**Is Our Naïve Theory of Time Dynamical?**

**Abstract**

We investigated, experimentally, the contention that the folk *view*, or naïve *theory*, of time, amongst the population we investigated (i.e. U.S. residents) is dynamical. We found that amongst that population, (i) ~70% have an extant theory of time (the theory they deploy after some reflection, whether it be naïve or sophisticated) that is more similar to a dynamical than a non-dynamical theory, and (ii) ~70% of those who deploy a naïve theory of time (the theory that have on the basis of naïve interactions with the world and not on the basis of scientific investigation or knowledge) deploy a naïve theory that is more similar to a dynamical than a non-dynamical theory. Interestingly, while we found stable results across our two experiments regarding the percentage of participants that have a dynamical or non-dynamical extant theory of time, we did not find such stability regarding which *particular* dynamical or non-dynamical theory of time they take to be most similar to our world. This suggests that there might be two extant theories in the population—a broadly dynamical one and a broadly non-dynamical one—but that those theories are sufficiently incomplete that participants do not *stably* choose the *same* dynamical (or non-dynamical) theory as being most similar to our world. This suggests that while appeals to the ordinary view of time may do some work in the context of adjudicating disputes between dynamists and non-dynamists, they likely cannot do any such work adjudicating disputes between particular brands of dynamism (or non-dynamism).

**1. Introduction**

Appeals are often made, in the metaphysics of time, to the *folk* *concept* [[1]](#footnote-1)or *naïve* *theory[[2]](#footnote-2)* of time. Many dynamists[[3]](#footnote-3) have thought that, at the very least, a dynamical account of time better accords with our ordinary view of time, and have, on those grounds, supposed that this provides defeasible reason to prefer a dynamical theory.[[4]](#footnote-4) Some have even thought that features of our ordinary view of time might give us defeasible reason to prefer one, over another, dynamical theory.[[5]](#footnote-5) Even some non-dynamists[[6]](#footnote-6) concede that dynamism gets *something* right about the way we ordinarily think about time, though non-dynamists suppose that whatever reason we might have, on these grounds, to embrace dynamism, are defeated by countervailing reasons.[[7]](#footnote-7)

It is common to suppose that dynamical theories best account for our temporal phenomenology. Things *seem* to us, phenomenologically, as though time passes, or flows. On the basis that there is such a seeming, some dynamists have argued that we ought accept a dynamical theory,[[8]](#footnote-8) and some non-dynamists have argued that we ought think that aspect of our phenomenology is illusory.[[9]](#footnote-9) Still others have been moved to reject the claim that things seem this way to us at all.[[10]](#footnote-10) These are important debates, but not ones with which we are concerned here. In this paper we are interested not in how things phenomenologically *seem* to us, but rather, in how we ordinarily take them to be. Of course, these might very well be connected—one might inform the other. But we take no stand on that. In what follows, then, we are interested in the claim that dynamical theories more closely resemble our ordinary view of time, than do non-dynamical theories.

What is our ordinary view of time? First, who is the ‘us’ in whose theory we are interested? In §2 we speak to this issue in more detail. For now, we can say that the ‘us’ in this paper, is the population from which we drew our sample: namely U.S. residents. We make no claims about whether our data generalise to other populations. What, then is an *ordinary view* of time?

We will suppose it to be a *theory*, or *model*, of time. Henceforth we will use the term ‘theory’ but ‘model’ would do just as well. Philosophical models, or theories, of time—presentism, the growing block theory, the eternalist B-theory, and so on—are examples of such models. We, however, we make no assumption that non-philosophers’ theories are as complete or consistent as these. Further, we want to allow that the theories of non-philosophers might to at least some extent be *tacit,* insofar as individuals may not be able to clearly articulate their theory. We suppose that non-philosophers’ theories can, however, be more, or less, *similar* to philosophical models, and hence that they can be more similar to dynamical models than non-dynamical models.

Further, we will distinguish what we will call a *naïve theory* of time, from a *sophisticated theory* of time. A naïve theory is the theory we arrive at, after only naïve interaction with the world. It is the theory that we would expect children to develop, and that we would expect adults to have, in the absence of having been exposed to any relevant science. In this sense, our naïve theory of time is a little like what is sometimes known as folk physics.[[11]](#footnote-11) It’s the theory we arrive at, given our cognitive resources, on the basis of naïve (i.e. non scientific) interaction with the world.

By contrast, a sophisticated theory is the theory we arrive on the basis of at least some scientific investigation into the nature of time (though this may not be first-hand investigation, but rather, includes knowledge of such investigation carried out by others). The sophisticated theory, then, may well be more complete and more detailed than the naïve theory, though we won’t assume that is so. As we will understand it, however, a sophisticated theory of time will largely *supplant* a naïve one in at least the following sense: in moments of reflection, when asked about time, people will deploy their sophisticated theory if they have one. This is consistent with people lacking a naïve theory altogether, once they have a sophisticated theory, or with them still having such a theory, and *sometimes* reflexively responding by using a naïve theory, in the way that perhaps sometimes even physicists respond the world by deploying a naïve physical theory. Nevertheless, in this latter case the naïve physical theory is not what these physicists think the world is like, and to this extent, it supplants their naïve theory. Since we interested in what people think the world is like, after at least some reflection, we assume that while reflecting, people will deploy *either* a naïve theory *or* a sophisticated theory, and that they will deploy a sophisticated theory if they have one. Further, we will refer to whatever theory someone does deploy, after reflection, as their *extant theory.* Hence, for any person, it can be an open question whether their extant theory of time is a naïve theory or a sophisticated theory. So we will say that people deploy a naïve theory if their extant theory is naïve, and deploy a sophisticated theory is their extant theory is sophisticated, where ‘deploying’ here, is using that theory in moments of reflection.

There are, then, two rather different claims that one might be making, when one claims that dynamical theories more closely resemble the way we ordinarily view time than do non-dynamical theories. One might be claiming that as a matter of fact, most people’s extant theory of time more closely resembles a dynamical, than a non-dynamical, theory of time.[[12]](#footnote-12) To suppose this to be so is either to suppose that most people have a sophisticated theory of time, and that this theory is dynamical, or to suppose that most people only have a naïve theory, and this theory is dynamical, or to suppose that either theory is dynamical, and hence it doesn’t matter which one is extant.

