpretation of the Change Thesis provides the resources to respond to the main objections to it. But before proceeding, it is worth clarifying that, in rejecting the Dimensional Thesis, I do not deny (for example) that physical reality is four-dimensional, or that a dimension of spacetime is temporal rather than spatial, or that there are times standing in earlier-than and later-than relations to one another[17]. What I reject is the view that time is a dimension of spacetime[18]. Rather, I think time is better understood as the occurrence of change, and that the four-dimensional structure of physical reality—including the temporal ordering of times—is a consequence of change.

2. Higher-Order Change

In the previous section I specified that 'change' in the context of the Change Thesis should be interpreted as Priorian Change, according to which for there to be change is for there to be at least one temporary proposition. But so understood, the Change Thesis may seem to objectionably reify time: if for there to be change is for there to be at least one temporary proposition then it seems that, given the Change Thesis, for there to be time is likewise for a certain kind of entity—a temporary proposition—to exist. In this section, I appeal to recent developments in higher-order metaphysics to show that the Change Thesis can be understood in such a way that it is entirely free of such 'existential' commitments[19].

Consider the following pair of true sentences:

(1) There is a way we both are.
(2) Everything is either true or false.

These sentences can be understood as involving the familiar sort of 'existential' quantification about which one learns in an introductory logic course; for example, in the case of (1), over *properties* ('There is a property we both possess'), and in the case of (2), over *propositions* ('Every proposition is either true or false'). However, they can also be understood as involving *higher-order quantification*: that is, quantification into syntactic positions other than that of singular terms like names and demonstratives. For example, (1) can be interpreted as involving quantification into *predicate* position, as follows:

(1*) $\exists F(F(\text{me}) \wedge F(\text{you}))$

And (2) can be interpreted as involving quantification into *sentence* position:

(2*) $\forall p(p \vee \neg p)$

How are we supposed to interpret the higher-order quantifiers in (1*) and (2*)? Some philosophers interpret them in terms of the standard first-order quantifiers of predicate logic[20]. However, others accept the 'higher-orderist' view of Frege [30] and Prior [31] that higher-order quantifiers are genuine quantifiers in their own right, irreducible to first-order quantification. According to them, (1*) should be interpreted as expressing the irreducibly higher-order fact that there is (quantifying into predicate position) a way we both are, and (2*) should be interpreted as expressing the irreducibly higher-order fact that everything (quantifying into sentence position) is either the case or not the case.

It is tempting to think of higher-orderism as the view that, in addition to *things* like objects and events, there are also *ways things are* ('properties') and *truths and falsehoods* about those things and ways ('propositions')[21]. But this way of thinking about the view is potentially misleading, since it can wrongly suggest that higher-orderism provides a meaningful way to generalise over distinct higher-order 'types'. In fact, there is no 'cross-type' quantification or 'cross-type' identity in higher-order languages: the type-theoretic hierarchy is a structural feature of the meanings of higher-order quantifiers, not a further object of quantification[22]. Higher-orderists argue that, far from being an expressive limitation, this is a significant virtue of the higher-order framework, because it helps to provide solutions (or 'dissolutions') to long-standing philosophical puzzles such as how properties can be instantiated and whether one can consistently accept a notion of absolute generality[23].

We can now show how higher-orderism provides defenders of the Change Thesis with a response to the objection that, given Priorian Change, the Change Thesis reifies time. That objection arises specifically from the *first-order* interpretation of Priorian Change, according to which for there to be change is for at least one temporary proposition to exist:

> **Priorian Change (First-order)**: Necessarily, there is change if and only if a temporary proposition exists ($\exists x(\text{Proposition}(x) \wedge \text{S}(\text{True}(x)) \wedge \text{S}(\text{False}(x)))$)[24].

But given higher-orderism, the sentence 'Sometimes, some proposition is sometimes but not always true' can also be interpreted as expressing the irreducibly higher-order claim that $\exists p(\text{S}p \wedge \neg \text{A}p)$, which from now on I shall express (albeit imperfectly) in English as the claim that *something (quantifying into sentence position) is sometimes but not always the case*. In that case, Priorian Change is equivalent to:

> **Priorian Change (Higher-Order)**: Necessarily, there is change if and only if something (quantifying into sentence position) is sometimes but not always the case ($\exists p(\text{S}p \wedge \neg \text{A}p)$).

