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Exploring people's beliefs about the experience of time

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Abstract
Philosophical debates about the metaphysics of time typically revolve around two contrasting views of time. On the A-theory, time is something that itself undergoes change, as captured by the idea of the passage of time; on the B-theory, all there is to time is events standing in before/after or simultaneity relations to each other, and these temporal relations are unchanging. Philosophers typically regard the A-theory as being supported by our experience of time, and they take it that the B-theory clashes with how we experience time and therefore faces the burden of having to explain away that clash. In this paper, we investigate empirically whether these intuitions about the experience of time are shared by the general public. We asked directly for people's subjective reports of their experience of time—in particular, whether they believe themselves to have a phenomenology as of time's passing—and we probed their understanding of what time's passage in fact is. We find that a majority of participants do share the aforementioned intuitions, but interestingly a minority do not.

Keywords Temporal passage · Temporal experience · Time · Metaphysics · Intuitions

1 Introduction

On one influential view of the metaphysics of time, time is seen as a dimension of reality alongside the three spatial dimensions. This view of time recognizes a temporal order amongst events—certain events happen before or after other events—but it says that all there is to time is events being arranged in this order. Following terminology

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introduced by McTaggart (1908), this view of the nature of time is often called the B-theory.

According to the rival A-theory, there is more to time than events being ordered along a dimension, or indeed the idea of time as a dimension is fundamentally mistaken. Crucial to the A-theory, as we will understand that theory in the context of this paper, is the idea that time is itself something that undergoes change, indeed it constantly does so, as expressed by the idea of the passage of time.[1]

Apart from metaphysical questions about the nature of time, the debate between A-theorists and B-theorists also raises questions about philosophical methodology—what should count as evidence for metaphysical claims. For instance, a common motivation among theorists defending a B-theoretic view of time is the idea that physics should guide how we approach questions regarding the metaphysics of time (see, e.g., Callender 2017; Smart 2008), and that modern physics—in particular General Relativity—is incompatible with the picture of time sketched by the A-theory. Conversely, A-theorists are often motivated by the idea that the B-theory cannot do justice to the way time appears to us in experience (see, e.g., Craig 2000; Norton 2010).

Our focus in what follows will be on this latter *argument from experience* for the A-theory.[2] Whilst there are other lines of argument that A-theorists can and do pursue,[3] our interest is in the argument from experience because, until recently, the idea that "experience favours the A-theory", as Prosser (2016, p. 41) puts it, has rarely been challenged. Indeed, it is easy to find emphatic statements of that claim. According to Schlesinger, "[t]here is hardly any experience that seems more persistently, or immediately given to us than the relentless flow of time" (Schlesinger 1991, p. 427). In a similar fashion, Savitt writes: "It seems manifest in our experience that time flows—from the past, to the present moment, and into the future" (Savitt 1996, p. 348). And Norton claims: "Time really passes … Our sense of passage is our largely passive experience of a fact about the way time truly is, objectively" (2010, p. 24).[4]

The claim here is that there is an ingredient in the phenomenology of one's ongoing experience that is apparently metaphysically loaded, in so far as it suggests that time is as the A-theory has it, rather than as the B-theory has it. Thus understood, the claim is also often endorsed by B-theorists, only with the proviso that the phenomenology

[1] There are A-theorists who don't believe that time passes. For example, Tallant (2015) outlines a position on which there is in an important sense a privileged present—he takes himself to be offering an A-theory of time—but on which time does not pass (because there is no 'time' to do the passing). Also see Merricks's (2007, esp. pp. 124–125) account of presentism. In what follows we focus on those A-theories on which time is said to pass.

[2] See Skow (2011) and Baron et al. (2015) for overviews of how theorists have presented arguments from experience in favour of the A-theory.

[3] For instance, authors such as Markosian (2004), Maudlin (2002, esp. p. 237), and Zimmerman (2008, esp. p. 221) argue for the A-theory on the grounds that it provides the best articulation of our commonsense commitments about time, without appealing specifically to considerations about experience. (This is something that we intend to probe in future research.) Another strand of arguments in favour of the A-theory focuses specifically on differences in our emotional attitudes toward the past and the future (Prior 1959; Pearson 2018).

[4] Also see the claims of Eddington (1928, pp. 89–97), Schuster (1986, p. 695), and Williams (1951, p. 466).

of experience is illusory in this respect. Miller et al. (2020) speak of this stance as that of the 'phenomenal illusionist'.[5]

However, as Miller et al. (2020) point out, there is also a separate strand of B-theorists, whom they call 'cognitive error theorists'.[6] According to the cognitive error theorist, the phenomenology of experience, properly characterized, is neutral between the A-theory and the B-theory of time – it is just what one would expect experience to be like if the B-theory was true. Yet, people mistakenly think that there is something about the phenomenology of experience that suggests that time is as the A-theory has it.

Both Miller et al.'s phenomenal illusionist and their cognitive error theorist are putting forward philosophical views of the phenomenology of people's experience of time. But such views might not accurately represent how people themselves think of their experiences—indeed, in the case of the cognitive error theorist the claim is precisely that people are in error about what their experience is like. Thus Miller et al.'s distinctions between different types of theorist already presuppose a certain assumption about people's everyday view of their own experience of time.

The same can be said for proponents of the original 'argument from experience'. We are familiar from other areas of philosophy with the worry that certain 'intuitions' that philosophers take as premises in their reasoning might have in fact been formed under the influence of their own theory and may not be shared by the general public (see, e.g., Nadelhoffer and Nahmias 2007, p. 125; Knobe and Nichols 2008, p. 9).[7] This might also be the case with the idea that there is something of potential metaphysical import to the phenomenology of experience.

In this paper, we describe a study intended to investigate to what extent people's everyday picture of their own experience of time is in line with the idea that there is an 'argument from experience' for the A-theory, focusing in particular on the idea that time passes. In order to demonstrate that people's beliefs about their own experience of time is in line with such an argument from experience, two conditions have to be fulfilled: First, people have to agree that they do experience time passing; secondly, when asked what they mean by time passing, they have to describe the idea of the passage of time in recognizably A-theoretic ways, rather than giving a description that is compatible with the truth of the B-theory.[8]

[5] Torrengo's (2017) phenomenal modifier view, on which a dynamic element is projected onto reality in experience, is plausibly best understood as one variant of this line of response. Prosser (2012& 2016) can also be read as offering a phenomenal illusionist proposal. He argues that change is experienced as A-theoretic because the objects of experience are (mis)represented as enduring as opposed to perduring. Also see Callender (2008).

[6] Recent support for the view can be read in Balcells (2019), Baron et al. (2015), Braddon-Mitchell (2013), Deng (2013a, b, 2018, 2019), Hoerl (2014), Miller et al. (2020), and Miller (2019).

