**An empirical investigation of the role of direction in our concept of time[[1]](#footnote-1)**

**Abstract**

This paper empirically investigates one aspect of the folk concept of time (amongst US residents), by testing how the presence or absence of *directedness* impacts judgements about whether there is time in a world. Experiment 1 found that *dynamists* (those who think the actual world contains an A-series), showed significantly higher levels of agreement that there is time in dynamically directed (growing block) worlds than in non-dynamical non-directed (C-theory) worlds. Comparing our results to those of Latham et al. (ms), we report that while ~70% of dynamists say there is time in B-theory worlds, only ~45% say there is time in C-theory worlds. Thus, while the presence of directedness makes dynamists more inclined to say there is time in a world, a substantial subpopulation of dynamists judge that there is time in non-directed worlds. By contrast, a majority of *non-dynamists* (those who deny that the actual world contains an A-series) judged that there was time in both growing block worlds (78.1%—80.5%) and C-theory worlds (70.7%—75.6%), with no significant differences between these judgements. Experiment 2 found that when participants are only presented with non-dynamical worlds—namely, a directed (B-theory) world and a non-directed (C-theory) world—they report significantly higher levels of agreement that there is time in B-theory worlds. However, the majority of participants (67.2%—73.8%) still judge that there is time in C-theory worlds. We conclude that while the presence of directedness bolsters judgements that there is time, most people do not judge it to be necessary for time.

**1. Introduction**

In this paper we take up the following question: what role does the presence of what we will call *directedness* play in folk judgements about whether a world contains time? An ordered sequence of events, or instants, is directed just in case there is a fact of the matter which event in the sequence is *first* and which *last*. So a temporal sequence is directed if there is a fact of the matter which direction along the temporal axis points to the past, and which direction along the temporal axis points to the future. In debates about the metaphysics of time, there are two positions which hold that time is a directed in this way.

A-theoretic views posit a directed ordering, where direction is the product of robust temporal passage. A-theorists posit an A-series: an ordering of times in terms of intrinsic, monadic, (typically irreducible) properties of being present, being past, and being future. While there is always exactly one time that possesses the property of being present, which time that is, changes. We take this to be definitive of robust temporal passage. For contemporary defences of the A-theory in its various guises see Forbes (2016), Skow (2015) and Deasy (2017). Henceforth we will often call A-theoretic views *dynamical views*. On such views the directedness of the temporal ordering is given by the direction of the movement of the present.

B-theoretic views, as we will understand them here, are non-dynamical views on which there is directedness.[[2]](#footnote-2) On these views, no moment is objectively present. Instead, every moment is present at itself, just as every location is here at itself. B-theorists posit a B-series ordering of times in terms of the unchanging B-relations of *earlier-than*, *later-than­* and *simultaneous with*. These B-relations are *directed*, asymmetric (except *simultaneous with*), relations, which generate a temporal ordering on which there is a fact regarding which temporal direction is past, and which future. Some versions of the B-theory hold that time’s having a direction is a primitive or fundamental matter (Maudlin 2007; Oaklander 2012; Tegtmeier 1996, 2009, 2014, 2016; Kajimoto, Miller & Norton 2019) while others hold that time’s having a direction reduces to there being some other, directed, asymmetric relation like causation (Mellor 1998; Le Poidevin 1991) or to some asymmetric distribution of properties through time (such as, for instance, the increase of entropy) away from a boundary condition (Loewer 2012; Albert 2000). Regardless, B-theorists all agree that the temporal ordering is directed.

A much less popular non-dynamical view is what we will call the C-theory of time. On that view, the temporal ordering is not directed (Price 1996; Farr 2012, 2018). We can think of the C-theory as, roughly, the view that there exists a block universe of events with no temporal arrow built into the block. If the block has two temporal boundary conditions, then there is no fact of the matter as to which boundary is the first, and which the last. Likewise, there is no fact of the matter which direction along the temporal axis points to the past, and which direction along the temporal axis points to the future. One way to spell this out is to say that there exists a C-series ordering of times in terms of C-relations,[[3]](#footnote-3) which are *undirected* asymmetric ordering relations.

While there has been a good deal of discussion about the folk concept, or naïve theory, of time as it pertains to dynamical versus non-dynamical theories of time, there has been very little discussion of the role that directedness plays in our folk judgements about time. It has been said that dynamical theories of time best capture the folk concept, or naïve theory, of time.[[4]](#footnote-4) Given the relative unpopularity of the C-theory, there is, we think, tacit consensus that the B-theory better accords with the folk concept, or naïve theory, of time, than does the C-theory. This paper empirically tests this presumption.

Henceforth we frame the discussion in terms of a folk *concept* of time,[[5]](#footnote-5) and the content of that concept, but we could just as easily frame it in terms of a naïve theory of time.[[6]](#footnote-6) Then we are interested in what role directedness plays in determining whether the folk concept of time is satisfied (i.e. something falls under it) at a world: that is, what role directedness plays, in folk judgements regarding whether a world contains time.

We begin, in §2, by clarifying some key terms and examining the relevant literature. In §3 we outline the methodology and results of our two experiments, and in §4 we discuss the implications of our results.

**2. The Literature**

There has been much research into the variety of ways in which people represent time through metaphorical language (especially using spatial metaphors), through diagrams (whether people draw a time-line vertically or horizontally; whether time runs left-to-right, right-to-left, top-to-bottom or bottom-to-top) and through gestures (pointing in a particular direction to point towards the future, or the past). Most of this research has focused on the ways in which these representations differ cross-culturally.[[7]](#footnote-7) Until recently, however, there has been little research into the content of the folk concept of time: in particular, into what sorts of structures—order, direction, dynamical properties—must exist in order for the folk concept to be satisfied. This is perhaps surprising, given that the folk concept of time is closely linked to other folk notions that have been regular targets of empirical work, including *inter alia* determinism (particularly in its connection to free will), deliberation, agency and causation. Indeed, it seems plausible that the folk concept of time is inextricably connected with folk concepts of causation, persistence, agency and deliberation. For instance, it’s hard to see how to make much sense of deliberation in the absence of some concept of time (even if that concept were in some sense merely tacit). After all, in order to deliberate we need to treat some events as past—as held fixed, and as the basis upon which we can deliberate, and other events as future—as open, and as events about which we can deliberate. Likewise, the folk concept of time seems deeply connected to notions of causation, both in that causal interventions seem to be things that we do in time, and in the sense that we typically suppose that earlier interventions have later effects. It goes without saying that the folk concept of time is connected to our concept of persistence. Given this important conceptual nexus, it seems especially important to understand the folk concept of time: to understand the conditions under which it would, and would not, be satisfied. That, in turn, can allow us to shed light on the conceptual connections between that concept and other important concepts.