And given higher-orderism, the truth of the sentence '$\exists p(\text{S}p \wedge \neg \text{A}p)$' carries no (implicit or explicit) commitment to the existence of propositions, temporary or otherwise: it is a true, irreducibly higher-order generalisation, free of 'existential' import[25]. Hence, the objection that given Priorian Change, the Change Thesis reifies time can be avoided when

the Change Thesis is understood as the irreducibly higher-order view that for there to be time is for something (quantifying into sentence position) to be sometimes but not always the case:

> **Change Thesis (Higher-Order)**: For there to be time is for something (quantifying into sentence position) to be sometimes but not always the case ($\exists p(Sp \wedge \neg Ap)$).

Before moving on, I would like to address an immediate objection[26]. I have argued that the Change Thesis should be interpreted as expressing a higher-order identity between two 'entities' of the type over which irreducibly higher-order quantifiers into sentence position are supposed to quantify, namely, that there is time, and that something (quantifying into sentence position) is sometimes but not always the case. For ease of exposition, following Jones [36] let us call them 'entities of type t'[27]. But the Change Thesis discussed in Section 1—for example, the view expressed by Aristotle in *Physics* Book IV—did *not* seem to involve quantification over entities of type t. And if it didn't, the higher-order Change Thesis is distinct from the Change Thesis I set out to defend in Section 1, so that rather than providing an interpretation of the view, I have merely changed the subject. Moreover, it is not clear in general how one gets from an identity between entities of type t such as the higher-order Change Thesis to an identity between entities *not* of type t.

This objection relies on the idea that the Change Thesis discussed in Section 1 does not involve quantification over entities of type t. It is easy to see why one would think that, because the surface grammar of the sentence 'Time is change' suggests that 'time' and 'change' are mass nouns. But in that case, the Change Thesis expresses an identity between entities of type e—i.e., objects—and one can infer from the Change Thesis that time and change exist (i.e., that $\exists x(\text{Time}(x) \wedge \text{Change}(x))$). However, it seems far more obvious to me that neither time nor change exist than that the Change Thesis does not involve quantification over entities of type t, despite its surface grammar. More generally, I agree with Prior [3] that many claims which appear to be about a 'monstrous object called Time'—such as that time is dense, or that time is circular—should not be taken literally, but rather should be treated as convenient ways of expressing irreducibly higher-order tense-logical propositions[28]. In light of that, I suggest it is a consequence of accepting Priorian Change that the Change Thesis should be treated as a convenient way of expressing an identity between entities of type t, so that, e.g., to assert that time is change is, in fact, to assert the irreducibly higher-order truth that *for there to be time is for there to be change*.

3. Objections and Replies

In this final section, I respond to objections to the Change Thesis. I begin with Aristotle's reasons for rejecting the view. In *Physics* Book IV, Aristotle presents two arguments against the Change Thesis ([5], IV.11.218b.10-18): that time is 'everywhere and present to all things', but changes exist only either in the things that are changing, or in their locations; and that time passes at a constant rate, but changes occur quickly or slowly, since 'anything which changes a lot in a short stretch of time is fast, and anything which changes little in a long stretch of time is slow'.

I am not persuaded by either of these arguments. The problem is that they rely on alleged differences between time and *particular instances of* change, whereas what is required to make trouble for the Change Thesis is a difference between time and change *in general*. But it is false that change in general—that is, its being the case that something (quantifying into sentence position) is sometimes but not always the case—is either localised in particular individuals or places, or occurs at variable rates.

It is true that some *instances of* change, such as my going from sitting to standing, involve specific individuals and occur in specific places. However, not all instances of change are like that: for example, the change from its being six minutes to its being seven

minutes since I sat down. More generally, there is no clear sense to be made of the idea that the higher-order generalisation that something (quantifying into sentence position) is sometimes but not always the case either involves particular individuals or occurs in particular places. Similarly, it makes sense to compare certain *instances of* change: for example, when the second hand of one clock A is moving faster than that of another clock B, we can say that the second hand of A is changing its position more rapidly than the second hand of B. But there is no clear sense to be made of the idea that the higher-order generalisation that something (quantifying into sentence position) is sometimes but not always the case has a rate, let alone a variable rate[29]. So, even if we accept Aristotle's claims that time is 'everywhere and present to all things' and passes at a constant rate, neither of his arguments present a serious challenge to the Change Thesis[30].