[7] This worry predates the rise in interest in experimental philosophy. For example Austin, an advocate of 'ordinary language' philosophy, warned against the appeal to ordinary language and intuitions in the case of time. He says that theorists' intuitions and ordinary language will often be "too much trodden into bogs or tracks by traditional philosophy" and "will often have become infected with the jargon of extinct theories, and our own prejudices too, as the upholders or imbibers of theoretical views" (Austin 1956, p. 8).

[8] Note that these two conditions are required in order to show that *people's picture* of their experience of time is in line with there being an argument from experience to support the A-theory. However, the A-theorist may have independent reasons to think that experience *does* support the A-theory even though people will

There are very few empirical studies that directly address how members of the general public understand what it means to say that time passes, and whether or not they do describe themselves as experiencing time as passing. An exception is the study of Latham et al. (2019), who were interested in whether dynamical theories of time—on which time flows or passes—more closely resemble people's ordinary view of time than non-dynamical theories—on which time does not flow or pass. Latham et al. presented participants with six different models of time—in the form of vignettes describing a universe—each representing a contemporary philosophical model of time (three dynamical, three non-dynamical). Participants were asked which universe—described in the vignettes—is most like our own. Across two experiments, Latham et al. demonstrated that the majority (~ 70%) of people's views of time appear to be dynamical, but a substantial minority (~ 30%) appear to hold a view of time as non-dynamical.

It is important to note our distinct focus in the current paper. We are primarily concerned with people's everyday view of their own experience of time; in this context we ask participants whether they believe that they experience time passing and their understanding of what it means to say that time passes. (The former issue is also probed by Latham et al. (*forthcoming*), whose findings are discussed in relation to our own in §2.3.) With regard to participants' understanding of what it means to say that time passes, we asked participants to select between four different possible meanings, two of which were recognizably A-theoretic and two of which were compatible with the truth of the B-theory (see method for details). By asking participants both whether they experienced time as passing, and what they take to be meant by saying that time passes, our study was designed to allow us to categorize participants into one of four groupings as shown in the table below (Table 1).

If a majority of participants were to respond as 'passage-experiencers', this would mean that people generally describe their experiences in a way that implies that the nature of those experiences, if veridical, would provide evidence for the truth of the A-theory. Note, though, that if a majority of participants fell into the category we call 'change-experiencers' this would not, conversely, be a convincing demonstration that people generally take the world as (apparently) presented to them in experience to be as the B-theorist has it.[9] This is because the descriptions of what it means for time to pass that are not distinctively A-theoretic could nevertheless be endorsed by someone who possessed an A-theorist metaphysics (e.g., an A-theorist could unproblematically agree that 'different things happen at different times'). The reverse is not true, or at least not straightforwardly true, of the descriptions that were A-theoretic in nature (e.g., a B-theorist could not easily agree that 'things move from the future to the present to the past'). Because of this, our study is best viewed as one regarding whether people's own descriptions of the nature of their experiences is in line with the idea that there is an argument from experience for the A-theory; we are not addressing whether people's

Footnote 8 continued
not typically characterise their experience in A-theoretic ways, perhaps given independent reasons to think that one needs to be suitably placed to articulate the phenomenology. This is not something that we sought to confirm or disconfirm.

[9] Thanks to an anonymous reviewer for the journal for pushing us to be clearer on this point.

Table 1 Summary of how participants were categorized

Category	Agree that they experience time passing	Endorse a description of what it means to say that time passes that is distinctively A-theoretic
Passage-experiencers	Yes	Yes
Passage-non-experiencers	No	Yes
Change-experiencers	Yes	No
Change-non-experiencers	No	No

description of their experiences might actually suggest that there is argument from experience for the B-theory.

The A-theorist using the argument from experience would predict that the general public are typically passage-experiencers. This is also, plausibly, what the phenomenal illusionist would predict, with the proviso that the experience of time passing is illusory. Depending on where the cognitive error theorist locates the source of subjects' error, she might share this prediction—if the error is said to arise because people independently believe that time passes, and (presumably given some further, perhaps implicit, assumptions) come to believe that whatever they experience includes time passing.[10] Or the cognitive error theorist may predict that the general public are change-experiencers; that they do generally agree that they experience time passing, but give descriptions of what they mean by time passing that are not metaphysically loaded in a distinctively A-theoretic way. The above philosophical positions are premised on the idea that subjects will agree that they experience time passing. If this isn't the case—if the general public are revealed to be largely passage-non-experiencers, for example – then such contemporary philosophical positions will be premised on a mistake.[11]

In addition to asking participants what they believe that it means to say that time passes, we also asked what reasons they take themselves to have for choosing the meaning that they do. Participants' answers to this question are of interest not only in and of themselves, but also because there are different views of the origin of the belief that time passes in the philosophical literature. On one view, the origin of the belief is to be located in the content of visual perception (see, e.g., Paul 2010). On another view, the origin is located in experience more generally (see, e.g., Torrengo 2017). On a further view, the origin of the belief that time passes implies a role for memory (see, e.g., Deng 2017). On a final view, the origin is located in a subject's awareness of their own agency (see, e.g., Ismael 2012). Thus, in the present study

[10] This would be compatible with finding that the majority of participants are passage-experiencers, since we do not claim to reveal the narrow content of participants' experience. Those participants whom we dub passage-experiencers might well be people who do not in fact have a metaphysically loaded phenomenology, but who nonetheless explain their phenomenology to themselves in such a way.

[11] We might also suppose that the general public hold diverse views, such that some will be passage-experiencers, some passage-non-experiencers, and so on. The issue of interest will then be what explains the differences between the populations.

(described below), in addition to questions about whether people experience time passing and about their understanding of what it means to say that time passes, we also asked people how they arrived at this understanding of what it means to say that time passes. As we will shortly describe, we also asked participants a small number of questions about their beliefs about the nature of time itself and some demographic questions.

2 The current study

In the current study, adults were asked directly to what extent they agreed that they experience time passing—'feeling' and 'seeing' time pass—and about the extent to which they endorse certain beliefs about time. We acknowledge that the term 'experience' can be understood in a number of ways (see, e.g., Hinton's [1973, ch. 1] discussion). The precise nature of participants' understanding of the appeal to experience was not our main focus, though it might be usefully investigated more systematically in future studies. However, we found it worthwhile to explicitly distinguish between claims to 'feel' and 'see' time passing. While we cannot guarantee that participants are responding with one particular conception of 'experience', 'see', or 'feel' in mind, we predicted greater agreement with the 'feel' claim than with 'see' for two reasons. First, 'feel' is commonly used in a broader sense than that of perceptual phenomenology (and while 'see' may sometimes be so used, this is plausibly less common). Second, when 'feel' is used to refer to perceptual phenomenology, there are cases in which we might feel change or passage happening (one's breathing or heartbeat, for example) even though we cannot see it happening (when in complete darkness, for example). Hence, we would expect those who claim to see time passing to also claim to feel time passing, and we would predict that some participants will claim to feel, but not see, time passing.[12]

As discussed previously, whether people report experiencing time passing might plausibly be related to their conception of what it means to say that time passes. If participants differ in their understanding of what it means for time to pass this might plausibly also affect how their experience has to present itself to them in order for them to believe that they have an experience as of time as passing. In order to investigate this relationship, we asked participants what they believe that it means to say that time passes, and we also asked what reasons they take themselves to have for choosing the meaning that they do. It will take a great deal more than the exploratory work presented here to gain a full understanding of these relationships, but we take our study to present an important first step.