Moreover, as we pointed out in §1, some philosophers use purported alignment with the folk concept of time to argue in favour their preferred account of temporal metaphysics. For simplicity, for now we will talk of ‘the’ folk concept. However, given the apparent cross-cultural variation we don’t assume that there is a single, shared concept.

In this paper we aim to target only one component of the folk concept of time: the role that directedness plays in whether that concept is satisfied at a world. To investigate this aspect of our concept we do not begin with the assumption that all concepts are explicit: rather, we think that some, including quite likely the folk concept of time, are tacit. That is why we don’t ask people to describe the content of their concept of time; instead, we ask them to *use* the concept by judging whether or not certain scenarios are ones in which there is time. We assume that these responses provide evidence of some aspects the content of even tacit concepts.

The studies we present in this paper build on recent empirical research into the role that dynamical properties play in people’s judgements about whether there is time. We know, from empirical research by Latham, Miller & Norton (2019), that the population they tested (US residents) robustly divides into the majority, who think time in our world is dynamical (~70%) and the minority who think it is non-dynamical (~30%).[[8]](#footnote-8) We also know from more recent work (Latham, Miller & Norton, ms) that the presence of dynamical properties in a world is important, in quite complex ways, for whether the population of folk tested (again US residents) judge that there is time in that world.

As our experimental design takes its cue from Latham et al. (ms), we will describe their approach in some detail. In one experiment, participants were presented with two ‘time-neutral’ vignettes,[[9]](#footnote-9) one describing a dynamical world (in the form a growing block world[[10]](#footnote-10)) and one describing a B-theoretic world. Participants were asked to judge which of the vignettes describes a world most like our world. Next, in random order, participants were told that the growing block world has in fact been discovered to be just like our world, and were asked whether there is time in that world, and then told that the B-theoretic world has been discovered to be just like our world, and asked whether there is time in that world. Finally, participants were split into two conditions. In one, participants were told that the growing block world has in fact been discovered to be just like our world, and were then asked whether there is time in a counterfactual B-theoretic world. In the other, participants were told that the B-theoretic world has been discovered to be just like our world, and then asked whether there is time in a counterfactual growing block world. Latham et al. used this methodology because they hypothesised that participants would take the presence of dynamical properties to be necessary for there to be time, only if actually, there are such properties, and not otherwise.

Latham et al. found that *dynamists* (i.e. participants who think that our world is dynamical, as indicated by their judgement that the growing block world is most like ours) showed significantly higher levels of agreement that there is time in a growing block world (~85%) than in a B-theoretic world (~70%). Moreover, they were inclined to say this regardless of whether they were considering the growing block world as actual (i.e. as a discovery made about how our world is) or as counterfactual (as being about some non-actual world), conditional on the B-theory world being actual. Nevertheless, it was still the case that a majority, (~70%) of dynamists judged that there was time in a B-theoretic world (whether actual or counterfactual), suggesting that most dynamists do not take dynamism to be *necessary* for there to be time.

By contrast, non-dynamists (i.e. participants who think that our world is non-dynamical, as indicated by their judgement that the B-theoretic world is most like our own) showed significantly higher levels of agreement that there was time in a B-theoretic world (~90%) than in a growing block world (~73%), (again, regardless of whether they were considering that world as actual or as counterfactual) though a majority still judged that there was time in the growing block world, suggesting that non-dynamists do not take non-dynamism to be *necessary* for there to be time.

We know, from this study, that the presence of dynamism influences people’s judgements about whether there is time in a world. Unsurprisingly, dynamists are more inclined to judge that there is time in a dynamical world than in a non-dynamical world. More surprisingly, perhaps, non-dynamists are more inclined to judge that there is time in non-dynamical worlds than in dynamical worlds.

What remains unclear is how much of a role *directedness* plays in judgements about time. It could be that the majority of participants judged that there was time in worlds that lacked dynamism, because these worlds were nonetheless *directed*, B-theoretic worlds. Hence the results could be taken to suggest that while for some small minority of participants, dynamism is necessary for there to be time, for most, it is only the presence of directedness that matters, and the presence of dynamism is one, but only one, way for a world to be directed.

To test this, we ran two experiments. Our first experiment is a near replication of Latham et al.’s experiment 2. The only difference is that we replaced the vignette describing a B-theoretic world, with a (time-neutral) vignette describing a C-theoretic world. Any difference between our results and Latham et al.’s, then, is down to a difference in the presence, or absence, of direction in the B- and C-theory vignettes, respectively. Following Latham et al.’s methodology, we asked participants which of the vignettes describes a world that is most like our own. In what follows we will call those who choose the growing block vignette as most like our world, dynamists, and those who choose the C-theoretic vignette as most like our world, non-dynamists. One might worry that this is not quite right, since it could be that some B-theorists (those who think the actual world contains a B-series but no A-series and are thus non-dynamists) will judge that the growing block world is more like our world that is the C-theoretic world, since the growing block world contains direction.

We think this unlikely, since the results of Latham et al. (2019) suggest that the folk most robustly track the distinction between dynamism and non-dynamism, rather than any other features of those worlds. If that is right, we should expect B-theorists to choose the C-theoretic world as most like ours.

Since Latham et al. found that dynamists showed significantly higher levels of agreement that there is time in the growing block world (considered as actual or counterfactual) than in the B-theoretic world, we predicted that dynamists would show significantly higher levels of agreement that there is time in the growing block world, whether it is considered as actual or counterfactual, than in the C-theoretic world. We also predicted—based on the hypothesis that Latham et al.’s dynamists judged there to be time in B-theoretic worlds because those worlds are directed—that where in the Latham et al. experiment a majority of dynamists judged that there *was* time in a B-theoretic world, we will instead find that a majority of dynamists judge that there is *not* time in a C-theoretic world. This predicted difference between the judgements of dynamists in Latham et al.’s experiment versus ours reflects the role that we think direction plays in dynamist’s judgements about time.