Alternatively, one might be claiming that of those people who deploy a naïve theory of time (rather than a sophisticated one) most of these people have a *naïve* theory that more closely resembles a dynamical, than a non-dynamical, theory of time. Notably, this latter claim could be true even if most people’s extant theory of time is non-dynamical, so long as their extant theory is sophisticated, and that theory largely supplanted a naïve dynamical theory. For then we would find that a majority of those who deploy a naïve theory, have a theory that is dynamical.

As it remains unclear which of these claims is intended, we empirically tested both. Following philosophers’ assumption that dynamical theories better accord with our ordinary view of time, we hypothesised (i) that people’s extant theory of time more closely resembles a dynamical than a non-dynamical theory of time, and (ii) that amongst those people who deploy a naïve theory of time, that theory more closely resembles a dynamical than a non-dynamical theory of time.

It is, of course, much more difficult to test hypotheses about people’s naïve theory of time than their extant theory of time, on the assumption that some (perhaps all) people have had their naive theory supplanted by a more sophisticated theory. Thus, experiment one focuses entirely on the first hypothesis: it aims to determine which extant theory of time people have. Experiment two focuses on the second hypothesis. Our aim is not to determine whether people’s extant theory is most likely to be naïve, or sophisticated: so we do not aim to determine what proportion of people deploy a naïve, as opposed to a sophisticated, theory of time since this would require quantifying how much familiarity with science (say) makes one’s extant theory sophisticated not naïve. Instead, we approach the second hypothesis by looking for correlations between people’s extant theory of time, in particular, whether that theory is dynamical or not, and various factors that are, in turn, associated with having a sophisticated theory of time, such as level of education, familiarity with science, familiarity with the science of time, and so on. Even if we can’t use those measures to determine whether someone’s extant theory is naïve or sophisticated, we can expect there to be a correlation between these latter things, and someone’s extant theory of time being sophisticated rather than naïve. By contrast, we’d expect there to be a correlation between someone believing that their extant theory just seems obviously true, and that theory being a naïve, rather than sophisticated, theory. We can then use this data to determine whether there is a correlation between various indicia of an extant theory being a sophisticated, or a naïve, theory of time, and that extant theory being dynamical or non-dynamical. The aim is to determine whether we have reason to think that the proportion of people who have a dynamical extant theory of time, is the same as the proportion of people *from amongst those who deploy a naïve theory* (as opposed to a sophisticated one) who have a dynamical theory of time. Another way to put this is as follows: do we have reason to think that of those people who deploy a naïve theory of time, a greater percentage (or indeed a lesser one) of those people have a dynamical (naïve) theory, than the proportion of people who have a dynamical extant theory? We focus principally on whether there is reason to think that a *greater* proportion of people who deploy a naïve theory, deploy a naïve *dynamical* theory, than the proportion of people who have an extant dynamical theory, since it seems most plausible to suppose that if a sophisticated theory supplants a naïve one, it will be a sophisticated non-dynamical theory supplanting a naïve dynamical theory.

In what follows we outline some preliminaries (§2), and then outline our methodology and results (§3). With regard to our first hypothesis, we found that some kind of dynamical theory is most similar to the majority of participants’ extant theory of time. That said, some kind of non-dynamical theory is most similar to the extant theory of a substantial minority (~30%) of participants. With regard to our second hypothesis, we found no correlations between levels of education or familiarity with the science of time, and whether people’s extant theory is dynamical or non-dynamical, and no correlation between the latter, and people’s belief that their extant theory just seems obvious. Given the lack of *any* of these correlations, we have no reason to think that the distribution, in the population, of *sophisticated* dynamical and non-dynamical theories, is any different from the distribution of *naïve* dynamical and non-dynamical theories. Finally, we note that although we found stable results regarding whether participants took a dynamical, or a non-dynamical, model to be most like our world, we did not find stable results regarding which particular model they chose. In §4 we consider the implications of these results for philosophical theorising about the nature of time.

**2. Preliminaries**

Quite generally, there is some evidence (though its extent and replicability is disputed[[13]](#footnote-13)) that different populations of participants deploy different concepts, or have different theories, that are relevant to philosophical questions.[[14]](#footnote-14) Moreover, social scientists have found cross-cultural and cross-linguistic differences across a broad variety of tasks that are relevant to people’s extant theory of time. For instance, English, Japanese, Chinese and the Niger-Congo language Wolof contain moving time expressions, such as ‘the weekend is approaching’ (Evans, 2003:14). However, Whorf (1950) argued (now controversially) that Hopi Indian does not contain any moving time expressions. More recently, Sinha and Gardenfors (2014) have argued that the presence of moving time or moving ego metaphors (such as ‘we are approaching the weekend’) is not universal, noting that Amondawa and Y´eli lack both kinds of metaphor.

We also know that the way linguistic communities speak about time, and write and read language, is correlated with the way that they explicitly conceptualise time. For instance, native Mandarin speakers (some of whom sometimes write vertically) are much more likely than native English speakers to use a vertical axis when mapping out time, with earlier events represented higher (Boroditsky 2001). Native English speakers show no such pattern (Boroditsky, Fuhrman & McCormick, 2011). Further, when tested in English, bilingual participants are more likely to arrange a sequence horizontally when tested in English, and vertically when tested in Mandarin (Boroditsky, Fuhrman & McCormick, 2011). Furthermore, Mandarin speakers use far more vertical metaphors than English speakers (Chen, 2007; Boroditsky, 2001), suggesting that there is relation between the way in which a language is represented in written form, and the way in which speakers represent the temporal dimension (see also Fuhrman & Boroditsky, 2010; Casasanto & Bottini, 2014).[[15]](#footnote-15)

Moreover, there is evidence of cross-cultural differences in the ways in which people use spatial metaphors and gestures when communicating about time: whether, for instance, they point in front of them for the future and behind for the past, or *vice versa* (or something else entirely) (Núñez et al., 2012). It is, however, controversial exactly how much either our extant theory, or our naïve theory, of time should be thought to vary in light of this cross-cultural data. Callender (2017:18) takes the view that the core features of our naïve theory of time are the same cross-culturally, though the communication and explicit representation (though gesture, linguistic expression, and diagram) of the theory might differ.