How subjects report their own temporal phenomenology may also be associated with other, independent tacit beliefs about time. These relationships are likely to be complex and interdependent, and it may be difficult to discern their direction. We can nevertheless approach some of these relationships in an exploratory way by identifying candidate independent beliefs. Some of these beliefs might concern the relation between change in the world and people's temporal experience. For instance, if sub-

[12] Thanks to an anonymous reviewer for the journal for pushing us to be clearer on this point.

jects believe that if nothing changes then time does not pass, this may reflect a tacit inference that time's passage is to be defined in terms of change in the world. Given the ubiquity of change in the world, we might expect those who make such a claim also to claim to feel or see time passing. Belief in a force such as fate may also be associated with reports about temporal phenomenology, where a belief in fate, or religious beliefs that may for some subjects entail a kind of fatalism, might imply a belief that the future already exists, such that reality is static and no change in what exists over time is required—i.e., time does not pass.

If there is variation in participants' reports about experiencing time passing, such a discrepancy might arise from various differences between individuals. We therefore also asked about demographic factors such as age (assuming that with age we accumulate a greater number of episodic memories, and that this may influence a person's beliefs about the passage of time); education (which might increase the awareness that one's experiences are not always veridical); and media or print exposure to scientists' views about the nature of time.

2.1 Method

Ethical approval for this study was received from the research ethics committee of the second author's institution.

2.1.1 Participants

Data collection took place both online using the Qualtrics platform and in person using paper questionnaires. Participants who took part online were recruited from the Prolific online subject pool (Peer et al. 2017) and a subject pool for undergraduate psychology students at the second author's institution. Paper questionnaires were completed at a series of research outreach events for the general public. Two hundred and twenty-five people participated online ($M = 29.51$ years, $SD = 10.44$, range: 18–67 years, 89 males), and 204 people participated at the outreach events ($M = 37.82$ years, $SD = 16.53$, range: 18–84 years, 85 males). Four participants who took part at outreach events did not report their age, and five participants who took part at outreach events did not report their gender. The full sample thus comprised 429 adults ($M = 33.42$ years, $SD = 14.25$, range: 18–84 years, 174 males). Potential participants approached via the Prolific subject pool all stated that they were fluent in English when registering with the pool and confirmed this when beginning the questionnaire.

2.1.2 Materials

Participants who were part of the Prolific subject pool or the undergraduate subject pool completed the questionnaire on desktop, laptop, or mobile devices. Participants who responded at outreach events completed the questionnaire on paper. Participants who were part of the Prolific subject pool each received compensation of £1.33 UK pounds. Those who were part of the undergraduate subject pool received course credit.

2.1.3 Design and procedure

The study comprised of four Temporal Phenomenology statements, two Meaning of Temporal Passage questions, five Beliefs Related to Time statements, and three Demographics questions. All participants first provided informed consent, and then their age and gender. Participants who completed the questionnaire online answered the Meaning of Temporal Passage question first and then rated their level of agreement with the Temporal Phenomenology Statements before responding to the Beliefs Related to Time statements, and finally the Demographics questions. Participants who completed the questionnaire on paper responded to the Temporal Phenomenology statements prior to responding to the Meaning of Temporal Passage question, advanced to the Beliefs Related to Time statements, and finally completed the Demographics questions. Participants were randomly allocated to one of four conditions, each of which presented the questions within the Temporal Phenomenology and Beliefs Related to Time sections in a different quasi-randomized order. Online participants were not able to skip any questions; a small number of participants who completed the questionnaire on paper skipped some questions, yielding slightly different *n*s across questions for the analyses below.

2.1.4 Temporal phenomenology statements

Participants saw a scale running from 0 to 100, where 100 represented 'completely agree' and 0 represented 'completely disagree'. A red dot was situated at the midpoint of the scale (50). The accompanying text asked participants to move the dot along a sliding scale (online completion) or mark a point on the scale (paper completion) to indicate the number that best reflected how much they agreed or disagreed with a statement. As online participants moved the dot, they saw a number reflecting its current location on the scale. Participants were also informed of a 'Don't Know' option.

Four Temporal Phenomenology statements were presented. Participants who completed the questionnaire online also responded to an additional initial practice statement (Fig. 1), 'Ripe bananas are delicious', which was always presented first. When online participants moved the slider in response to the practice statement, they received feedback based on the number they chose (0–25, 'This means you dislike ripe bananas'; 25–49, 'This means you don't like ripe bananas all that much'; 50–74, 'This means you quite like ripe bananas'; 75–100, 'This means you really like ripe bananas'). If online participants selected the 'Don't Know' option in response to the practice statement, they then answered an additional question: 'Which is closer to what you were thinking when you selected this option?' Three statements were presented, from which participants were required to choose one: 'I don't personally know to what extent the statement is true or untrue', 'I don't think it is possible to know to what extent the statement is true or untrue', and 'I don't understand the question'. After choosing one of these statements, online participants saw the statement 'When you choose 'Don't Know', you will always be given the three options that you just saw' followed by a reiteration of the three options. Participants who completed a questionnaire on paper did not receive a practice question, since marking a point on a line

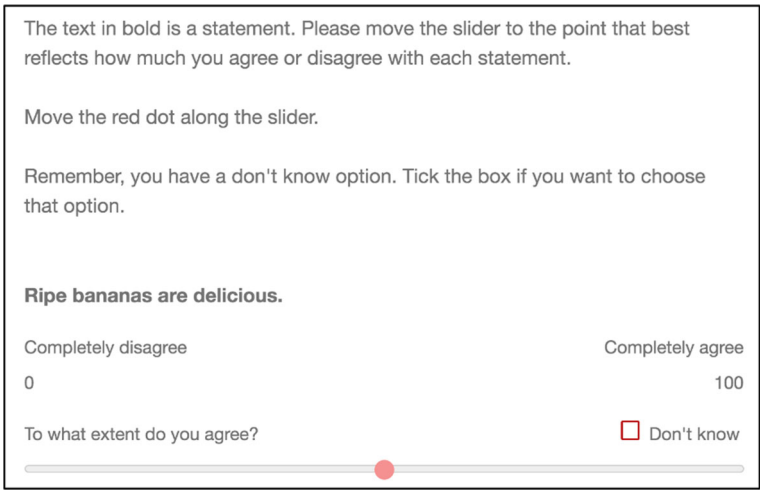

Fig. 1 Practice statement, Temporal Phenomenology

was likely to be a more familiar task than moving an online slider. Participants who received questionnaires on paper could also select a 'Don't Know' option followed by the same three 'Don't Know' alternatives printed underneath each question.