These are the only predictions we made regarding the comparison of the results between Latham et al.’s experiment and the one we run here. For those predictions we focussed entirely on the percentages of participants who judge there to be time at a world. We also made some predictions about what we would find just confining ourselves to this experiment. Given that Latham et al. found that non-dynamists’ level of agreement that there was time was lower in dynamical worlds than in non-dynamical worlds, we predicted that non-dynamists’ levels of agreement that there is time in the growing block world would be significantly lower than their levels of agreement that there is time in the C-theoretic world. We also hypothesised that dynamists would more strongly agree that there is time in the dynamical world than in the C-theoretic world, and that overall, people would more strongly agree that there is time in the dynamical world than in the C-theoretic world. Finally, we hypothesised that a majority of non-dynamists would nevertheless still judge that there is time in a growing block world.

Our second experiment focuses on participants’ judgements when they are only presented with a vignette that time-neutrally describes a non-dynamically directed world (a B-theoretic world) and a vignette that time-neutrally describes a non-directed world (a C-theoretic world). We call participants who choose the non-dynamically directed world as most like ours, *directionists*, and those who choose the non-directed world as most like ours, *non-directionists.*

If participants are told that our world is non-dynamically directed, or that it is non-directed, what will they judge about time actually, and counterfactually? We considered three hypotheses.

First, it could be that a majority of participants, regardless of whether they are directionists or non-directionists, are what we call *sensitive directionists*. Sensitive directionists hold that there is time only in directed worlds, *conditional on the actual world being directed and not otherwise.* If participants are sensitive directionists, we should expect the following pattern of responses. When told that the non-dynamically directed world is actual, sensitive directionists will judge that there is time only in the non-dynamically directed world, and not in the counterfactual non-directed world. When told that the non-directed world is actual, they will judge that there is time in both the non-directed and the non-dynamically directed worlds.

Second, it could be that directionists are what we call *insensitive* *directionists:* they hold that there is time only in directed worlds, *irrespective of what the actual world is like*. McTaggart (1908) and Williams (1998; 2003) have this view. If participants are like this, they will judge that there is no time in a non-directed world, regardless of whether it is considered as actual or counterfactual. It seems unlikely that non-directionists will be insensitive directionists: for non-directionists think that the actual world is non-directed, and hence unless they are actually error theorists about time, they must not be insensitive directionists.

Finally, participants might be such that there being directional properties is sufficient, but not necessary, for there to be time, and is so regardless of what the actual world is like. We will call this an *insensitively directionally sufficient* concept. If participants are like this, they will judge that there is time in both the non-dynamically directed and the non-directed worlds, and will do so regardless of which of these is taken to be actual.

We had little basis on which to make a prediction on this matter. However, Latham et al. (ms) found that most people do not have a concept of time that is sensitive with regards to the presence of *dynamism*, and instead seem to deploy an insensitive concept on which a world’s being dynamical is sufficient, but not necessary, for it to contain time, regardless of whether the actual world is dynamical or not. While it clearly does not follow that just because people do not take dynamical properties to be necessary if actual, that the same is true of directional properties, this at least gives us some reason to reject this hypothesis. Thus, since it seems plausible that we will be sensitive to the presence, or absence, of direction in a world, we predicted that directionists would have an insensitive directional concept, and that non-directionists would have an insensitively directionally sufficient concept.

In light of this, with regard to the second experiment we had three predictions. First, we predicted that a majority of the population would be directionists, and, as a corollary, that people would more strongly agree that there is time in a directed world than a non-directed world. Second, we predicted that directionists would judge that there is time only in actual or counterfactual directed worlds. Third, we predicted that non-directionists would judge that there is time in both actual and counterfactual non-dynamically directed and non-directed worlds, and that there would be no statistically significant differences between the strength of the judgement of non-directionists about non-dynamically directed and non-directed worlds.

**3. Experimental Design and Results**

We ran two experiments. In each experiment we presented participants with a pair of vignettes, each of which describes a world. In experiment 1, one vignette describes a dynamically directed world—a growing block world—and the other a non-directed world—a C-theoretic world. In experiment 2, one vignette describes a non-dynamically directed world—a B-theoretic world—and the other describes a non-directed world—a C-theoretic world.

In each experiment we aimed to determine:

1. Which world participants took to more closely resemble the actual world, and
2. Whether participants judge that the actual world contains time, given the discovery that it is dynamically directed or non-directed (experiment 1) or given the discovery that it is a non-dynamically directed or non-directed (experiment 2), and
3. Whether participants judge that a counterfactual world contains time, when that world is either dynamically directed or non-directed (experiment 1) or non-dynamically directed or non-directed (experiment 2) conditional on them making the opposite discovery about the actual world.

The result is a three-way index between judgements about what the actual world is like, judgements about whether there is actually time when given certain discoveries about the actual world, and judgements about whether there is time in some counterfactual world, given certain discoveries about the actual world.

**3.1 Experiment 1 Method**

*3.1.1 Participants*

392 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. 72 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 (3). 177 participants were excluded from the analyses for failing to answer correctly 2 out of 3 comprehension questions for either of the vignettes. The remaining sample was composed of 143 participants (aged 21-68; 64 female). Mean age 37.34 (SD = 10.49). 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*

Participants were randomly assigned to one of two conditions. Condition 1: actual dynamically directed universe (growing block) with *counterfactual* non-directed universe (C-theoretic). Condition 2: actual non-directed universe (C-theoretic), with *counterfactual* dynamically directed universe (growing block). All participants begin by reading both vignettes, which are as follows:

The Time-Neutral[[11]](#footnote-11) Dynamically Directed (Growing Block) Vignette:

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 we can generate an ordering of events in terms of the coming into existence of new events and objects. Some scientists, philosophers and theologians in Universe E think that the set of events and objects that have just come into existence are those that are in the present. They think that as new events and objects come into existence, already existing events and objects become part of the past. They think that 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 some scientists and philosophers in this universe think that 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).

Participants were then presented with the following comprehension questions:

1. Scientists in Universe E think that the present is real, the past and future are not.
2. Scientists in Universe E think that the present moves as new events come into existence.
3. Scientists in Universe E think that the present is just whichever time one is at. Every time is present to the individuals located at that time.