Aristotle's arguments against the Change Thesis can be thought of as instances of the 'Leibnizian' argument that since there are properties possessed by time which are not possessed by change and vice versa, it cannot be the case that time is identical to change. A further such argument is that time *passes* or *flows*, but change does not, and therefore time cannot be identical to change[31]. But what does it mean to say that 'time passes'? According to Prior [39], the claim that time passes—like other claims about time in general—should be interpreted as expressing an irreducibly higher-order tense-logical statement. Specifically, according to Prior, the claim that time passes should be interpreted as equivalent to the higher-order statement that something (quantifying into sentence position) that was true isn't anymore (formally: $\exists p(\mathrm{P}p \wedge \neg p)$).

However, there are two problems with Prior's suggestion. First, what Prior seems to provide is an interpretation of the claim that *time has passed*, rather than that *time passes*. Second, it is natural to think that necessarily, if there is change then time passes. But, that something (quantifying into sentence position) is sometimes but not always the case ($\exists p(\mathrm{S}p \wedge \neg \mathrm{A}p)$) is compatible with every past truth's still being true ($\neg\exists p(\mathrm{P}p \wedge \neg p)$). Therefore, I suggest that the claim that time passes should instead be understood as equivalent to the claim that there is (higher-order) Priorian Change, i.e., something (quantifying into sentence position) is sometimes but not always the case[32]. In that case, it follows straightforwardly that necessarily, there is change just in case time passes. More generally, it follows that the facts that there is time, that there is change, and that time passes are all equivalent to the higher-order truth that something (quantifying into sentence position) is sometimes but not always the case[33].

Here is another instance of the Leibnizian argument against the Change Thesis: time cannot be change because there could not be time without there being *times*, but there could be change without there being times. Let us grant to the objector that there could not be time without there being times. Then, the question is whether there could be *change* without there being times. Given higher-order Priorian Change, the answer to this question is 'no'. This follows from the widely accepted principle that necessarily, it is sometimes the case that p if and only if there is a time at which it is the case that p:

Sometimes Principle: $\Box(\mathrm{S}p \leftrightarrow \exists t(\mathrm{At}\text{-}t(p)))$[34]

Given the Sometimes Principle together with an analogous principle for the tense operator 'A' ('It is always the case that'), the higher-order statement of change '$\exists p(\mathrm{S}p \wedge \neg \mathrm{A}p)$' is equivalent to the claim that something (quantifying into sentence position) is the case at some but not every time (formally: $\exists p \exists t(\mathrm{At}\text{-}t(p) \wedge \neg\forall t(\mathrm{At}\text{-}t(p)))$); and, this implies that there are at least two times.

An opponent of the Change Thesis might respond as follows: if higher-order Priorian Change implies that there are at least two times, it follows that, given the Change Thesis, physical reality has a temporal dimension; and, if so, there is no good reason not to identify time with that dimension, rather than with the change which apparently requires

it. However, it does not follow from the fact that there are at least two times that physical reality has a temporal dimension. The reason is that times do not have to be identified with hypersurfaces. In fact, it is natural for those who accept the higher-order interpretation of change to also accept a higher-order interpretation of times. For example, on one popular such view, a time is something (quantifying into sentence position) that is sometimes the case and 'settles every question', in the sense that, for any p, either it always implies p or always implies not-p[35]:

Times (Higher-Order): $\Box(\text{Time}(p) \leftrightarrow \forall q(\text{A}(p \rightarrow q)\ \text{A}(p \rightarrow \neg q)) \bigwedge \text{S}p)$

Given this higher-order theory of times, it is natural to accept the following related higher-order views of what it is for a time to be *present*, what it is for one time to be *earlier than* another, and what it is for something to be the case *at* a time:

Present Time (Higher-Order): Necessarily, a time is present if and only if it is the case ($\Box\forall t(\text{Present}(t) \leftrightarrow t)$).

Earlier Than (Higher-Order): Necessarily, a time t is earlier than another time t' if and only if whenever t is present, t' will be present. ($\Box\forall t\forall t'(t < t' \leftrightarrow \text{A}(t \rightarrow \text{F}t'))$).