Participants then read a number of statements describing potential features of one's temporal phenomenology and were asked to move the slider (online) or mark a point (on paper) to indicate how much they agreed with each statement. Two phenomenological claims were offered. Each was presented twice, once in the positive ('I feel time passing' and 'I see time passing') and once in the negative ('I do not feel time passing' and 'I do not see time passing'), yielding four statements in total (Table 2).

2.1.5 Beliefs Related to Time statements

Participants saw five statements describing certain beliefs about time. Two of these statements ('Humans perceive every aspect of time' and 'Our experience of time tells us something about time that science can't') are not discussed here as they are not the focus of the current study. The remaining three statements are presented in Table 2. Participants again moved a dot along a sliding scale (online) or marked a point on the scale (paper) to indicate the number that best reflected how much they agreed or disagreed with a statement. Two of these statements formed a pair, one phrased positively and one phrased negatively (e.g., 'Time passes even if nothing changes' and 'If nothing changes, time does not pass') as a check on comprehensibility.

2.1.6 Meaning of Temporal Passage question and reasons

Participants were presented with four statements and asked to rank them according to how well they described what it means for time to pass, starting with 1 (best describes what it means for time to pass), then 2 (the next best statement), and so

on (Fig. 2). Participants were presented with two statements that were putatively A-theoretic ('Things move from the future to the present to the past' and 'What time is now changes') and two statements that were consistent with the B-theory ('One thing happens at one time, another thing happens at another time' and 'Different things happen at different times'). Participants were then presented with five possible reasons for thinking that their top-ranked statement was the best way to describe what it means for time to pass (Fig. 3), the last of which was 'Other', and selected as many reasons as applied. If 'Other' was among the options chosen, the participant was invited to state their reason by typing a response into a free text box.

2.1.7 Demographics questions

At the conclusion of the questionnaire participants were asked about the level of their highest qualification on a 9-point scale (according to levels of qualifications obtainable in the UK and in Ireland), how often within the last three years they were exposed to information in the media or in print about the scientific study of time (never; once; two or three times; more than two or three times), and whether or not they believe in a God (no, not sure, or yes).

2.1.8 Data scoring and analysis

Participants' responses on negatively worded statements were reverse-scored by subtracting the value of each response from 100. For the purposes of analysis and classification of participants (see below), dichotomized scores were calculated for Temporal Phenomenology statements by categorizing values over 50 as agreement with the statement, values below 50 as disagreement with the statement, and values of 50 (the midpoint) as missing. Pairs of positively and negatively worded statements demonstrated acceptable, but not excellent reliability (Spearman-Brown split-half coefficients between .707 and .794). For this reason, we did not collapse responses to pairs of positively and negatively worded statements prior to analysis. Given the complexity of the domain and the possibility that participants were reflecting on their own beliefs related to time and temporal phenomenology for the first time, the fact that reliability ratings are moderate rather than high is perhaps unsurprising.

2.2 Results

Means, 95% confidence intervals, and reliability between pairs of positively and negatively worded Temporal Phenomenology and Beliefs Related to Time statements are reported in Table 2. 'Don't Know' responses were excluded from analyses, yielding slightly different *n*s for the analyses below. Across Temporal Phenomenology and Beliefs Related to Time statements, the number of participants who chose any one of the three Don't Know options ranged from 0 (0%) to 25 (5.87%). Very few participants stated that they did not understand the question (range: 0 (0%) to 8 (2.05%)). Responses to the Meaning of Temporal Passage question are presented in Fig. 2.

First, we checked whether the order in which participants completed the questionnaire (i.e., Temporal Phenomenology statements preceding or following Meaning of Temporal Passage statements) had an impact on responding. There was no significant order effect on participants' responses to the Temporal Phenomenology statements, regardless of whether the question was phrased positively or negatively (all $ps > .110$).

2.2.1 Temporal Phenomenology Statements

We next examined participants' responses to the Temporal Phenomenology statements. The modal score was 100 for both positively worded statements and 0 for both negatively worded statements, indicating that the most common response to the positively worded statements was complete agreement and the most common response to the negatively worded statements was complete disagreement. Wilcoxon signed-ranks tests revealed that participants agreed significantly more strongly that they feel time passing than that they see time passing, both for positively worded statements ($z = -4.13$, $p < .001$) and negatively worded statements ($z = -3.41$, $p < .001$).

On the basis of dichotomized responses, 83% of participants indicated agreement with the statement 'I feel time passing' (that is, gave a response that was equal to or above 51), and 78% indicated agreement with the statement 'I see time passing'. Seventy-eight percent of participants indicated disagreement with the statement 'I do not feel time passing', and 73% indicated disagreement with the statement 'I do not see time passing'. Dichotomized responses for positive and negative question pairs were largely consistent with one another: 84.1% of participants were consistent across the 'feel time pass' pair and 82.7% were consistent across the 'see time pass' pair. For positively worded questions a small minority claimed to see, but not to feel time passing ($n = 26$; 6.8%) and a slightly larger minority claimed to feel, but not to see time passing ($n = 45$; 11.8%). A McNemar test demonstrated that the proportion of participants who claimed to see, but not to feel time pass when answering positively worded questions was significantly lower than the proportion who claimed not to see, but to feel time passing ($p = .032$). For negatively worded questions, similar results were apparent: a small minority of participants claimed that they do not see, but do feel time passing ($n = 51$; 13.18%), and this was significantly higher than the proportion of participants who claimed that they do see, but do not feel time passing ($n = 26$; 6.72%, $p = .006$).

Thus, the majority of participants believed themselves both to feel and to see time passing. Participants believed more strongly that they feel time passing than that they see time passing; as we expected 'feel' to be understood as a broader experiential notion, this result is as we predicted. Nonetheless, the most common response both in the case of claiming to see and to feel time passing was complete agreement that this was the case.