The Time-Neutral Undirected (C-theoretic) Vignette:

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 certain 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 relations. Some scientists, philosophers and theologians in Universe D call these relations of *betweenness*. In Universe D no set of events is special, in that 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 betweenness 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 the detector. But some scientists, philosophers and theologians in Universe D think that from one perspective, P3’s being deflected from the 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.

Participants were then presented with the following comprehension questions:

1. Scientists in Universe D think that the present is real, the past and future are not.
2. Scientists in Universe D think that the present moves from earlier time to later times. For instance, they think the present was once located in the year 1009, and is now located in the year 2019, and will be located in the year 2100.
3. Scientists in Universe D think that the present is just whichever time one is at. Presentness does not move from earlier times to later times. Every time is present to the individuals located at that time.

After reading both vignettes, participants were asked the question: “which universe do you think is most like our own?” and are given two options to choose from: Universe E and Universe D. They are then asked to indicate their level of confidence in that judgement, on a Likert scale from 1 (very unsure) to 7 (very sure). Participants who failed to correctly answer two or more of the comprehension questions, about either vignette, were excluded from all of the analyses. At no point could participants return to a previous screen. Those we subsequently refer to as *dynamists* are those who chose universe E, and those we refer to as *non-dynamists* are those who chose universe D, as being most like our universe.

Participants then see both vignettes (on separate screens) in random order. For each vignette, they are asked to imagine that the actual universe has been discovered to be just like that universe. They are then presented with the statement “there is time in universe [E/D]” and asked how strongly they agree/disagree on a Likert scale of 1—7.

Participants then see both vignettes side by side. Those in condition 1 are told that universe E is just like the actual universe, and universe D is a parallel universe, and those in condition 2 are told that universe D is just like the actual world, and universe E is a parallel universe.

The instructions are the following “imagine scientists discover that the *actual*Universe (the one where you and I live) is exactly like Universe [**E**/D]. Now imagine scientists are suddenly able to observe a *parallel* Universe. The parallel Universe is like the actual universe in many respects: it contains many of the same things as our universe. However, the *parallel* Universe is exactly like Universe [E/**D**]. The scientists are right about this: the actual Universe is exactly like Universe [**E**/D] and the parallel Universe is exactly like Universe [E/**D]**. Imagining that is the case, please answer the following question about the *parallel* Universe. Remembering that the actual universe is just like Universe **[E**/D], and the parallel universe is just like Universe [E/**D]**.” Participants are then asked to indicate their level of agreement, on a Likert scale of 1-7, with the following statement: “there is time in the parallel universe.” They are then asked to indicate their level of confidence in their previous judgement.

**3.2 Experiment 2 Method**

*3.2.1 Participants*

396 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. 93 participants had to be excluded for failing to follow task instructions. This means that they failed to answer the questions (82), or failed an attentional check question (11). 208 participants were excluded from the analyses for failing to answer correctly 2 out of 3 comprehension questions for either of the vignettes. The remaining sample was composed of 95 participants (aged 21-61; 28 female). Mean age 30.25 (SD = 7.10). 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*

The procedure for experiment 2 was the same as that for experiment 1, except that a non-dynamically directed (B-theoretic) world replaced the dynamically directed (growing block) world. That vignette is below:

Time-Neutral Non-dynamically Directed (B-theoretic) Vignette:

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 certain relations 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. Some scientists, philosophers and theologians in Universe B think these relations are the relations of earlier-than, later-than, and simultaneous-with. In Universe B no set of events is special, in that 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 prior, in the ordering, to 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 prior to the event of P2 hitting the detector. Or, as some of the scientists, philosophers and theologians in Universe B would put it, 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).

Participants were presented with the following comprehension questions about universe B:

1. Scientists in Universe B think that the present is real, the past and future are not.
2. Scientists in Universe B think that the present moves from earlier time to later times. For instance, they think the present was once located in the year 1009, and is now located in the year 2019, and will be located in the year 2100.
3. Scientists in Universe B think that the present is just whichever time one is at. Presentness does not move from earlier times to later times. Every time is present to the individuals located at that time.

**3.3 Analyses**

*3.3.1 Experiment 1 Main Results*

Let’s begin with a summary of our main findings. Our first two hypotheses concerned differences between our results in experiment 1, and Latham et al.’s previous results. First, we predicted that more dynamists would judge that there is time in the growing block world as compared to the C-theoretic world, whether it is considered as actual or counterfactual. We found this. As can be seen in table 1, ~90% of dynamists judge there to be time in the dynamical world, and ~76% judge there to be time in a counterfactual dynamical world, while ~45% of dynamists hold that there is time in the C-theoretic world. Second, we predicted that while Latham et al. found that a majority of dynamists judged that there was time in a directed B-theoretic world, we would find that a majority of dynamists would judge that there was *not* time in a C-theoretic world, be it actual or counterfactual. Although we found that ~44-46% of dynamists judged that there was no time in the C-theoretic worlds, separate one-sample 𝜒2-tests (which tested the proportion of people who said ‘Yes’ against those who said ‘No’ or ‘4’) showed that this was not statistically significantly different from a 50/50 split (Actual C-Theory: 𝜒2 (1) = 1.412, *p* = .235; Counterfactual C-Theory: 𝜒2 (1) = .627, *p* = .428). Hence our hypothesis was not supported. Instead, it appears that dynamists are divided regarding whether or not there is time in C-theoretic worlds.

Table 1, below, presents the descriptive data of experiment 1. The ‘Yes’ column indicates the proportion of participants who responded with either 5, 6, or 7 when asked their level of agreement that there is time in the universe being evaluated; the ‘No’ column represents the proportion of participants who responded with either 1, 2, or 3. The ‘4’ column is the proportion of people who neither agree nor disagree. The mean is the mean level of agreement to the statement that there is time in the world being evaluated. Table 2 is from Latham et al.’s (ms) original experiment.