Truth-at-a-Time (Higher-Order): Necessarily, p is true time t if and only if whenever t is the case (i.e., is present), p is the case ($\Box\forall t\forall p(\text{At}\ t(p) \leftrightarrow \text{A}(t \rightarrow p))$).

Naturally, there is a lot more to say about the higher-order theory of times[36]. The point I want to make here is just that it does not follow from the fact that higher-order Priorian Change implies that there are at least two times that physical reality has a temporal dimension, or indeed, that times *exist* in the standard first-order sense, e.g., as hyperplanes[37].

But why not identify time with the *higher-order* temporal dimension? Markosian [4] rejects this view—which he calls 'Time as a Logical Construction from Propositions'—on the basis that 'time itself is clearly more complicated, and has many more things true of it, than some ordered set of propositions'. However, one might agree with Prior ([3], p. 75) that how we speak about time (and, how we experience time) is not a reliable guide to the nature of time itself. Nevertheless, I think there is a good reason to prefer the higher-order Change Thesis to the view that time is the higher-order temporal dimension, namely, that *the reason there is* a higher-order temporal dimension is because there is higher-order change, and not vice versa. Change, and therefore time, come first; that there are times is a consequence of there being time and change.

Another objection to the Change Thesis is that the identification of time with change is unenlightening, because we have no better grip on the notion of change (in general) than we do on the notion of time (in general). I think the higher-order interpretation of Priorian Change provides a response to this objection, as long as one accepts—as many now do—the meaningfulness of irreducibly higher-order quantification. As we saw in the previous section, according to higher-order Priorian Change for there to be change is for something (quantifying into sentence position) to be sometimes but not always the case. Since this analysis of change can be expressed in clear, precise, and meaningful terms ($\exists p(\text{S}p \bigwedge \neg\text{A}p)$), it is wrong to suggest there is any significant difficulty in grasping the notion of change in general on this theory.

A related objection to the Change Thesis is that it is circular. The reason is that to understand the statement of higher-order Priorian Change, one has to understand what it is for something (quantifying into sentence position) to be *sometimes* or *always* the case; and, understanding *that* requires understanding what time is. In contrast, Aristotle's definition of time in *Physics* Book IV as 'a number of change in respect of before and after' ([5], IV.11.219a37) has been argued to rely on an ultimately *non-temporal* understanding of change (as *movement*) and 'before' and 'after', and therefore to provide a genuinely non-circular explanation of time[38].

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The problem with this objection is that it relies on the false assumption that the Change Thesis is intended to provide a reductive analysis or explanation of the *concept* of time. In fact, the Change Thesis as I have interpreted it expresses a (higher-order) metaphysical identity statement, and the significance of such statements requires only that they present their referent under different 'guises' or 'modes of presentation'. For example, suppose Lois Lane knows Superman only as *Clark's superhero friend*. It would still be a matter of great interest to Lois to know that Clark is identical to Superman, despite her concept of Superman being cognitively dependent on her concept of Clark. Similarly, even if the concept of change is an essentially *temporal* concept, it is a significant question as to whether, in reality, time is identical to or distinct from change.

Finally, by the standard logic of (higher-order) identity, the Change Thesis implies that necessarily, there is time if and only if there is change, and therefore that there cannot be change without time, and there cannot be time without change. To close this section, I address arguments against each of these claims in turn.

Some philosophers argue that recent theories in contemporary physics demonstrate the physical (and therefore, metaphysical) possibility of change without time. For example, according to Barbour's [44] interpretation of quantum physics, fundamental physical reality is 'timeless' in the sense of lacking any physically fundamental time-ordering, and yet also contains 'change' conceived as variation between static 'time-capsules'. More generally, Barbour's view is one of several competing physical theories such as loop quantum gravity (LQG) and string theory which aim to unify general relativity and quantum physics, and some prominent advocates and interpreters of those theories describe them as implying that there is change but no time. For example, here is Rovelli, a prominent defender of LQG ([45], p. 86):

> The absence of the quantity 'time' in the fundamental equations does not imply a world that is frozen and immobile. On the contrary, it implies a world in which change is ubiquitous. . ..

And ([45], p. 92):

> The absence of time does not mean. . . that everything is frozen and unmoving. It means that the incessant happening that wearies the world is not ordered along a timeline. . . It is a boundless and disorderly network of quantum events.