Table 2 Extent of agreement with Temporal Phenomenology and Beliefs Related to Time statements

Statement	*n*	M (SD)	Min	Max	95% CI	Reliability (Spearman-Brown split-half)
Temporal phenomenology						
I feel time passing	418	71.53 (25.63)	0	100	69.07, 74.00	.769
I do not feel time passing[a]	420	27.00 (26.75)	0	100	24.44, 29.57	
I see time passing	415	66.99 (28.18)	0	100	64.27, 69.70	.794
I do not see time passing[a]	417	32.24 (29.76)	0	100	29.38, 35.10	
Beliefs related to time						
Time passes even if nothing changes	417	81.04 (27.72)	0	100	78.37, 83.70	.707
If nothing changes, time does not pass[a]	412	15.82 (25.33)	0	100	13.37, 18.28	
There is such a thing as fate, destiny, or karma	401	46.35 (34.37)	0	100	42.98, 49.73	

[a]While responses to the statements 'I feel time passing' and 'I see time passing' were reverse-scored for the purposes of analyses, original response values are presented here

2.2.2 Meaning of temporal passage questions

Next, we examined participants' responses to the Meaning of Temporal Passage question and the reasons that they gave for their answer. Recall that participants ranked four statements according to how well they described what it means for time to pass on a scale of 1–4 (where 1 represented the top rank and 4 the lowest rank) and then selected as many reasons for their choice as were applicable. Figure 2 presents the ranks assigned by participants to each Meaning of Temporal Passage statement, and Fig. 3 stratifies endorsement of reasons by top-ranked statement.

It can be seen from Fig. 2 that the two putatively A-theoretic statements received higher rankings than the two statements that are consistent with the B-theory. A Friedman test indicated significant differences between the ranks assigned by participants to statements ($\chi^2\,(1) = 171.39, p < .001$). Dunn-Bonferroni post hoc tests revealed statistically significant differences in ranked position between every pair of statements, with the exception of the two statements consistent with a B-series conception of time. Thus, the A-theoretic statement 'Things move from being in the future to being in the present to being in the past' was ranked significantly higher than the A-theoretic statement 'What time is now changes'. Both of these A-theoretic statements were ranked significantly higher than either of the two statements that were also consistent with the B-theory ('Different things happen at different times' and 'One thing happens at one time, another thing happens at another time').

When asked to select one or more reasons for their choice of top-ranked statement, more than half of participants endorsed 'Because I experience things this way' and

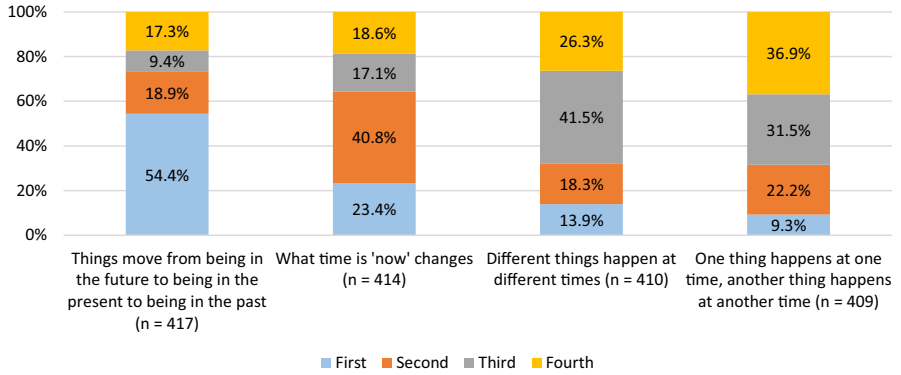

Fig. 2 Ranks assigned by participants to each meaning of temporal passage statement

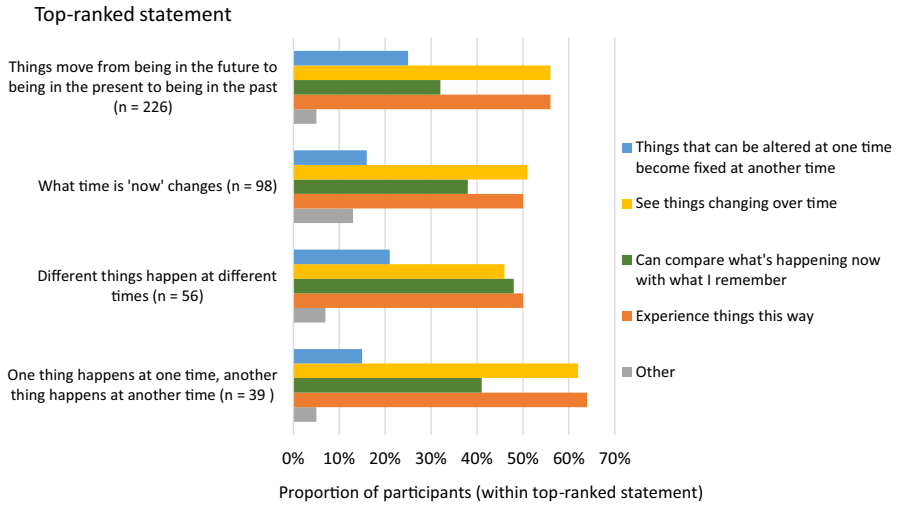

Fig. 3 Proportion of participants endorsing one or more reasons for choosing their top-ranked statement, by top-ranked statement

'Because I see things changing over time'. Over 40% endorsed 'Because I can compare what's happening now with what I can remember', over 20% endorsed 'Because things that can be altered at one time become fixed at a later time', and 7.5% provided their own reason. A series of chi-square tests on the four specific reasons presented to participants indicated that whether a subject endorsed one of these reasons did not differ as a function of the first-ranked statement that the reasons were intended to explain (all $ps > .277$). The overall pattern of results was largely consistent across first-ranked statements (Fig. 3). Thus, regardless of whether participants first-ranked an interpretation of what it means for time to pass that was more distinctively A-theoretic or one that was also consistent with the B-theory, they tended to explain their interpretation in terms of their experience, in terms of seeing change, and, to a lesser extent, in terms of memory.

2.2.3 Classification of participants

We proceeded to classify participants on the basis of their responses to both Temporal Phenomenology and Meaning of Temporal Passage statements ($n = 358$; Fig. 4). Responses to 'seeing time pass' paired questions and 'feeling time pass' paired questions were initially considered separately. Participants were coded as seeing time pass if they endorsed the 'I see time passing' statement (score 51–100) and rejected 'I do not see time passing' (score 0–49). The same coding was applied to the 'feeling time pass' question pair. Among participants who were consistent across positive and negative question pairs, 87.5% were coded as feeling time pass and 80.7% as seeing time pass. Participants were subsequently classified according to the system given in Table 1. The percentage of participants who were classified in each category is shown in Fig. 4. The plot also shows the distributions of participants' scores for the positively worded statements 'I feel time passing' and 'I see time passing' (for simplicity, negatively worded responses are not plotted). From the figure, it can be seen that the modal response for passage- and change-experiencers to these statements was 100, whereas there was no clear modal response for passage- or change-non-experiencers. A chi-square test indicated that there was no statistical association between being an experiencer and selecting an A- or B-theoretic Meaning of Temporal Passage statement ($\chi^2 = .13$, $p = .72$).