We won’t take a stand on the extent to which there are cross-cultural differences in people’s theory (naïve or otherwise) of time. Our sample population is drawn exclusively from the U.S. So we can be taken to be asking the following question: is a dynamical theory most similar to the extant, or naïve, theory of time amongst U.S. residents? We make no claims about whether our data generalise to other populations. Indeed, we make no assumption that there is a single theory to be found even amongst our participants. It could be (and indeed, we think it is the case) that there are multiple such theories at play.

Our methodology is well attuned to discovering this to be so, since we present participants with six different models of time, and ask them which of these they think is most similar to our world. Thus we collect quite fine-grained results: we are able to distinguish participants who think that the growing block model is most similar to our world, from participants who think that presentism is most similar to our world. In theory, then, we could discover not only whether most, or all, of the population have a dynamical extant theory of time, or whether the population is split between those who have a dynamical, and those a non-dynamical, extant theory of time, but also whether, amongst those who have an extant dynamical theory of time, *which* dynamical theory of time they have. In fact, however, as we will see in §3 (and as we discuss in §4) while we found stable results across both experiments regarding the percentage of participants who choose a dynamical, or a non-dynamical, theory as being most similar to our world, there were not stable results regrading which particular such theory they chose. As such, our later analyses collapse our data across all the dynamical results, and across all the non-dynamical, so that we compare extant dynamists with extant non-dynamists since *this* seems to be the crucial distinction that participants are making. We return to discuss this further in §4.

**3. Experimental Design and Result**

**Experiment 1**

**3.1 Method**

*3.1.1 Participants*

600 people participated in the study. Participants were U.S. residents, recruited and tested online using Amazon Mechanical Turk,[[16]](#footnote-16) and compensated $2 for approximately 20 minutes of their time. 65 participants had to be excluded for failing to follow task instructions. This means that they failed to answer the questions (55), or failed an attentional check question (10). The remaining sample was composed of 535 participants (aged 20-70; 229 female). Mean age 35.80 (SD = 11.07). Ethics approval for this study was obtained from the [blanked] Human Research Ethics Committee. Informed consent was obtained from all participants prior to testing. The survey was conducted online using Qualtrics.

*3.1.2 Materials and Procedure*

All participants read a series of 6 vignettes, presented in random order. Each vignette described a universe, which represented a contemporary philosophical model of time. Three of the vignettes described dynamical models—presentism,[[17]](#footnote-17) the growing block,[[18]](#footnote-18) and the moving spotlight[[19]](#footnote-19)—and three described non-dynamical models—eternalist B-theory,[[20]](#footnote-20) eternalist C-theory,[[21]](#footnote-21) and a Quantum Gravity model.[[22]](#footnote-22) As comprehension questions, participants were asked whether the following three statements are true or false of each universe:

1. In Universe [A/B/C/D/E/F] the present is real, the past and future are not.
2. In Universe [A/B/C/D/E/F] which events are present, changes.
3. In Universe [A/B/C/D/E/F] the past, present, and future, are real.

Finally, participants were then shown all six vignettes, and were asked “Which of these Universes is most like our Universe?”.

Although we attempted to make the six vignettes accessible to non-philosophers, we also wanted them to be recognisable descriptions of philosophical models of time. Given the danger that not all participants would understand the vignettes as we intended, participants who incorrectly answered two or more of the comprehension questions regarding the universe they judged to be most like our universe were excluded. At no point could participants return to a previous screen.

The six vignettes are below.

**Universe A: Moving Spotlight**

Imagine a universe (Universe A) where a single set of events exists. All these events are equally real. The sum total of reality never grows or shrinks, so the totality of events that exist never changes. These events bear relations of earlier-than and later-than to one another and these relations between events in Universe A are fixed and never change. In addition, in this universe some of those events have a special property: the property of *presentness*. Only those events that have this special property are in the present, while any events that do not have it are either in the past, or the future. In Universe A this property moves. When one set of events has it, the set of events that did have it, no longer do so. The movement of the property is a fundamental feature of the universe and cannot be explained by anything else. In this universe events can be ordered in terms of the movement of this property.

For example, in Universe A there are two particles, P1 and P2. In this universe, there is an event of P1 hitting a particle detector, and an event of P2 hitting that particle detector. If the property of presentness moves from the event of P1 hitting the particle detector to the event of P2 hitting the particle detector, then the order of events generated by the movement of presentness in this universe is: first P1 hits the particle detector; second, P2 hits the particle detector. P1’s hitting the particle detector is earlier-than P2’s hitting the particle detector. The ordering of events that is generated via the movement of presentness has a single, correct, direction. In this case, it goes *from* P1’s hitting the detector, *to* P2’s hitting the detector (not from P2’s hitting the detector to P1’s hitting the detector).

**Universe B: B-Theory**

Imagine a universe (Universe B) where a single set of events exists. All these events are equally real. The sum total of reality never grows or shrinks, so the totality of events that exist never changes. These events bear relations of earlier-than and later-than to one another and these relations between events in Universe B are fixed and never change. It is possible to order the events in that universe in terms of these relations of earlier-than and later-than. In Universe B no set of events is special. Every event is present from the perspective of those located at it, just as every location is ‘here’ from the perspective of those located at it.

For example, in Universe B there are two particles, P1 and P2. In this universe, there is an event of P1 hitting a particle detector, and an event of P2 hitting that particle detector. The event of P1 hitting the particle detector is earlier-than the event of P2 hitting the detector. That relation never alters; it is always the case that the event of P1 hitting the detector is earlier-than the event of P2 hitting the detector. The ordering of events that is generated via these relations has a single, correct direction. In this case, it goes *from* P1’s hitting the detector *to* P2’s hitting the detector (not from P2’s hitting the detector to P1’s hitting the detector).