*Table 1.* *Levels of agreement* *that there is time in worlds taken as actual or counterfactual. In parentheses we note how the actual world is taken to be when making the judgement about the counterfactual world.*

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
|  | **%Yes** | **%No** | **%4** | **Mean** | **SD** |
| **Group: Growing Block is most like the actual world (*N* = 102)** | | | | | |
| Actual Growing Block | 90.2 | 3.9 | 5.9 | 6.10 | 1.07 |
| Counterfactual Growing Block (Actual C-Theory) | 76.5 | 14.7 | 8.8 | 5.31 | 1.37 |
| Actual C-Theory | 44.1 | 50 | 5.9 | 3.90 | 1.90 |
| Counterfactual C-Theory (Actual Growing Block) | 46.1 | 50 | 3.9 | 3.99 | 1.94 |
| **Group: C-Theory is most like the actual world (*N* *=* 41)** | | | | | |
| Actual Growing Block | 80.5 | 14.6 | 4.9 | 5.41 | 1.66 |
| Counterfactual Growing Block (Actual C-Theory) | 78.1 | 14.6 | 7.3 | 5.17 | 1.60 |
| Actual C-Theory | 75.6 | 17.1 | 7.3 | 5.24 | 1.56 |
| Counterfactual C-Theory (Actual Growing Block) | 70.7 | 22 | 7.3 | 4.95 | 1.47 |

*Table 2.* *Levels of agreement* *that there is time for different contexts given participants’ belief about the actual world. (This table is drawn from Latham, Miller & Norton, ms).*

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
|  | **%Yes** | **%No** | **%4** | **Mean** | **SD** |
| **Group: Growing Block is most like the actual world (*N* = 62)** | | | | | |
| Actual Growing Block | 88.7 | 6.5 | 4.8 | 5.89 | 1.38 |
| Counterfactual Growing Block (Actual B-Theory) | 85.5 | 11.3 | 3.2 | 5.71 | 1.43 |
| Actual B-Theory | 69.3 | 24.2 | 6.5 | 5.08 | 1.73 |
| Counterfactual B-Theory (Actual Growing Block) | 70.9 | 22.6 | 6.5 | 4.98 | 1.69 |
| **Group: B-Theory is most like the actual world (*N* =79)** | | | | | |
| Actual Growing Block | 74.7 | 17.7 | 7.6 | 5.41 | 1.65 |
| Counterfactual Growing Block (Actual B-Theory) | 73.4 | 19 | 7.6 | 5.47 | 1.69 |
| Actual B-Theory | 94.9 | 3.8 | 1.3 | 6.18 | 1.05 |
| Counterfactual B-Theory (Actual Growing Block) | 83.6 | 13.9 | 2.5 | 5.71 | 1.50 |

Notably, while we didn’t make any predictions regarding differences in the mean levels of agreement in the two experiments, we can see that in the original Latham et al. experiment the mean levels of agreement of dynamists, that there is time in the actual or counterfactual B-theoretic world is ~5, while we found that the mean levels of agreement of dynamists that there is time in the C-theoretic world is ~3.9.

Our second class of predictions regarded the responses of dynamists and non-dynamists within experiment 1. To test these hypotheses we ran a 2x2x2 repeated measures ANOVA. Before reporting the detailed results of the ANOVA, let’s see how our predictions fared.

First, we predicted that amongst non-dynamists, the levels of agreement that there is time in the dynamical world would be significantly lower than their levels of agreement that there is time in the C-theoretic world. Instead, we found that amongst non-dynamists, there was no significant difference between their responses to the conditions examined here, and in each condition the majority of non-dynamists thought that there was time. Hence this first hypothesis in this class was not vindicated.

Second, we hypothesised that a majority of non-dynamists would judge that there is time in a growing block world. We found this. We also hypothesised that dynamists would more strongly agree that there is time in the dynamically directed world than in the C-theoretic world, and that overall, people would more strongly agree that there is time in the dynamically directed (growing block) world than in the C-theoretic world. Both of these hypotheses were supported.

Results of a 2x2x2 repeated measures ANOVA found a significant main effect of whether the world being evaluated was dynamically directed or non-directed (*world evaluated*) F(1, 141) = 29.829, *p* < .001, and a significant main effect of whether the world evaluated was taken to be actual or counterfactual (*context of evaluation*) F(1, 141) = 10.920, *p* = .001. We also observed a significant two-way interaction between world evaluated and which world people believed to be most like our own F(1, 141) = 19.109, *p* < .001. We also found a significant three-way interaction between world evaluated, context of evaluation, and which world people believed to be most like our own F(1, 141) = 4.826, *p* = .03.

The main effect of world evaluated showed that the level of agreement was significantly higher for dynamically directed (growing block) vignettes (M = 5.50, S.D. = 1.26) than for non-directed vignettes (M = 4.522, S.D. = 1.81).

The main effect of context of evaluation showed that level of agreement was significantly higher for vignettes described as actual (M = 5.17, S.D. = 1.26) than for vignettes described as being parallel (M = 4.86, S.D. = 1.26).

Simple effects tests using a Bonferroni correction were carried out on the two-way interaction between world evaluated and which world participants believed to be most like the actual world.

First, for dynamically directed (growing block) vignettes, there was no significant difference in levels of agreement between dynamists (M = 5.71, S.D. = 1.14) and non-dynamists (M = 5.29, S.D. = 1.14; *p* = .053).

Second, for non-directed vignettes, levels of agreement were significantly higher for non-dynamists (M = 5.10, S.D. = 1.63) than for dynamists (M = 3.95, S.D. = 1.64; *p* < .001).

Third, for non-dynamists, there was no significant difference in levels of agreement between dynamically directed (growing block) vignettes and non-directed vignettes (*p* = .520).

Fourth, for dynamists, levels of agreement were significantly higher for dynamically directed (growing block) vignettes than for non-directed vignettes (*p* < .001).

In order to understand the three-way interaction, we split the data-set between dynamists and non-dynamists. For non-dynamists there was no significant main effect or interaction of world evaluated and context of evaluation (see Figure 1).

*Figure 1: World evaluated versus context of evaluation for non-dynamists. Non-dynamists report similar levels of agreement that there is time in dynamically directed and non-directed worlds considered as actual or counterfactual. Error bars are for the 95% confidence interval.*

For dynamists there was a significant main effect of world evaluated F(1, 101) = 75.717, *p* < .001, and a significant main effect of context of evaluation F(1, 101) = 14.699, *p* < .001. We also observed a significant two-way interaction between world evaluated and context of evaluation F(1, 101) = 15.339, *p* < .001; see Figure 2)

The main effect of world evaluated showed that level of agreement was significantly higher for dynamically directed (growing block) vignettes (M = 5.71, S.D. =1.00) than for non-directed vignettes (M = 3.95, S.D. = 1.78).