2.2.4 Beliefs related to time statements and demographics questions

Finally, we conducted exploratory analyses to compare the responses of experiencers and non-experiencers, and of participants who endorsed distinctively A-theoretic and B-theory-consistent Meaning of Temporal Passage statements, to Beliefs Related to Time statements and Demographics questions. We were unable to compare responses to these questions across all four groups into which we had classified participants (passage-experiencers, change-experiencers, passage-non-experiencers, change-non-experiencers) due to loss of statistical power and empty cells resulting from the small number of participants in the change-non-experiencer group.

We began by comparing participants who endorsed distinctively A-theoretic Meaning of Temporal Passage statements to those who chose versions of these statements also compatible with the B-theory, regardless of their claims about their temporal experience. A Welch's independent t test demonstrated that participants who endorsed A-theoretic statements ($M = 5.81$, $SD = 1.56$) were better-educated than those who endorsed statements compatible with the B-theory ($M = 5.36$, $SD = 2.03$; $t\,(128.73) = 2.01$, 95% CI [.01, .90], $p = .046$). No other comparisons were statistically significant (all $ps > .376$).

We then compared experiencers (participants who claimed to experience time passing: that is, those who were coded as either 'feeling time pass' or 'seeing time pass') and non-experiencers (that is, those who were coded as neither feeling nor seeing time pass), regardless of their choice of Meaning of Temporal Passage statement. A chi-square test demonstrated that experiencers were more likely to be educated to a standard at or above high-school leaving (examinations at the age of approximately 18) than non-experiencers, $p = .02$. However, the presence of only 24 non-experiencers in

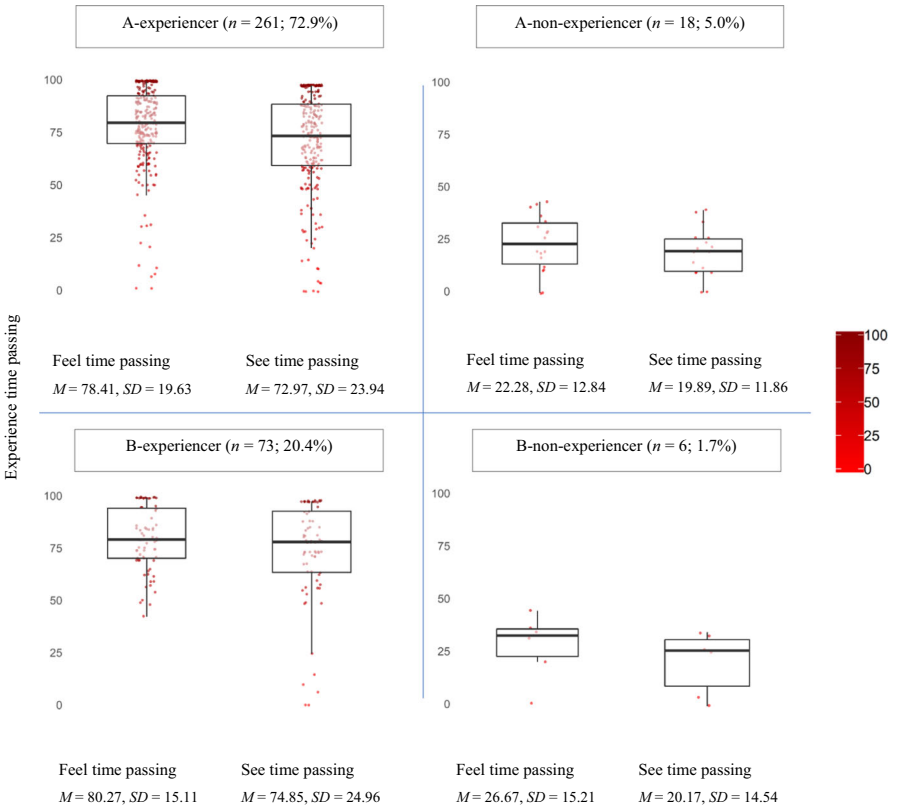

Fig. 4 Distributions, means, standard deviations and 95% confidence intervals for Temporal Phenomenology statements, by group. Being an A- or B-experiencer requires scoring either 'I feel time passing' or 'I see time passing' at or above 51, but not necessarily scoring both statements at or above 51. Some A- and B-experiencers therefore score at or below 49 for one of the two statements

the sample renders this conclusion tentative. No other comparisons were statistically significant (all $ps > .079$).

3 Discussion

We explored participants' beliefs regarding the purported experience as of time passing, their conception of temporal passage, and relations between them. We also asked how these experiences and beliefs may be informed by independent beliefs about time, as well as being associated with demographic factors.

Before distinguishing between participants' understandings of what it means to say that 'time passes', it is notable that a substantial majority of participants described themselves as having a phenomenology as of time passing, manifesting both as feeling and seeing time passing. The most common response to the statements 'I feel time passing' and 'I see time passing' was complete agreement, regardless of whether the

statements were expressed positively or negatively. A minority of participants gave responses that indicated disagreement with either or both of these statements. It could be that the existence of this minority indicates that there genuinely are differences across individuals' experiences of time passing. Alternatively, these participants may have understood the question(s) in a different way than other participants, which, given that we did not provide any further guide to participants as to how to interpret the question, remains possible. Participants were somewhat more likely to agree with the statement that they felt time passing than that they saw time passing, in line with the idea that 'feel' is interpreted more broadly than 'see'. Nevertheless, there were a small number of participants who reported seeing, but not feeling the passage of time. This might signal that these participants did not understand 'feel' to be a broad experiential notion that includes 'see' (for example, they may have only interpreted 'feel' in terms of tactile sensations). Alternatively, it might signal that while these participants claim to see time passing, they do not take 'time passing' to show up anywhere else in experience, and so thought it inappropriate to also agree with the 'feel' claim.

We previously indicated that subjects' understanding of what it means to say that time passes might seem to reflect either a putatively A-theoretic conception, or a tacit conception that is also compatible with the B-theory. (Recall that our results do not reveal whether or not participants' phenomenology *is* metaphysically loaded, but whether or not participants describe their phenomenology in a way that implies that it is metaphysically loaded.) Our results suggest the former. A large majority of participants indicated that the best way to describe what it means for time to pass was a statement describing movement through time or a changing present. Furthermore, when asked to select one or more reasons for their choice, participants tended to appeal to experience and to perceived change rather than to the persistence of things through time in memory, and rarely appealed to the fixed nature of the past. Our results suggest that people tend to claim to have a phenomenology as of temporal passage and that this is most often construed as a process of movement through time or a changing present. Our results also provide evidence that people represent these construals as a function of subjective experiences rather than as a function of memory or of agency. However, we did not find evidence that the extent to which participants claimed to feel and to see time passing was related to their conception of temporal passage.