**Universe C: Presentism**

Imagine a universe (Universe C) in which the only events and objects that exist, are those in the present moment. So in Universe C, past events and objects, and future events and objects, do not exist.  Universe C is a giant three dimensional object that is is extended in space, but not extended in time. It is comprised of only present objects. In Universe C, which objects exist, and what properties those objects have, *changes.*So Universe C is constantly changing, so that objects that did exist, in the past, go out of existence as present objects come into existence. But past objects no longer exist, and objects that will exist in the future do not yet exist.

For example, in Universe C there are two particles, P1 and P2. In this universe, there is an event of P1 hitting a particle detector and an event of P2 hitting that particle detector. But when the event of P1 hitting the particle detector exists, the event of P2 hitting the particle detector does not exist, and when the event of P2 hitting the particle detector exists, the event of P1 hitting the particle detector does not exist. In Universe C events can be ordered in terms of their coming into, and out of, existence. This ordering of events has a single, correct, direction. In this case, the event of P1’s hitting the detector is earlier, in the ordering, to the event of P2’s hitting the detector. Or, as we might say, the direction goes *from* P1’s hitting the detector, *to* P2’s hitting the detector (not from P2’s hitting the detector to P1’s hitting the detector).

**Universe D: C-Theory**

Imagine a universe (Universe D) where a single set of events exist. All these events are equally real. The sum total of reality never grows or shrinks, so the totality of events that exist never changes. These events bear *between-ness* relations to one another and these relations between events in Universe D are fixed and never change. It is possible to order the events in that universe in terms of these between-ness relations. In Universe D no set of events is special. Every event is present from the perspective of those located at it, just as every location is ‘here’ from the perspective of those located at it.

For example, in Universe D there are three particles, P1, P2, and P3. In this universe, there is an event of P1 hitting a particle detector, and an event of P2 hitting that particle detector, and an event of P3 being deflected from the particle detector. The event of P1 hitting the particle detector is *between* the event of P3 being deflected from the particle detector, and the event of P2 hitting the particle detector. That relation never alters; it is always the case that the event of P1 hitting the particle detector is between the events of P2 hitting the detector, and P3 being deflected from the detector. In this universe the ordering of events generated by the between-ness relations does not generate a direction: there is no fact of the matter as to whether the ordering goes *from* P3’s being deflected from detector, *to* P1’s hitting the detector *to* P2’s hitting the detector or, alternatively, *from* P2’s hitting the detector *to* P1’s hitting the detector, *to* P3’s being deflected from detector. Instead, in Universe D think from one perspective, P3’s being deflected from detector occurs earlier than P1’s hitting the detector which occurs earlier than P2’s hitting the detector, and that from another perspective P2’s hitting the detector occurs earlier than P1’s hitting the detector, which occurs earlier than P3’s being deflected from detector.

**Universe E: Growing Block Universe:**

Imagine a universe (Universe E) where new events and objects constantly come into existence. The events and objects that come into existence remain in existence, so the sum total of reality grows as new events and objects come to exist. In this universe the set of events and objects that have just come into existence are those that are in the present. As new events and objects come into existence, already existing events and objects become part of the past. No future events and objects exist.

For example, in Universe E there are two particles, P1 and P2. In this universe, there is an event of P1 hitting a particle detector, and an event of P2 hitting that particle detector. When the event of P1 hitting the detector has just come into existence, the event of P2 hitting the detector does not exist; but when the event of P2 hitting the detector has just come into existence, the event of P1 hitting the detector exists. So when P1’s hitting the detector has just come into existence, P2’s hitting the detector is future and does not exist, and when P2’s hitting the detector has just come into existence, P1’s hitting the detector exists, and is past. In this universe the ordering of events that is generated via the coming into existence of new events and objects has a single, correct, direction. In this case, it goes *from* P1’s hitting the detector, *to* P2’s hitting the detector (not from P2’s hitting the detector to P1’s hitting the detector).

**Universe F: Quantum Gravity Machian Theory**

Imagine a universe (Universe F) where a single set of events exist. All these events are equally real. The sum total of reality never grows or shrinks, so the totality of events that exist never changes. While all these events exist there is no correct way to order these events in terms of relations of earlier-than and later-than. Instead, Universe F is like a deck of cards. Each card represents all the events that bear purely spatial relations to one another. Purely spatial relations are relations such as Mike being three feet from Lily, or Boston being 16000kms from Sydney. In Universe F, the only distance relations that exist are spatial distance relations. There are no temporal distance relations. So each ‘card’ represents all the events that are spatially separated from one another, and which bear no other distance relations to one another. In Universe F all the events ‘on the same card’ occur simultaneously. While there is a fact of the matter regarding the spatial relations between objects and events located on the same card, there is no fact of the matter as to the order of the cards. Any way of ordering the cards is just as good as any other way. Because of this, there is no fact of the matter about the distance relations between events on different cards.

For example, in Universe F there are three particles, P1, P2 and P3. In this universe, there is an event of P1 hitting a particle detector, an event of P2 hitting that particle detector, and an event of P3 being deflected by that particle detector. The event of P1 hitting the detector and the event of P3 being deflected from the detector bear spatial relations to each other. So there is a fact of the matter as to spatial distance between P1’s hitting the detector and P3’s being deflected by the detector. So we can say how far away P1 is, from P3, when each encounters the detector. These two events occur simultaneously. But the event of P2 hitting the detector does not occur simultaneously with either P1 hitting the detector or P3 being deflected by the detector. P2’s hitting the detector is, as it were, on a different card from P1’s hitting the detector and P3’s being deflected by the detector. So there is no fact of the matter regarding the distance between P1’s hitting the detector and P2’s hitting the detector, or between P3’s being deflected by the detector and P2’s hitting the detector. Nor is there any fact of the matter which order these events occur in. It is no more true to say that first P3 is deflected from the detector, and later, P2 hits the detector, than it is to say that first P2 hits the detector, and later, P3 is deflected by the detector. And that is true for all events in Universe F that are not simultaneous with one another. Any way of ordering non-simultaneous events is equally good.