The main effect of context of evaluation showed that the level of agreement was significantly higher for vignettes described as actual (M = 5.00, S.D. = 1.08) than for vignettes that described as being parallel (M = 4.65, S.D. = 1.15).

Simple effects tests using a Bonferroni correction were carried out on the two-way interaction between context of evaluation and world evaluated.

First, for vignettes described as actual, levels of agreement were significantly higher for dynamically directed vignettes (M = 6.10, S.D. = 1.07) than for non-directed vignettes (M = 3.90, S.D. = 1.90; *p* < .001).

Second, for vignettes described as parallel, levels of agreement were significantly higher for dynamically directed vignettes (M = 5.31, S.D. = 1.37) than for non-directed vignettes (M = 3.99, S.D. = 1.94; *p* < .001).

Third, for dynamically directed vignettes, levels of agreement were significantly higher when described as being actual than when described as being parallel (*p* < .001).

Fourth, for non-directed vignettes, there was no significant difference in levels of agreement between when being described as being actual and when being described as parallel (*p* = .548).

*Figure 2: World evaluated versus context of evaluation for dynamists. Error bars are for the 95% confidence interval*.

*3.3.2 Experiment 2 Main Results*

The descriptive results allow us to make two main observations. The first observation is that as we predicted, a majority of people think that our world is more like the non-dynamically directed (B-theory) world than the non-directed (C-theory) world: more people are directionists than non-directionists. The second observation is that there is no statistically significant difference between the judgements made by directionists and non-directionists regarding whether or not there is time in the worlds we present as actual or counterfactual. That is to say, our prediction that people would not have a sensitively directional concept appears to be vindicated.

In addition, it appears as though the majority of participants judge that there is time across all the conditions we evaluated. This is in line with our fourth prediction, but contrary to our third. We predicted that non-directionists would judge that there is time in all of the conditions we evaluated, and we found this. However, the prediction that directionists would only judge there to be time in directed worlds was not supported. Instead, a majority of directionists judge that there is time in actual non-directed worlds, and in counterfactual non-directed worlds conditional on the actual world being directed. Table 3 below presents the descriptive data of experiment 2. It is to be read in the same way as Table 1.

*Table 3.* *Levels of agreement* *that there is time in worlds taken as actual or counterfactual. In parentheses we note how the actual world is taken to be when making the judgement about the counterfactual world.*

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
|  | **%Yes** | **%No** | **%4** | **Mean** | | **SD** |
| **Group: B-Theory is most like the actual world (*N* = 61)** | | | | |
| Actual B-Theory | 91.8 | 1.6 | 6.6 | 5.70 | | 0.92 |
| Counterfactual B-Theory (Actual C-Theory) | 88.5 | 6.6 | 4.9 | 5.51 | | 1.11 |
| Actual C-Theory | 73.8 | 16.4 | 9.8 | 5.13 | | 1.52 |
| Counterfactual C-Theory (Actual B-Theory) | 67.2 | 24.6 | 8.2 | 4.90 | | 1.54 |
| **Group: C-Theory is most like the actual world (*N* *=* 34)** | | | | |
| Actual B-Theory | 85.3 | 11.8 | 2.9 | 5.35 | | 1.41 |
| Counterfactual B-Theory (Actual C-Theory) | 94.1 | 5.9 | 0 | 5.62 | | 1.05 |
| Actual C-Theory | 85.3 | 11.8 | 2.9 | 5.41 | | 1.42 |
| Counterfactual C-Theory (Actual B-Theory) | 85.3 | 8.8 | 5.9 | 5.35 | | 1.18 |

Results of a 2x2x2 repeated measures ANOVA found a significant main effect of world evaluated F(1, 93) = 6.307, *p* = .014. No other main effects, or interaction effects were significant.[[12]](#footnote-12)

The main effect of world evaluated showed that the level of agreement was significantly higher for non-dynamically directed (B-theory) vignettes (M = 5.55, S.D. = 0.97) than for non-directed (C-theory) vignettes (M = 5.20, S.D. = 1.37).

**4. Discussion**

First, the split in experiment 1 between participants who thought the growing block world was most like the actual world (71.3%) and participants who thought the C-theory world was most like the actual world (28.7%) closely matches Latham et al.’s (2019) split between dynamists (66.3%—72.8%) and non-dynamists (27.2%—33.7%). This supports our prediction that participants would choose between these vignettes on the basis of the presence or absence of dynamism (rather than of direction) and hence supports our characterisation of the former group as dynamists and the latter group as non-dynamists.

Second, recall that we formed two classes of hypotheses regarding experiment 1. The first centres around predictions about the differences between the results of our experiment 1, and Latham et al.’s results reported in Table 2. We predicted that in our experiment a higher percentage of dynamists would judge that there is no time in a non-directed (C-theoretic) world, than the percentage of dynamists Latham et al. found judged that there is no time in the non-dynamically directed (B-theoretic) worlds. We found this to be so. Where Latham et al found that ~70% of dynamists judged there to be time in non-dynamically directed (B-theoretic) worlds, we found that ~45% of participants judge there to be time in non-directed (C-theoretic) worlds. So the presence, or absence, of direction makes a difference to participants’ judgements about whether there is time in a world: roughly 25% more dynamists judge there to be time in a non-dynamically directed world, than a non-directed world. So dynamists are not just sensitive to whether there is dynamical direction, they are also, in part, sensitive to whether there is non-dynamical direction.

However, contrary to our prediction, we did not find that a majority of dynamists judged there to be no time in the non-directed world; instead, we found there to be a 50/50 split regarding whether there is time in that world. So for roughly half the dynamist sub-population, a world need not be directed in order to contain time. Nevertheless, this result differs from Latham et al.’s finding that a clear majority of dynamists judged there to be time in the directed non-dynamical world. This is also reflected in the mean levels of agreement that there is time in the relevant worlds, where Latham et al. found mean levels of agreement, amongst dynamists, that there is time in the non-dynamically directed (B-theoretic) world, of around 5, while we found mean levels of agreement that there is time in the non-directed (C-theoretic) world, of around 3.9. Again, then, this comparison shows us that amongst dynamists, the presence of direction matters.