Let us assume that possibly, LQG is true. Does this show that there could be change without time, contrary to the Change Thesis?

I don't think so. When Rovelli asserts that according to LQG there is change without time, he means that if LQG is true, *there is no fundamental physical or geometric structure corresponding to time as it is ordinarily conceived based on human experience*. To see this, let us continue the first quotation above:

> [. . .] it implies a world in which change is ubiquitous, without being ordered by Father Time; without innumerable events being necessarily distributed. . . along the single Newtonian timeline, or according to Einstein's elegant geometry.

And ([45], p. 86; author's emphasis):

> Time, as Aristotle suggested, is the measure of change; different variables can be chosen to measure that change, and none of these has *all* the characteristics of time as we experience it. But this does not alter the fact that the world is in a ceaseless process of change.

In other words, it is a premise of Rovelli's interpretation of LQG as timeless that necessarily, there is time only if there is some fundamental physical or geometric structure corresponding to time as it is ordinarily conceived based on human experience. But one does not

have to accept this premise. For example, one might think that if LQG is true, time is metaphysically emergent from certain patterns of correlation, physical asymmetries, or dynamical relations at the fundamental physical level[39]. On such a view, the absence of a time variable at the fundamental physical level is compatible with the existence of time at a non-fundamental level. Or, one might think that time is change, and therefore that since there is change given LQG, there is also time. Indeed, Rovelli clearly expresses the latter view ([45], p. 92; author's emphasis):

> If by 'time' we mean nothing more than happening, then everything is in time. There is *only* that which exists in time.

In other words, if time is change, the ubiquity of change in LQG entails the ubiquity of time as well.

But is it true that there is change in LQG? For a defender of the higher-order Change Thesis, this comes to the question of whether LQG is compatible with there being something (quantifying into sentence position) that is sometimes but not always the case. If it is not, then defenders of the higher-order Change Thesis must admit that if LQG is true, there is neither change nor time. And whilst this would not falsify the Change Thesis, it would have the implausible consequence that whether there is time and change depends on the truth of LQG.

Is there any reason to think that LQG is *incompatible* with higher-order Priorian Change? Some philosophers associate Priorian Change with A-theories such as Presentism—according to which there are only present events—and the Growing Block and Moving Spotlight theories, which on their standard formulations imply that there is a fundamental distinction between present and non-present events[40]. If Priorian Change required the truth of such views then it would clearly be in tension with physical theories such as LQG, which posit no such distinction between present and non-present events. However, higher-order Priorian Change does not require the truth of such A-theories. For example, both Bacon [48] and Cian Dorr [49] defend A-theories according to which there is no fundamental distinction between present and non-present events, times are irreducibly higher-order entities, and higher-order Priorian Change is true[41].

Some philosophers have also argued for the possibility of time without change. An influential source of this view is Shoemaker [50], who argues as follows: there could be a world formed entirely of three regions, A, B, and C, such that each region appears from the perspective of agents located at other regions to periodically undergo a "local freeze": that is, an interval of time in which nothing changes[42]. If local freezes appear to last for a year each time, and A appears to freeze every three years, B appears to freeze every four years, and C appears to freeze every five years, then according to Shoemaker, the agents in that world could justifiably believe that reality as a whole undergoes a "global freeze" for one year every sixty years, and therefore that there are intervals of time without change.

As Le Poidevin [51] points out, Shoemaker's argument is intended to establish the *epistemic* claim that there could be justification for believing in time without change, not the *metaphysical* claim that there could be time without change[43]. However, taking inspiration from Shoemaker, Le Poidevin [51] defends the metaphysical claim. Le Poidevin's argument is as follows: first, say that an object is in a 'local freeze' if it undergoes no intrinsic change at all over an interval of time. Second, there could be something—e.g., a fundamental particle—which is in a local freeze. Third, if there could be an object that is intrinsically a certain way in a spatiotemporal region, it is possible for that object to be that way and for there to be absolutely nothing else[44]. Therefore, possibly, there is exactly one object and it is locally frozen. Since this object—call it 'Lonely'—would be the only object and would be locally frozen, reality as a whole would be frozen, i.e., there would be a 'global freeze'. Fourth, say that for an object to be 'temporally changeless' is for it to be in a series of

successive, qualitatively identical but numerically distinct states, such that each state in the series intrinsically causally sustains the next. Fifth, Lonely could be temporally changeless. Sixth, the existence of exactly one temporally changeless object is sufficient for the existence of time. Therefore, it is possible for there to be an interval of time during which nothing changes, i.e., there could be time without change[45].