**Experiment 2:**

**3.2 Method**

*3.2.1 Participants*

600 people participated in the study. Participants were U.S. residents, recruited and tested online using Amazon Mechanical Turk, and compensated $2 for approximately 20 minutes of their time. 87 participants had to be excluded for failing to follow task instructions. This means that they failed to answer the questions (69), or failed an attentional check question (18). The remaining sample was composed of 513 participants (aged 20-71; 195 female; 1 prefer not to answer). Mean age 35.21 (SD = 10.59). Ethics approval for this study was obtained from the [blanked] Human Research Ethics Committee. Informed consent was obtained from all participants prior to testing. The survey was conducted online using Qualtrics.

*3.2.2 Materials and Procedure*

It is difficult to target participants’ naïve theory of time, since it is difficult to know whether their extant theory is the result of sophisticated learning, and hence is a sophisticated theory, or not. We reasoned, however, that there should be a correlation between people deploying a sophisticated theory and (a) levels of education, (b) having some understanding of what science tells us about the nature of time, and (c) thinking it likely that science will discover that our universe is as they take it to be. We reasoned that there would be a correlation between people deploying a naïve theory and (d) it seeming obvious that our universe is as their preferred model says it is.

Given that current popular science is best thought of as suggesting that time is *not* dynamical, it seems most likely that if participants have a sophisticated theory that supplants a naïve theory, that sophisticated theory will be more likely to be non-dynamical than dynamical. Moreover, if, as we hypothesised, most people’s naïve theory is dynamical, then it is more likely that a sophisticated theory will supplant a naïve dynamical theory than a naïve non-dynamical theory. If that is right, then we should expect that amongst those who deploy a naïve theory, a greater percentage will have a dynamical theory, than the percentage of people who have an extant dynamical theory. For many people with an extant theory will have a sophisticated theory, and a sophisticated theory is more likely to be non-dynamical than is a naïve theory. If that is the case, we would expect there to be a correlation between having an extant non-dynamical theory, and (a) through (c) above, and would expect a correlation between having an extant dynamical theory, and (d) (since we’d expect that more people with a dynamical extant theory are deploying a naïve theory that has not been supplanted with a sophisticated non-dynamical theory). In the absence of any such correlation, we have no reason to think that amongst those who deploy a naïve theory, the percentage of people whose theory is dynamical, is any different from the percentage of people who have an extant dynamical theory.

In this experiment participants were shown the same vignettes, in the same manner, as in experiment 1. In this, we aimed to replicate the results from experiment 1. In this experiment, however, we collected a range of demographic data on education levels, and on the final screen where participants were shown all six vignettes, and were asked “Which of these Universes is most like our Universe?”, participants were then asked to indicate their level of confidence in their choice on a 7-point Likert scale. A ‘1’ response meant that they were completely unconfident while a ‘7’ response indicated that they were completely confident. Finally, participants were asked how much they agree, on a Likert scale of (1) strongly disagree through to (7) strongly agree with the following statements. (For statements (b) and (c), the universe the participant judged to be the most like the actual universe is featured.)

1. I have some understanding of what science tells us about the nature of time.
2. It is very likely that through science we will discover that Universe [A/B/C/D/E/F] is most like our Universe.
3. It just seems obvious that Universe [A/B/C/D/E/F] is most like our Universe.

**3.3 Analyses**

*3.3.1 Experiment 1*

We predicted that more people would think that a vignette describing a dynamical theory of time is most like the actual world (our universe) than would think that a vignette describing a non-dynamical theory of time is most like the actual world. We found this; the majority of participants surveyed think that one of the dynamical theories of time is most like the actual world (*X*2 (1, N = 334) = 36.465, *p* < .001). However, it is important to point out that a substantial minority of people think that a non-dynamical theory of time is most like the actual world (see Table 1).

*Table 1.* *Frequency with which participants judged various philosophical models to be most like the actual world. Table 1 shows only of those participants that answered 2 out of 3 comprehension questions correctly.*[[23]](#footnote-23)

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Dynamical** | | | **Non-Dynamical** | | |
| 228 (66.3%) | | | 116 (33.7%) | | |
| **Moving Spotlight** | **Presentism** | **Growing Block** | **Block** | **C-Theory** | **Quantum Gravity** |
| 50 (14.5%) | 60 (17.4%) | 118 (34.3%) | 59 (17.2%) | 32 (9.3%) | 25 (7.3%) |

*3.3.2 Experiment 2*

We predicted that more people would think that a vignette describing a dynamical theory of time is most like the actual world (our universe) than would think that a vignette describing a non-dynamical theory of time is most like the actual world. We found this; the majority of participants surveyed think that one of the dynamical theories of time was most like the actual world (*X*2 (1, N = 334) = 69.174, *p* < .001). However, once again it is important to point out that there was a substantial minority of people who think a non-dynamical theory of time was most like the actual world as well (see Table 2).

*Table 2.* *Frequency with which participants judged various philosophical models to be most like the actual world. Table 2 shows only of those participants that answered 2 out of 3 comprehension questions correctly.[[24]](#footnote-24)*

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Dynamical** | | | **Non-Dynamical** | | |
| 243 (72.8%) | | | 91 (27.2%) | | |
| **Moving Spotlight** | **Presentism** | **Growing Block** | **Block** | **C-Theory** | **Quantum Gravity** |
| 80 (24%) | 82 (24.6%) | 81 (24.3%) | 43 (12.9%) | 24 (7.2%) | 24 (7.2%) |

While we find differences regarding the specific theory of time that people believe is most like the actual world, we find a consistent preference across experiment 1 and experiment 2 for a dynamical theory of time as opposed to a non-dynamical theory of time. We were therefore interested in whether there were any obvious differences between those who chose a dynamical theory of time relative to those who chose a non-dynamical theory of time that might potentially explain this difference. There was no significant difference in confidence between those who think the actual world is most like a dynamical theory of time (*M* = 4.68, *SD* = 1.50) and those who think the actual world is most like a non-dynamical theory of time (*M* = 4.38, *SD* = 1.63; *t*(332) = 1.582, *p* = .114). As mean confidence levels are around 4.5, it seems that participants were not completely confident, irrespective of which kind of theory they chose.[[25]](#footnote-25)

We made two further hypotheses. We hypothesised that having a non-dynamical extant theory of time would be correlated with (1) level of education, (2) understanding of what science tells us about time, and (3) perceived likelihood of being vindicated by science and that having a dynamical extant theory of time would be correlated with (4) the seeming obviousness of the relevant dynamical theory.