Our second class of predictions related to the differences we would find, within our experiment, between the judgements of dynamists and non-dynamists. We predicted that amongst non-dynamists, the levels of agreement that there is time in the dynamical world would be significantly lower than their levels of agreement that there is time in the C-theoretic world. Instead, we found there to be no significant difference in levels of agreement, for non-dynamists, between dynamically directed vignettes and non-directed worlds. We did, however, confirm the remaining hypotheses. We found that a majority of non-dynamists judged there to be time in the non-directed worlds, and we found that dynamists did more strongly agree that there is time in the dynamical world than in the C-theoretic world, and, finally, that overall, people did more strongly agree that there is time in the dynamical world than in the C-theoretic world.

Turning to experiment 2, our prediction that we would find more directionists than non-directionists, was borne out. ~64% of participants were directionists. This is a surprisingly low proportion in the light of Latham et al.’s (2019) results, as we discuss below. Further, as predicted we did not find that either directionists or non-directionists had a concept that was sensitively directional. Our prediction that directionists would have an insensitively directional concept, however, was not vindicated. A majority of directionists judged that there is time in an actual non-directed world (~74%), and indeed that there was time in a counterfactual non-directed world, even when the actual world is directed (~67%). However, our prediction that non-directionists have an insensitive directionally sufficient concept was supported by the finding that a majority of non-directionists judged that there was time across all conditions. In all, then, evidence from the second experiment tends to suggest that both directionists and non-directionists have an insensitive directionally sufficient concept. Directedness is sufficient, but not necessary, for their concept to be satisfied. The difference between these groups, then, concerns their beliefs about the actual world, not their concept of time.

This is not to say that the presence or absence of direction makes no difference to people’s judgements: the only significant results we find in experiment 2 are that people more strongly agree that there is time in a directed world than a non-directed world, and do so regardless of which world is actual. So, as in experiment 1, we found that the presence of direction bolsters people’s judgements that there is time. It is just that a majority of participants, directionists and non-directionists, still judge there to be time even in the non-directed world.

Jointly, what do experiments 1 and 2, in combination of Latham et al.’s (ms) results, tell us about the role of directedness in folk judgements about time? We think they tell us that when dynamical worlds are salient, dynamists are sensitive to whether or not there is *direction* in a world, as well as whether there is *dynamism* in a world. For while a majority of dynamists judge that there is time in *non*-dynamically directed worlds, when evaluating non-directed worlds dynamists are split roughly 50/50 on whether there is time. Thus, it is clear that for dynamists, direction is playing a role over and above the role that dynamism plays in their making judgements about whether there is time in a world. Having said that, the other 50% of dynamists judge that there is time in a non-directed world. For this population of of dynamists, direction is clearly not necessary for the satisfaction of their concept of time.

One might think that our finding that only 50% of dynamists judge that there is no time in non-directed worlds is in conflict with the findings in experiment 2, in which we found that a majority of participants across all conditions judged that there was time in the non-directed world. On the assumption that the distribution of dynamists in the second experiment is the same as the distribution in the first experiment, why didn’t half of those dynamists judge that there is no time in non-directed worlds? Since dynamists are ~70% of the population, had they done so we ought to have found a higher percentage of directionists judging that there is no time in non-directed worlds.

However, as we discussed in §2, Latham et al.’s (2019) findings suggest that participants most robustly track the distinction between dynamical and non-dynamical worlds, and less robustly track more fine-grained differences between kinds of dynamism and kinds of non-dynamism. In the first experiment participants are presented with a dynamically directed world and a non-directed world. This makes the possibility of dynamism salient. In the second experiment participants are presented with a non-dynamically directed world and a non-directed world, and thus dynamical worlds are not salient at all. What these results suggest is that how people judge worlds, with regard to whether or not they contain time, is in part sensitive to the comparison class that is salient to them (see McArthur 1981 and Taylor & Fiske 1978 for more on salience).

In concert with this, it could be that we are seeing a priming effect. By presenting participants in experiment 1 with a dynamical vignette we prime people to make the dynamical aspect of their concept (if there is one) more accessible (where according to Higgins (1996:141), accessibility is “the activation potential of available knowledge”). Because experiment 2 lacks this prime, the dynamical component of participants’ concept is less accessible.

The relevant kind of priming effect is called a *contrast effect*. This effect was noted by Herr, Sherman, and Fazio (1983) and Herr (1986), and occurs when following priming by some extreme exemplars of F-ness, participants later judge stimuli as relatively un-F. For instance, following priming with exemplars of either extremely hostile persons, extremely ferocious animals, or extremely large animals, participants judged subsequent stimuli as either relatively nonhostile, un-ferocious, or small, respectively. Herr et al. suggest that the exemplars serve as a standard of comparison for subsequent judgments. Where priming produces judgements in the opposite direction from the exemplars presented, these are considered contrast effects. Hence it could be that in experiment 1 we are seeing priming contrast effects. Not only does the introduction of the dynamical vignette make salient what might otherwise have been merely tacit dynamical components of participants’ concepts, but in addition, it produces a contrast effect whereby worlds that are not dynamical are judged not to contain time, even though they would not be judged this way in the absence of the dynamical vignette.

That shouldn’t be surprising. Given that people’s concept of time is likely to be tacit, they may not have a well-worked-through representation of how they take time to be, either actually or necessarily. In this regard, their representation might be ambiguous, or indeterminate in certain ways. These are precisely the conditions under which we find that priming has the greatest effect on people’s judgements (Higgins et al. 1977). Moreover, priming that produces contrast effects can be expected to have the greatest impact on participants whose tacit concept of time includes, amongst its components, (perhaps ambiguously) the most metaphysically substantial aspects, such as the presence of dynamism. For these participants can be expected to be ones who, when primed with a description of a metaphysically substantial world, will be most likely to experience a contrast effect in which any vignette they then see, which describes a much less metaphysically substantial world, will be a vignette they are likely to judge does not contain time.