Of particular relevance to the A-theorists' argument from experience are the weightings of passage-experiencers and passage-non-experiencers. Recall that the first premise of the argument from experience (as presented in §1) states that almost all subjects would agree that they experience time passing. We put this in terms of the idea that people are, by and large, passage-experiencers: that they do take themselves to experience time passing, and that they do understand talk of 'time passing' in a way that is distinctively A-theoretic in nature. Our results reveal that 72.9% of participants can be classed as passage-experiencers. Those participants who also understand talk of time passing in a distinctively A-theoretic sense and yet *disagreed* with the statements 'I feel time passing' and 'I see time passing' were classified as 'passage-non-experiencers', and made up only 5% of participants. This may be a greater minority than the A-theorists using the argument from experience would have predicted, but

the majority group is nonetheless the passage-experiencers, as those theorists would have predicted.

We found some evidence that certain independent factors may be associated with participants' claims to feel and see time passing, and with their endorsement of A-theoretic definitions of time's passage or definitions compatible with the B-theory. Participants who endorsed the distinctively A-theoretic definitions were better-educated than those who endorsed those compatible with the B-theory. This might appear counterintuitive, given that the latter statements are typically thought to align better than A-theoretic statements with the views of contemporary physicists. One possible explanation is that the more educated participants were more likely to recognize and attend to the differences in meaning between the distinctively A-theoretic and B-theory compatible statements, making it less likely that they chose statements at random. Another possibility is that education tends to encourage people to reflect on their beliefs, and that the more people engage in this kind of reflection, the more likely they are to notice that they tend to think and speak of time as passing or flowing. Thus, the more likely such participants are to have some understanding of the differences between the definitions, the more likely they are to appeal to the distinctively A-theoretic definitions that align with the ways in which they think and talk about time. There was also some evidence that experiencers were better-educated than non-experiencers. Again, it may be that better-educated participants more readily reflect on their experience of time, where this may make them more likely to conclude that they have an experience as of time passing.

There are interesting parallels between our results and those of Latham et al. (2019). Using a very different procedure, in which participants had to choose a description of a universe that most resembled our universe, these authors found that a majority (~ 70%) of participants appeared to hold views of time as dynamical, but they also found a substantial minority (~ 30%) who appeared to hold a view of time as non-dynamical. Our results reveal a similar pattern, in that over three-quarters of participants first-ranked an A-theory-like description of what it means for time to pass (either 'Things move from being in the future to being in the present to being in the past', or 'What time is 'now' changes'). Note, though, that the aim of Latham et al.'s (2019) study was to directly examine people's metaphysical beliefs about time, which they did by means of providing contrasting (and in fact quite technical) descriptions of universes with different temporal properties. In our study, we did not ask people whether they believed that time was dynamic or not. Rather, we asked them about their understanding of what it means to say that time passes; this was because we could only confidently classify participants as passage-experiencers if they both (i) claimed to experience time as passing, and (ii) understood 'time passing' in a distinctively A-theoretic way. Nevertheless, despite the differing aims of the studies, the similarity in our findings with those of Latham et al. suggest that it is very possible that our participants' definition of what it means to talk about time as passing also reflects their underlying beliefs about the nature of time itself.

In recent work published after the current study was conducted, Latham et al. (forthcoming) also empirically investigated whether people report having a phenomenology as of time passing, where—if they do—this might be construed as providing prima facie support for an argument from experience in support of the claim that time does

pass. We now consider how our findings compare with theirs. First, the overall percentage of our participants who agreed that they felt or saw time passing is broadly similar to the average percentage of participants in their study who agreed with statements about experiencing time in a dynamic way. As we will discuss below, Latham et al. asked a much larger set of questions about temporal experience, but typically participants agreed with positive statements about experiencing time's passage around 70–85% of the time. Thus, both studies suggest that the majority of people agree that they have some type of experience of time as passing. Where the findings of the studies seem to diverge is in (a) the nature of participants' responses to the parallel negative statements about temporal experience and (b) the strength of participants' agreement with statements regarding experiences about the passage of time. These differences require consideration because of their implications for the interpretation of the two sets of findings.

With regard to (a), the proportion of participants in our study who disagreed with negative statements about experiencing time's passage was very similar to the proportion who agreed with positive statements, and participants' responses to positive and negative statements were generally consistent (over 80% of the time). By contrast, Latham et al. found participants were significantly less likely to disagree with a negative statement than to agree with a positive one. Moreover, there was much less consistent responding across positive and negative statements, and correlations between responses to positive and the equivalent negative statements were either weak or non-significant. Lack of perfect consistency in responses to negatively and positively worded (but otherwise identical) statements is very common in questionnaire-based research (e.g., Barnette 2000; Chang 1995), and, as Latham et al. point out, may be, at least to some extent, explicable in terms of an acquiescence bias—a tendency to agree to statements regardless of their content. However, it may also reflect participants' difficulties with understanding or consistently interpreting a statement, and there is long-standing evidence that suggests that participants struggle in particular with negatively worded statements (e.g., Johnson et al. 2004; Van Sonderen et al. 2013). The particularly low levels of correlations between negative and positive statements in the Latham et al. study raise the issue of the extent to which participants were confident or reliable in their interpretations of the statements.

In fact, Latham et al. (forthcoming) draw an important inference from the difference between responses to their positively worded and negatively worded statements: they suggest that it supports what they term the 'ambiguity hypothesis'. The idea is that "there is ambiguity either in the content or character of the phenomenology, or in what its character tells us about the world". They argue that because of this ambiguity, participants' responses to statements are heavily shaped by the framing of a statement (positive or negative). Moreover, Latham et al. provide the same interpretation of why they find levels of agreement to statements of both kinds to be weak: participants only weakly agree with statements because of this ambiguity. In arguing that their results support some version of the ambiguity hypothesis, they then conclude "that there is no overwhelming need for philosophers of time to attempt to accommodate the presence of some unambiguous, and strongly felt, phenomenology as of time passing".

Indeed, with regard to (b), it was the case that, on average, their participants only weakly agreed that it seems as though time passes (and Latham et al. did not find the

predicted relationship between reported phenomenology of time passing and endorsement of a theory of time entailing that time actually passes). For almost all statements (both positive and negative) the modal (i.e., most frequent) responses in Latham et al.'s study were at the midpoint of their scale (i.e., 4 on a 7-point scale). By contrast, our modal responses were complete agreement with statements indicating that participants experience time as passing (that is, 100 on our 1–100 scale). How can this discrepancy between the findings of the two studies be explained, and do our findings cast doubt on the ambiguity hypothesis as described by Latham et al.?