However, there were no significant differences between those who think the actual world is most like a dynamical theory of time or most like a non-dynamical theory of time for any of these factors. First, a chi-square test of independence was performed to examine the relation between level of education and having an extant dynamical theory of time. There was no relationship between these variables (*X2* (7, N = 334) = 6.783, *p* = .452). That is, level of education is not associated with whether or not someone thinks that the actual world is most like a dynamic theory of time or a non-dynamic theory of time (see Table 3).

*Table 3.* *Frequency with which participants of different levels of education judged a dynamical or non-dynamical theory of time to be most like the actual world. Table 3 shows only of those participants that got 2 out of 3 comprehension questions correct.[[26]](#footnote-26)*

|  |  |  |
| --- | --- | --- |
| **Education** | **Dynamical** | **Non-Dynamical** |
| Less than high school diploma | 0 (0%) | 1 (1.1%) |
| High school diploma or GED | 22 (9.1%) | 7 (7.7%) |
| Some college, but no degree | 34 (14%) | 20 (22%) |
| Associates degree | 26 (10.7%) | 11 (12.1%) |
| Bachelor’s degree | 121 (49.8%) | 37 (40.7%) |
| Master’s degree | 32 (13.2%) | 12 (13.2%) |
| Professional degree | 6 (2.5%) | 2 (2.2%) |
| Doctorate degree | 2 (0.8%) | 1 (1.1%) |

Second, participants were asked their level of agreement on a 7-point Likert scale for the following statement: “I have some understanding of what science tells us about the nature of time”. There was no significant difference in level of agreement for this statement between those who think that the actual world is most like a dynamical theory of time (*M* = 4.95, *SD* = 1.40) and those who think that the actual world is most like a non-dynamical theory of time (*M* = 5.14, *SD* = 1.27; *t*(332) = 1.168, *p* = .244).[[27]](#footnote-27)

Third, participants were asked their level of agreement on a 7-point Likert scale for the following statement: “It is very likely that through science we will discover that Universe [A/B/C/D/E/F] is most like our Universe”, where the universe they were asked about is the one they chose as being most like the actual universe. There was no significant difference in level of agreement for this statement between those who think that the actual world is most like a dynamical theory of time (*M* = 4.83, *SD* = 1.41) and those who think that the actual world is most like a non-dynamical theory of time (*M* = 4.74, *SD* = 1.37; *t*(332) = 0.529, *p* = .597).[[28]](#footnote-28)

Fourth, participants were asked their level of agreement on a 7-point Likert scale for the following statement: “It just seems obvious that Universe [A/B/C/D/E/F] is most like our Universe” where the universe they are asked about is the one they chose as being most like the actual universe. There was no significant difference in level of agreement for this statement between those who think that the actual world is most like a dynamical theory of time (*M* = 4.66, *SD* = 1.49) and those who think that the actual world is most like a non-dynamical theory of time (*M* = 4.52, *SD* = 1.63; *t*(332) = 0.776, *p* = .439).[[29]](#footnote-29)

**4. Discussion**

The results of experiments 1 and 2 show that a majority of people have an extant dynamical theory of time, and that there is no reason to think that these percentages are different when we look to people’s naïve theory of time (if they have one). Hence, amongst the population we targeted, people’s ordinary view of time—on either way of conceiving it—is indeed dynamical.

Of course, this methodology has limitations. It is possible that shifts in the representation of time found in ordinary media—film, book, and television—change people’s naïve theory of time into a more sophisticated theory, even if those people report having no explicit scientific knowledge (and regardless of education levels). For instance, it could be that there being a lot of time travel stories present in contemporary western culture, in which people travel to the past, or future, suggests to these people that past and future exist, and, perhaps, that the present is just a matter of where one is located. If there being time travel stories is, itself, the result of scientific development which created the conceptual space to think in these ways, then one might argue that people’s extant theory of time will, at least in part, be the affected by these stories, and so will in fact be a sophisticated representation. If that is so, then it might be that almost all our participants’ extant theories are in fact sophisticated theories, despite the lack of the correlational data. If that is so, then we simply cannot speak to whether people’s naïve theory of time is dynamical or not: we can only speak to whether their extant theory (which in fact is sophisticated) is dynamical or not.

Having said that, it remains unclear to what extent these tacit representations of time in the popular media have an effect on people’s extant theory of time, and also unclear to what extent those stories are the product (perhaps indirectly) of scientific knowledge. After all, early time travel stories begin at least as far back as Wells’ 1888 “The Chronic Argonauts” which is before Einstein’s theories of general and special relativity, and well before those theories were translated into a four-dimensional space-time by Minkowski. Nevertheless, we have to allow that it might be that scientific knowledge has ‘infected’ by some means or other, people’s extant theories of time, without that infection going via explicit scientific learning. So we ought be cautious about interpreting our results about people’s naïve theory of time. Nevertheless, it seems safe to assume that were that so, we would find that amongst those who deploy a naïve theory of time, more than 70% have a dynamical theory.

At present, however, we will assume, with some caution, that our results provide some reason to think that of those people who deploy a naïve, (as opposed to sophisticated) theory of time, ~70% of those have a dynamical theory. If this is so, then a substantial minority of participants (~30%) have an extant non-dynamical theory of time and, amongst those who deploy a naïve theory of time, a substantial minority of those (i.e ~30%) have a naïve non-dynamical theory.

Since there is such variation in the philosophical purposes to which an appeal to our ordinary view of time is put, it remains an open question whether these statistics (if correct) vindicate the uses to which an appeal to the ordinary view of time has been put (even when restricted to this population). For instance, one might think that if an ordinary view of time is to provide defeasible evidence in favour of, say, a dynamical theory, the *greater* the percentage of people who have that theory, the *better* that evidence (after all, if only 55% of people had a dynamical theory of time, it’s not clear whether that would really provide much (even defeasible) evidence in favour of dynamism. It may be, then, that although our studies vindicate the claim that a majority of people have a dynamical theory of time, a 70/30 split is somewhat less impressive those who advance such arguments would ideally like.