What also seems to be clear, however, is that something other than just priming is needed to explain the results in experiment 2. For there, we find that in the absence of any priming of dynamical worlds, we find that participants tend to be *less* inclined to draw fine distinctions between classes of worlds with relatively non-substantial temporal metaphysics. Recall that we found 36% of participants to be non-directionists. On the basis of Latham et al. (2019), however, we would predict that only ~15% of participants would identify as non-directionists. This suggests that amongst the majority of participants—who are dynamists and hence have a metaphysically substantial view of what time is like—when a metaphysically substantial world (a dynamical world) was not made salient, the distinction between non-dynamically directed and non-directed worlds was not seen as making much difference. Once dynamical worlds are, as it were, off the table, dynamists don’t really have strong views about whether our world is non-dynamically directed, or non-directed. That explains why we find more people judging that our world is non-directed than we would expect.

This same phenomenon explains why, in experiment 2, we find that a majority of participants judge there to be time in all conditions. If some dynamists don’t have a strong view regarding whether our world is non-dynamically directed or non-directed (given that it’s not dynamically directed) then they can be expected to judge that if there is time in a non-dynamically directed world, there is time in a non-directed world. That is what we find. This, however, cannot easily be explained just by the effects of priming, since there seems to be no reason to think that in the absence of an extreme prime regarding F-ness, participants will tend not to finely discriminate between things that are each F to some degree or other. Instead, this seems to reflect something more like the sense in which when the best deserver to count as being an F is missing, and there are two deservers that each is sort-of-F, that participants are disinclined to say that one of the deservers is F, and the other is not, even though they are not both equally F. This might reflect something like a just-noticeable-difference issue. Perhaps when the difference between the two degrees of F-ness is quite small, and neither is very F (though enough to be categorised as F) people are inclined to say either both are F, or that neither are. That is, they are disinclined to say that the small difference makes a difference.

**5. Conclusion**

The presence or absence of directedness appears to play a role in the folk concept of time, though precisely what role that is will require further experimentation. Nevertheless, some striking results emerge from these two experiments.

Overall, people are more inclined to judge that there is time in a world, if that world is directed rather than non-directed. This is apparent in the main effects of *world evaluated* across our two experiments. Moreover, our results, taken in concert with those of Latham et al. (ms), show that while ~70% of dynamists are inclined to judge that there is time in B-theory worlds, only ~45% are inclined to judge that there is time in C-theory worlds. Dynamists, then, are clearly sensitive to whether a world is directed when making these judgements.

It is notable, however, that ~45% of dynamists judged that there is time in C-theory worlds (even if the C-theory world is counterfactual and the actual world is a growing block world), and we see even higher percentages amongst non-dynamists in experiment 1 and both directionists and non-directionists in experiment 2, where the possibility of dynamism is not made salient. That such a substantial sub-population do not judge that directedness is necessary for the satisfaction of their concept suggests that this concept is more minimal than one might have thought, and is evidence in favour of what Baron & Miller (2015(b)) call the *relative ineliminability* of the folk concept of time.

Indeed, our results go beyond supporting Baron & Miller’s contention that there are few discoveries we could make about *the actual world* that would lead (most of) us to deny that there is actually time, for they suggest that for many people, there are few discoveries that could be made about *counterfactual* worlds that would lead (most of) us to judge that there is no time. This suggests a fruitful avenue for future research, investigating people’s judgements about worlds (considered as both actual and counterfactual) that lack even a C-series.

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1. On behalf of all authors, the corresponding author states that there is no conflict of interest.  [↑](#footnote-ref-1)
2. Sometimes people use ‘B-theory’ synonymously with ‘block universe theory’. Used this way, the view does not entail that time has a direction. However, that usage makes little sense of the debate between B-theorists and C-theorists, (nor is it faithful to McTaggart’s (1908) introduction of the terms) or the debate amongst B-theorists, regarding in virtue of what time has a direction. At any rate, we intend to use ‘B-theory’ to pick out a view on which time has a direction, regardless of whether or not this is standard usage. [↑](#footnote-ref-2)
3. While McTaggart (1908), who introduced C-relations, thought of them as being *non*-temporal precisely because they are undirected, C-theorists contend that C-relations generate a temporal ordering. [↑](#footnote-ref-3)
4. Zimmerman, (2008) Smith (1994), Craig (2000) and Schlesinger (1994). See See Baron, Cusbert, Farr, Kon, and Miller (2015) for discussion. [↑](#footnote-ref-4)
5. When we, following Baron & Miller (2015(a), 2015(b)), talk of the (or a) folk concept of time, what we mean by ‘concept’ is nothing more than a contentful state that can be a constituent of a thought. [↑](#footnote-ref-5)
6. Callender (2017) frames his discussion of these issues in terms of a naïve theory of time. [↑](#footnote-ref-6)
7. See *inter alia* Evans (2003:14), Sinha & Gardenfors (2014), Boroditsky, Fuhrman & McCormick (2011), Fuhrman, et al. (2011), Chen (2007), Boroditsky (2001), Casasanto & Bottini (2014) and Núñez et al. (2012). [↑](#footnote-ref-7)
8. Though surprisingly, Latham, Miller & Norton (forthcoming) found that people only weakly agree that time *seems* to pass. [↑](#footnote-ref-8)
9. These are vignettes in which the worlds are described using time-neutral language—language which makes no mention of times, or relations of earlier-than or later-than, or properties of presentness, etc.—and whose description is then supplemented with a claim that *some* *people* *believe* that the relations/properties are relations of earlier-than/later-than or the property of presentness. [↑](#footnote-ref-9)
10. See Tooley (1997) and Forbes (2016). [↑](#footnote-ref-10)
11. These vignettes did not explicitly characterise worlds in terms of time, times, or temporal relations, or otherwise use temporal locutions. As this makes it more difficult to understand the world described, we introduced the locution: ‘some scientists, philosophers and theologians in universe [C/D/E] think that…’ followed by a shorter description of some aspects of the universe making use of temporal locutions. To allay concerns about whether participants understand time-neutral vignettes, we re-ran Latham et al.’s (2019) study using time-neutral versions of their 6 vignettes (only three of which are used in the present two experiments). Our distribution is similar to theirs, which supports the idea that participants understand time-neutral vignettes. [↑](#footnote-ref-11)
12. Our final sample size in this experiment was lower than anticipated due to the large number of people who failed the comprehension test. However, we observe no changes to the reported results if we include all those participants who failed the comprehension questions. [↑](#footnote-ref-12)