We note a number of plausible explanations for this discrepancy between our findings and those of Latham et al., two of which concern the particular statements used in Latham et al.'s study. One is that part of Latham et al.'s specific interest was in studying participants' responses to both moving-ego and moving-time statements (whereas we only appealed to feeling/seeing time passing). Some participants may thus have noticed that many of the statements represented one or the other mode of expression, and may have come to the conclusion that they were expected to demonstrate a preference for one or the other. While Latham et al. found that levels of agreement with moving time and moving ego statements were positively correlated, such an assumption on the part of participants may have led to greater uncertainty and so weaker agreement with both than would have been the case had participants been faced with either type of statement in isolation. A related explanation is that some of Latham et al.'s descriptions have a more overtly metaphorical flavor (for instance, "it feels like time is *whizzing towards* me" and "It feels like time is *a moving river that I am floating upon*."). It seems plausible that people may be cautious about expressing complete agreement with something that is clearly a metaphor (and indeed a metaphor that carries implications about the speed of time's passage), and we note that the mean agreement given to the overtly metaphorical statements of Latham et al. is somewhat lower than that given to other statements. Further, the presence of such overtly metaphorical statements may also have had the effect of highlighting (what the B-theorist would maintain is) the ultimately metaphorical nature of the remaining A-theoretic statements about time passing. Finally, and more prosaically, the two studies used different ways to measure agreement: we used 0–100 scales with only the end and mid-points marked whereas Latham et al. used a more restricted 7-point Likert scale. All of these differences may have contributed to the strikingly weaker agreement with claims to experience time passing reported by Latham et al. compared to the levels of agreement reported in the current study.

The important issue, then, is whether we wish to argue that our results suggest Latham et al.'s (forthcoming) ambiguity hypothesis is incorrect. It seems to us plausible that people do indeed—as we report in our study—typically have, or believe themselves to have, experiences of time as passing. Nevertheless, the nature or content of the phenomenology might be such that it is extremely difficult to give a rich verbal description of it, such that it can only be partially captured in metaphorical terms. One way to put this point is to say that the phenomenology itself may not be ambiguous, but any verbal description attempting to capture it is likely to prove

ambiguous.[13] Further studies could try to examine this phenomenology in more detail, perhaps by allowing open-ended rather than forced-choice questions, and also try to pinpoint the exact explanation of why our findings differ from those of Latham et al. As things stand, we are inclined to conclude that participants *do*, by and large, take themselves to experience time as passing.

Given the claim that there is an argument from experience in support of the A-theory, it might be argued that the majority of subjects arrive at an A-theoretic conception of temporal passage *as a result* of experiencing (either feeling or seeing) time passing. We cannot, in the present study, provide any evidence for the direction of the relationship between participants reporting that time seems to pass and the participants having an A-theoretic conception of time's passage. It is also worth noting that Latham et al. found no relationship between reported phenomenology of time passing and endorsement of a theory of time entailing that time actually passes, although their line of enquiry differed somewhat from our own focus on interpretations of what it means to say that time passes. Related future research might seek to examine the causal relations between the two.[14]

Our findings do demonstrate that participants tend to favour the distinctively A-theoretic characterizations of 'time passing'. To this extent, there is support for the A-theorist employing the argument from experience, but the first premise of the A-theorists' argument from experience has not been shown to be beyond reproach. That 5% of participants are passage-non-experiencers—in addition to 22.1% of participants favoring conceptions of time passing not necessarily implying a commitment to the A-theory—may give the A-theorist appealing to people's everyday intuitions about time (and their experience of time) pause for thought. Even in our study, there appears to be a greater distribution of folk intuitions about time passing, and whether or not time passing is experienced, than the A-theorist is often cast as predicting. Yet, as the A-theorist predicts, the majority of participants (72.9%) are passage-experiencers, which is to say both that they understand talk of time passing in a metaphysically loaded A-theoretic sense and that they claim to experience time passing.

It could be argued that placing such an emphasis on people's testimony is naïve; it would, among other things, assume that people are suitably situated to give voice to the phenomenal character of their experience. We grant that, given our results, it is still possible that some participants do (or do not) experience time as passing, even if they do not believe that this is the case. The Phenomenal Illusionist's and the Cognitive Error Theorist's responses to the second premise in the A-theorists' argument from experience are compatible with our results.

4 Conclusion

Our discussion is pitched in the context of debates regarding whether or not our experience of time supports one metaphysical view of time over another. In the philosophical

[13] This would be in line with the philosophical literature on the difficulty of arriving at a coherent conception of what it would be for time to pass (McTaggart 1908; Price 2011). See also Skow (2011), especially on descriptions of alleged experiences of time's passage.

[14] Thanks to an anonymous reviewer for the journal for pushing us to be clearer on this point.

literature it is currently a debated issue as to whether time does *seem* to pass. That is, there are disagreements over how to characterise the phenomenology; consequently there are disagreements about what the apparent ingredients of the phenomenology are for the A-theorist and B-theorist to appeal to, or to explain away, in an effort to gain a dialectical advantage.

On the basis of our results (discussed in §2), we conclude that people tend to claim to have a phenomenology as of temporal passage, most often construed as a process of movement through time or a change in the time that is 'now'. Our results also provide evidence that people take the passage of time to be a function of subjective experiences. In the wider debate, our results could be interpreted as providing some defeasible support for the first premise in the A-theorist's argument from experience. At least, it would appear that for a majority of subjects, it is not only part of the naïve view of time that time is the sort of thing that passes, but there is also a widely endorsed (perhaps tacit) belief that some metaphysically loaded ingredient of the phenomenal character of experience can be picked out as time seeming to pass. However, we also recommended caution in drawing the conclusion that subjects do in fact experience time as passing. Strictly speaking, our data only show that participants claim to have a phenomenology of temporal passage, rather than conclusively showing that they do have such a phenomenology.

While our discussion has focused upon how subjects report their experience, it is to be granted that not all A-theorists are motivated by an appeal to experience. Some theorists have argued that the A-theory is the best articulation of our common-sense commitments about time and persistence, rather than being straightforwardly supported by reflection on experience. In future research we aim to investigate subjects' beliefs about time more directly, rather than beliefs about their temporal experience. The hope is that such research may begin to reveal something about what those belief structures actually are—i.e. what naïve view of time, if any, subjects in fact operate with in their day-to-day lives—and how such beliefs about time arise.

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Compliance with ethical standards

Ethics approval Ethical approval was received from the research ethics committee of the Faculty of Engineering and Physical Sciences at Queen's University Belfast, protocol number EPS 18_126.

Informed consent All participants gave informed consent.

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