Le Poidevin's argument relies on several substantive and not uncontroversial premises: for example, that if an object could be intrinsically a certain way in a region then it could be that way and be entirely alone, and that being locally frozen is an intrinsic property. However, Le Poidevin ([51], pp. 171; 179) also defends a second, and more straightforward argument for the possibility of time without change: namely, that if 'spacetime substantivalism' is true, there could be time without change[46]. I discuss both of Le Poidevin's arguments below.

Interestingly, Prior comes unexpectedly close to accepting the possibility of time without change. Prior [54] argues that all change could cease without time ending, so that there would be an interval of time such that for any moment in it, all and only what is true at that moment is also true at every moment later than it. In other words, Prior accepts the possibility of a temporal series of the following kind:

$t_1, t_2, t_3, t_3, t_3, t_3 \ldots$[47]

In the above series, t_2 is the last moment of 'live' time, and t_3 is the first moment of 'dead' time[48]. Now, to accept the possibility of such a temporal series is *not* to accept the possibility of time without change, since there is Priorian Change in the above series: t_1, t_2, and t_3 are all times at which something (quantifying into sentence position) is the case but not always the case. However, one might think that if the above temporal series is possible then so is this one:

$t_3, t_3, t_3, t_3 \ldots$

Assuming that, necessarily, if there are at least two temporally related times then there is time, this series represents a situation in which there is time without change. But Prior is not forced to accept such a possibility: for example, he could argue that there cannot fail to be Priorian Change, in which case such a series is impossible.

Although Prior is not committed to the possibility of time without change, by accepting the possibility of 'dead' time, he makes a surprising concession to those who defend the possibility of time without change: namely, that a time can succeed itself, and therefore that there could be distinct times at which all and only the same things are true. Not only does this violate the standard assumption that the *earlier than* relation between times is necessarily irreflexive[49], but it is at odds with Prior's commitment to a higher-order view of times, on which (standardly) there cannot be distinct times at which all and only the same things are true[50]. It is also at odds with the view that times are hyperplanes. The reason is that necessarily, every time is present at, and only at, itself. It follows that if there could be distinct times at which all and only the same things are true, there could be two times such that at each of them, the other is present. But that is impossible whatever one's view of what it is for a time to be present at itself, including on the 'deflationary' view favoured by B-theorists that for a time to be present at itself is for it to be located at, or identical to, itself. Therefore, whether one conceives of times in a higher-order way or as hyperplanes, there are powerful reasons to reject Prior's view that times could succeed themselves.

The problem with the idea that there could be time without change is exactly that it requires the possibility of there being distinct times at which all and only the same things are true. For example, consider Le Poidevin's [51] argument that there could be a single, intrinsically unchanging, but nevertheless temporal object. If there really was time but no change in such a situation, there would be a series of times such that all and only

what is true at each time is true at every other time. But as we have seen, whatever one's view of times, such a temporal series is impossible. Therefore, there could not be a single, intrinsically unchanging, but nevertheless temporal object. Or consider Le Poidevin's [51] argument that if spacetime substantivalism is true, there could be time without change. I assume the thought here is that if spacetime substantivalism is true then there could be an empty, four-dimensional region of spacetime and nothing else, in which case there would be time but no change. However, even if there was nothing but an empty, four-dimensional region of spacetime, there would still be change: for example, change in which 'empty' point-events are occurring, or in how much time has elapsed since those events occurred, or in which times are present[51]. In other words, there would still be times, but at no pair of those times would all and only the same things be true.

How can those who defend the possibility of time without change have failed to notice this problem? Strikingly, both Shoemaker [50] and Le Poidevin [51] acknowledge it, and duly restrict the scope of their conclusions. For example, here is Shoemaker ([50], p. 364):

> [. . .] 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 unchanged for an infinite length of time. [. . .] I think that philosophers who have claimed that time involves change have generally meant. . . that during every interval of time, no matter how short, something or other must change with respect to some such property or other.