Of additional interest is what our findings suggest about the more specific theories of time we find in the population targeted. Recall that in experiment 2 we collapsed our data into two groups—dynamical and non-dynamical—in order to determine whether there were correlations between people having an extant dynamical (or non-dynamical) theory, and the various demographic features (i.e. levels of education etc.). One might have wondered why collapsing in this way was permissible; after all, one might worry that the distinction between dynamical and non-dynamical theories is a philosophical distinction that non-philosophers might not track, in which we case we have no more reason to collapse the data into dynamical vs dynamical, than to collapse it any other way. What made it permissible to collapse these results is that we found no statistically significant difference in the percentage of participants who chose a dynamical theory (or a non-dynamical theory) in experiment 1, compared to experiment 2. This result was stable. By contrast, when we look at the distribution of participants who chose the *particular* dynamical (or non-dynamical) theories they did, across experiment 1 and 2, we do not find those distributions to be stable.

Though further work would need to be done, this suggests that rather than there being at least six fairly complete and determinate theories of time in the population we studied (one corresponding to each of the philosophical theories that participants thought were most like our world), instead, there are two theories of time in that population, one dynamical and non-dynamical, and that these theories are incomplete, or indeterminate, in various respects. Suppose some participants have a somewhat incomplete, or indeterminate, dynamical theory, and the rest have an incomplete, or indeterminate, non-dynamical theory. Then we would expect to get the same distribution of people choosing a dynamical, as opposed to non-dynamical theory, in each of our experiments: which is exactly what we find. However, if each of these theories is sufficiently incomplete, or indeterminate, then it might be quite unclear to participants *which* of the *particular* models described is most like the way they take our world to be.

For instance, those with a dynamical theory might be unsure which of the three dynamical theories is most like the theory they deploy. That would explain why we found different distributions between the particular dynamical models, and between the particular non-dynamical models, between experiments 1 and 2. Further this hypothesis seems to be supported by participants’ confidence judgements. When asked how confident participants were in their judgements about which universe is most like our own, we find that the mean response (with a fairly small standard deviation) is in the mid 4’s on a Likert scale. While these results tend towards more certainly than uncertainty, 4 is halfway between being completely certain, and completely uncertain, and so these results might be taken to show that, in general, participants are not *overly* certain of which philosophical model of time is most like our universe. Perhaps, instead, what they are certain of is that the right model is dynamical, or that it is non-dynamical, though they are unsure which dynamical (or non-dynamical) model is the right one to choose. In turn, that suggests that any arguments in favour of one, over another, particular theory (dynamical or non-dynamical) on the basis of our ordinary view of time, is misplaced. For neither of our ordinary theories of time—the dynamical or the non-dynamical theory—appear to be sufficiently complete, or determinate, to provide even *defeasible* evidence in favour of a particular dynamical or non-dynamical theory.

**5. Conclusion**

We empirically tested whether a dynamical theory of time more closely accords with people’s extant, or naïve, theory of time than does a non-dynamical theory of time. We found that ~70% of participants have a dynamical extant theory of time, and, of those who have a naïve theory of time, ~70% have a dynamical theory. While this result is stable over both experiments, the split regarding which *particular* dynamical or non-dynamical theory of time most closely accords with people’s theory of time is not stable across both experiments. This suggests that there are two theories of time in this population: a somewhat incomplete or indeterminate dynamical theory, and a somewhat incomplete or indeterminate non-dynamical theory, and that it is unclear, to those who deploy a dynamical theory, *which* of the more complete dynamical philosophical models is *most* like the theory they deploy, and likewise, it is unclear to those who deploy a non-dynamical theory, which of the more complete non-dynamical philosophical models is most like the theory they deploy.