And here is Le Poidevin ([51], p. 179):

> Nevertheless, it might be insisted, although a relationism of the kind just mooted permits a period of time without qualitative change, it still requires, for the differentiation of times, existential change. For one state of affairs has to give way to another. If this is a kind of change, however, it is a rather esoteric kind, and certainly not the sort that participants in the debate generally have in mind. The traditional issue is whether there can be time without either purely qualitative change, or the coming into or going out of existence of ordinary objects (which itself would imply qualitative change).

In other words, neither Shoemaker [50] nor Le Poidevin [51] defend the possibility of time without *any change at all* (or in Shoemaker's case, the possibility of justified belief in time without any change at all). Rather, they defend the possibility of time without 'purely qualitative change', i.e., the possibility of there being something that undergoes no purely intrinsic change over an interval. But the question we are interested in is not whether there can be time without change *in some restricted sense*; it is whether there can be time without any change at all. And none of the arguments we have considered succeed in establishing that conclusion.

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Notes

1 I was motivated to address this question by the work of my former PhD student Rachel Russell, and by a presentation by Ned Markosian at the 2025 LanCog Summer Metaphysics Workshop entitled 'What is Time?'.
2 It is important to distinguish the question 'What is time?' from the question 'What is a (moment of) time?'. The latter question has received more attention than the former in contemporary philosophy of time. Two popular views are that times are certain cross-sections of the spacetime manifold—see, e.g., Sider [2]—and that times are certain kinds of propositions; see, e.g., Prior [3].
3 In what follows, I use 'thing' and 'object' interchangeably. I assume that to be a thing or object is just to exist, or to be something.
4 In addition to Fiocco [1], see Markosian [4] for recent engagement with this question.
5 What exactly Aristotle means by this is a matter of ongoing debate. See, for example, Bostock [6], Coope [7], and Zachhuber ([8], 14ff).
6 See Moravec [11] for relevant discussion.
7 After Bertrand Russell and Arthur Prior respectively; see, e.g., Russell [12] and Prior [3].
8 By 'true' here and throughout I mean 'monadically true' or 'true *simpliciter*', unless otherwise specified.
9 Propositional Eternalism is defended by Frege [13] and Russell [14]. Examples of eternal propositions are that it is cloudy in London now; that I am dancing at some time before this one; and that 2 + 2 = 4.
10 Examples of temporary propositions include the propositions that it is cloudy in London; that I am dancing at a time before the present time; and that it is a Tuesday.
11 Propositional Temporalism is not be treated as equivalent to the view that some propositions are true *relative to some but not all times*, even if it entails that view. This is because some philosophers—for reasons which are too complicated to go into here—think that the latter view is compatible with Propositional Eternalism. See, e.g., Zimmerman [15].
12 For a general defence of Propositional Temporalism, see Brogaard [16].
13 See Markosian [4]. Markosian calls this 'The Standard Account of What Time Is'.
14 Markosian [19] provides three arguments against the view that the spacetime manifold in unified.
15 As Minkowski [20] writes: 'henceforth space by itself, and time by itself, are doomed to fade away into mere shadows, and only a kind of union of the two will preserve an independent reality'.
16 See Skow [21] for an argument against this response. On the Growing Block theory, see Correia & Rosenkranz [22] and Forrest [23]. On the Moving Spotlight theory, see Cameron [24], Deasy [25], and Cameron & Deasy [26].
17 I also defend a higher-order interpretation of what it is for something to be a 'time'—see Section 3.
18 On this, I agree with Markosian [4].
19 For an introduction to higher-order metaphysics, see Fritz & Jones [27].
20 For example, Quine ([28], pp. 66–68) analyses higher-order quantification in terms of first-order quantification over sets, and Boolos [29] analyses higher-order quantification in terms of first-order plural quantifiers such as '$\exists xx$' ('For some things').
21 And also *ways ways are* ('properties of properties'), *ways truths and falsehoods are* ('properties of propositions'), and so on ad infinitum. The best way to get to grips with the full generality of higher-orderism is via 'type-theory', which provides a formal specification of the infinite syntactic categories to which the expressions of a higher-order logic can belong; informally, the 'types' are the different kinds of higher-order entities over which the different higher-order quantifiers can quantify. For an introduction to type theory in connection with higher-order logic, see, e.g., Dorr ([32], Section 2).
22 Trueman [33] rightly emphasises this point.
23 On the higher-order approach to puzzles about property instantiation, the *locus classicus* is Jones [34]. On the higher-order approach to understanding the notion of absolute generality, the *locus classicus* is Williamson [35].
24 The symbol 'S' in this sentence is the temporal operator 'It is sometimes the case that', or equivalently, 'It is, was, or will be the case that'.
25 But does it not require the existence of *times*, given that it involves the tense operators 'S' and 'A'? I address this point in the next section.
26 I am grateful to an anonymous reviewer for raising this.
27 Think of them as propositions if you can resist thinking of propositions as *things* like sets or abstract objects.
28 See Prior ([3], pp. 75; 189).
29 If change itself *does* have a rate, then necessarily, that rate is one second per second, and so is certainly not variable. See Prior [37].
30 See Corish ([38], pp. 223–226) for a different set of responses to Aristotle's arguments against the Change Thesis.
31 Corish ([38], p. 228) discusses an objection along similar lines.
32 This suggestion is in the spirit of Prior [3], who interprets both the claim *that time passes or flows* and the claim *that a change has occurred* as expressing the higher-order fact *that something (quantifying into sentence position) that was true is not true any more*.

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[33] It could be objected that the claim that something (quantifying into sentence position) is sometimes but not always the case fails to capture the idea that time is *constantly* passing, and that change is *constantly* occurring. For a way to capture these particular claims in higher-order terms, see Van Cleve ([40], p. 162).

[34] 'At-*t*' here expresses the tense operator 'It is the case at time *t* that. . .'. For Priorians, 'At-*t*, *p*' is naturally treated as equivalent to 'It is always the case that if *t* is present then *p*'.

[35] See, e.g., Prior [3], Prior & Fine [41], Dorr & Goodman [42], and Banfi & Deasy [43].

[36] See, for example, the sources cited in footnote 35 above.

[37] This is not to suggest that the higher-order view of times is *incompatible* with the view that there is a spacetime manifold, and therefore that there are hyperplanes.

[38] See Coope ([7], Chapter 4).

[39] See especially Huggett & Wüthrich [46].

[40] On Presentism, see Prior [47].

[41] A notable difference between Bacon's and Dorr's views is that on Dorr's theory, higher-order Priorian Change is restricted to propositions about particular individuals, so there is no change in the purely qualitative facts. This is a consequence of Dorr's reductive analysis of tense operators such as 'sometimes' and 'always' in terms of temporal counterpart relations between first- and higher-order entities.

[42] By 'interval' throughout I mean non-zero or 'proper' interval.

[43] Note that on some theories of doxastic justification, the epistemic thesis entails the metaphysical thesis. For example, if a belief is justified only if it is known and knowledge is factive, then if it is possible for someone to justifiably believe there is time without change, it is possible for there to be time without change.

[44] This premise is supposed to follow from Lewis's ([52], p. 88) 'principle of recombination'.

[45] Van Cleve ([40], p. 168) defends a similar argument.

[46] On theories of spacetime, see Pooley [53].

[47] I assume that the members of this series are temporally ordered. For ease of exposition, I also assume that time is discrete. If it was not, then as Prior ([54], p. 156) points out, there would be no last moment of 'live' time. See also Van Cleve ([40], p. 160).

[48] I assume for the purposes of discussion here that once dead time begins, it never ends.

[49] I assume that if *t* succeeds t' then t' is earlier than *t*.

[50] Suppose times *t* and t' are such that all and only the same things are true at them. On the higher-order view, for a proposition *p* to be true at a time *t* is for it to be the case that whenever *t* is true, *p* is true ($A(t \rightarrow p)$)). So, the supposition amounts to: $\forall p(A(t \rightarrow p) \leftrightarrow A(t' \rightarrow p))$. Since (always) *t* is true at *t* and t' is true at t', it follows from the above that $A(t \leftrightarrow t')$, i.e., *t* and t' are 'eternally equivalent'. And on the higher-order view, eternally equivalent times are identical.

[51] On the higher-order view of times, change in which time is present would amount to change in which times are true; on the view of times as hyperplanes, it would amount to variation across the temporal dimension in which times exist.

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