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1. See Baron & Miller (2015a; 2015b). [↑](#footnote-ref-1)
2. See Callender (2017). [↑](#footnote-ref-2)
3. Dynamists hold that events are ordered in terms of whether they are objectively past, present or future; the location of events within that ordering is dynamic in that a set of events, *E*, is future, will be present, and will then become past. According to dynamists time flows by virtue of a set of events being objectively present, and which sets of events that is, changing. Dynamists take tensed thought and talk to pick out genuinely dynamical (A-theoretic) properties. For a defense of the dynamism in its various guises see Broad (1923; 1938), Cameron (2015), Tallant (2012), Tooley (1997), Prior (1967; 1968; 1970), Gale (1968), Schlesinger (1980; 1994), Smith (1993), Craig (2000), Crisp (2003), Markosian (2004), Baron (2014), Bourne (2006), Monton (2006), Sullivan (2012) and Zimmerman (2005). [↑](#footnote-ref-3)
4. See Baron et al. (2015). [↑](#footnote-ref-4)
5. See Miller (2008). [↑](#footnote-ref-5)
6. Non-dynamists suppose that there are no objective tensed properties of properties of pastness, presentness or futurity; all that exists is an ordering of events in terms of the relations of earlier-than, later-than and simultaneous-with. Non-dynamists take tensed thought and talk to be indexical, picking out the time at which a proposition is expressed either in speech or via some doxastic state. According to non-dynamists there is no temporal flow. Defenders include Callender (2008), Lee (2014), Mellor (1981; 1998), Paul (2010), Price (1997; 2011), Prosser (2000; 2007; 2012; 2013) [↑](#footnote-ref-6)
7. See Callender (2008). [↑](#footnote-ref-7)
8. See Smith (1994), Craig (2000) and Schlesinger (1994). [↑](#footnote-ref-8)
9. See Paul (2010), Prosser (2007; 2012; 2013), Callender (20080, Le Poidevin (2007) and Dainton (2011:405). [↑](#footnote-ref-9)
10. See Hoerl (2014), Torrengo (forthcoming), Braddon-Mitchell (2013), Deng (2013; 2018), Bardon (2013:95), Baron et al. (2015) and Miller, Holcombe & Latham (2018). [↑](#footnote-ref-10)
11. On folk physics, see Norton (2003), Livengood & Machery (2007), Shanahan (1996) and Elga (2005). [↑](#footnote-ref-11)
12. Or, at least, they are closer to being temporal dynamists than non-dynamists. [↑](#footnote-ref-12)
13. See Nagel et al. (2013), Kim & Yuan (2015) and Seyedsayamdost (2015). [↑](#footnote-ref-13)
14. See Stich (1990), Weinberg et al. (2001), Machery et al. (2004) and Buckwalter & Stich (2014). [↑](#footnote-ref-14)
15. See Furhman et al. (2011). The spatial morphemes sháng (up) and xiá (down) are used to talk about the ordering of events, weeks, months, and so on. Earlier events are sha`ng (up), and later events are xiá (down). For example, ‘sháng ge yuè’ refers to the last or previous month, and ‘xiá ge yuè’ refers to the next or following month. [↑](#footnote-ref-15)
16. These are people in a large database who partake in a range of online experiments, usually in psychology, behavioral economics and sociology, for monetary compensation. While they have significant experience in completing online experiments, there is little reason to think that these people will have a particular interest in, or knowledge of, philosophy. [↑](#footnote-ref-16)
17. The view that only the present exists, and that the present changes. See Tallant (2012). [↑](#footnote-ref-17)
18. The view that the past and present exist, but the future does not, and time passes by new three-dimensional slices of space-time (new times) coming into existence. See Forbes (2016) and Tooley (1997). [↑](#footnote-ref-18)
19. The view that the past, present, and future exist, but that which moment is objectively present changes as the ‘light’ of presentness moves over a fixed four-dimensional block. More recent versions of the view are somewhat more sophisticated than this, where the block is often rather than unlike the fixed block of B-theoretic eternalism. See for instance Cameron (2015) and Skow (2015). [↑](#footnote-ref-19)
20. Also known as the block universe model. This is the view that the past, present, and future exist, and no moment in objectively present. Instead, presentness is a mere indexical that picks out wherever one happens to be. See Mellor (1991; 1998). As we will present the model, it is a model in which although there is no temporal flow or passage (since there is no objective present to move) nevertheless, time has a direction: it points from earlier, to later. For discussion of direction and the B-theory see Tegtmeier (1996) and Maudlin (2007). [↑](#footnote-ref-20)
21. The C-theory is much like the block universe theory, except that it posits that time has no direction. At best, time has an apparent direction, at certain locations within the block, due to various physical processes being asymmetric in that location. See Price (1997; 2007). [↑](#footnote-ref-21)
22. This is the theory that is usually called timeless, insofar as it holds that there exists a set of three-dimensional ‘instants’ in configuration space, which bear no temporal relations to one another (i.e. no temporal ordering or distance relations). See Barbour (1994a; 1994b; 1999). [↑](#footnote-ref-22)
23. It makes no difference to the reported result if we include those who do not comprehend the vignette they chose as being most like the actual world. When all responses are tallied, 332 (62%) choose a dynamical theory of time and 203 (38%) choose a non-dynamical theory of time. Theory preference was still not equally distributed in the population (*X2* (1, N = 535) = 31.105, *p* < .001). Likewise, it makes no difference to the reported result if we only include those who comprehendedevery vignette. Looking at just these participants, 60 (75%) choose a dynamical theory of time and 20 (25%) choose a non-dynamical theory of time. Theory preference was still not equally distributed in the population (*X2* (1, N = 80) = 20, *p* < .001) [↑](#footnote-ref-23)
24. Once again it makes no difference to the reported result if we include those who do not comprehend the vignette they chose as being most like the actual world. When all responses are tallied, 346 (67.4%) chose a dynamical theory of time and 168 (32.6%) chose a non-dynamical theory of time. Theory preference was still not equally distributed in the population (*X2*(1, N = 514) = 61.642, *p* < .001). Likewise, it makes no difference to the reported result if we only include those who comprehendedevery vignette. Looking at just these participants, 53 (81.5%) choose a dynamical theory of time and 12 (18.5%) choose a non-dynamical theory of time. Theory preference was still not equally distributed in the population (*X2* (1, N = 65) = 25.862, *p* < .001) [↑](#footnote-ref-24)
25. It makes no difference to the reported result if we include those who do not comprehend the vignette they chose as being most like the actual world. There was still no significant difference in confidence between those that think the actual world is just like a dynamical theory of time (*M* = 4.76, *SD* = 1.48) and a non-dynamical theory of time (*M* = 4.63, *SD* = 1.56; *t*(512) = 0.954, *p* = .34). [↑](#footnote-ref-25)
26. It makes no difference to the reported result if we include those who do not comprehend the vignette they chose as being most like the actual world. There was still no association between level of education and having a dynamical representation of time (*X2* (7, N = 514) = 3.857, *p* = .796) [↑](#footnote-ref-26)
27. It makes no difference to the reported result if we include those who do not comprehend the vignette they chose as being most like the actual world. There was still no significant difference in level of agreement for the statement “I have some understanding of what science tells us about the nature of time” between those who think the actual world is most like a dynamical theory of time (*M* = 5.08, SD = 1.34) and those who think the actual world is most like a non-dynamical theory of time (*M* = 5.18, SD = 1.32; *t*(512) = 0.851, *p* = .395). [↑](#footnote-ref-27)
28. It makes no difference to the reported result if we include those who do not comprehend the vignette they chose as being most like the actual world. There was still no significant difference in level of agreement for the statement “It is very likely that through science we will discover that Universe [A/B/C/D/E/F] is most like our Universe” between those who think the actual world is most like a dynamical theory of time (*M* = 4.89, SD = 1.41) and those who think the actual world is most like a non-dynamical theory of time (*M* = 4.84, SD = 1.32; *t*(512) = 0.414, *p* = .679). [↑](#footnote-ref-28)
29. It makes no difference to the reported result if we include those who do not comprehend the vignette they chose as being most like the actual world. There was still no significant difference in level of agreement for the statement “It just seems obvious that Universe [A/B/C/D/E/F] is most like our Universe” between those who think the actual world is most like a dynamical theory of time (*M* = 4.76, SD = 1.45) and those who think the actual world is most like a non-dynamical theory of time (*M* = 4.68, SD = 1.47; *t*(512) = 0.595, *p* = .552). [↑](#footnote-ref-29)