



Moving ego versus moving time: investigating the shared source of future-bias and near-bias

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Abstract

It has been hypothesized that our believing that, or its seeming to us as though, the world is in some way dynamical partially explains (and perhaps rationalizes) future-bias. Recent work has, in turn, found a correlation between future-bias and near-bias, suggesting that there is a common explanation for both. Call the claim that what partially explains our being both future- and near-biased is our believing/it seeming to us as though the world is dynamical, *the dynamical explanation*. We empirically test two versions of the dynamical explanation. The first is *the moving ego explanation*—according to which it is our belief that the ego moves, or our phenomenology as of the ego moving, that jointly (partially) explains future- and near-bias. The second is the *moving time explanation*—according to which it is our belief that time robustly

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passes, or our phenomenology as of robust passage, which jointly (partially) explain future- and near-bias. We found no evidence in favour of either explanation.

Keywords Future bias · Near bias · Experimental philosophy · Moving ego · Moving time · Time · Self · Persistence

1 Introduction

Humans are time-biased—we have preferences for where some events are located in time, and these preferences are sensitive to where in time those events are represented as being. There are a variety of ways in which agents can be time-biased. An agent is said to be *near-biased* if she tends to prefer that positive events are located temporally near to her, and that negative events are located temporally far from her, holding fixed relevant factors.¹ An agent is said to be *future-biased* if she tends to prefer that positive events are located in the future rather than the past, and that negative events are located in the past rather than the future, again holding relevant factors fixed.² Though the nature of near-bias and future-bias have both been studied (the former much more extensively than the latter), there has been very little work on the relationship between these biases. This could be because it is largely assumed that near-bias and future-bias have little in common.

While most philosophers take near-bias to be rationally objectionable,³ they take future-bias to be rationally permissible.⁴ On this assumption, it is rationally impermissible to value the utility of temporally nearer selves over the utility of temporally distant selves, but there is nothing rationally amiss about valuing the utility of temporally future selves over the utility of temporally past selves. What could explain this normative asymmetry? According to one plausible explanation, which we call the *independence assumption*, these biases are normatively asymmetrical because they

¹ Thaler (1981) showed that people prefer less money given now to more money given later, and Hausman (1979) found that people were willing to buy cheaper air conditioners with higher operating costs down the line. For overviews see Soman et al (2005), Frederick et al (2002), Ainslie and Haslam (1992) and Hardisty et al (2012). In economics and psychology this is sometimes known as temporal discounting, or as having a high time preference (as opposed to having a low time preference). For example, see Fredrick et al (2002), and, Lawless et al (2013). People have been shown to vary both intra and inter-personally when it comes to the rate with which they discount goods/events. See for instance Loewenstein and Elster (1992) and Frederick et al (2002) for an informative meta-analysis.

² Recent empirical work has found evidence of both positive and negative hedonic future-bias (Caruso et al (2008), Greene et al (2021)) and that people continue to show that pattern of preferences even when there is an inequality of utility between the past/future event. That is, Greene et al (2021) found that a significant majority of people are negatively hedonically future-biased even when ten negative past events are weighed against a single negative future event. This study did not find that positive future-bias continued when the ratio of positive past events to future events was 10:1. However, recent work by Greene et al (2022) shows that people still prefer more positive events in the past compared to fewer in the future, when the ration is 2:1. For other work on future-bias see Latham et al (2020) and Lee et al (2022).

³ Economists tend to disagree, arguing that near-bias is only irrational when it leads to dynamical inconsistency (e.g., Fishburn & Rubinstein, 1982; Koopmans, 1960; Lancaster, 1963; Strotz, 1955).

⁴ Although the normative status of future-bias has been the subject of recent controversy (Brink, 2011; Dorsey, 2018, 2011; Dougherty, 2011, 2015; Greene & Sullivan, 2015; Hare, 2007, 2013; Sullivan, 2018, Parfit, 1984).

have distinct sources.⁵ Perhaps future-bias arises because there is a relevant asymmetry between the past and future, and since the near future and distant future do not have this same kind of asymmetrical relationship, this factor can only explain and (potentially) justify future-bias and not near-bias.

Recent research by Latham et al (2023) places the independence assumption in jeopardy. Latham et al. found a moderately strong association between being future-biased and being near-biased and a significant correlation between the strength of future-biased preferences and near-biased preferences. This suggests that at least one factor partially explains both future-bias and near-bias, and in turn undermines the independence assumption. Latham et al. go on to argue that without the independence assumption, it is unlikely that there could be a normative asymmetry between near and future-bias. We take no stand on this latter issue. Rather, we focus on the prior question of what kind of factor could (partially) explain both near- and future-biased preferences.

Philosophers and psychologists have recently begun to investigate two broad classes of explanation of future-bias: the *practical irrelevance explanation* and the *dynamical explanation*.

According to the practical irrelevance explanation, we are future-biased because we have some degree of causal control over future events, which makes them objects of practical concern, whereas the past is largely causally inaccessible to us, and thus practically irrelevant.⁶ Since the practical irrelevance explanation does not seem well suited to explain near-bias (at least insofar as people show this bias even when both events are fairly temporally close, and each appear to be causally accessible) we set this explanation aside.

According to the dynamical explanation,⁷ our (likely tacit) beliefs about, or phenomenology of, movement *in or of time* explains our future-biased preferences.⁸ It is often thought that our world seems to us, either in experience or belief, to be *dynamical*.⁹ Often this is captured by the idea that we believe, or it seems to us as though, time robustly passes.¹⁰ By ‘robust temporal passage’, we mean the kind of passage posited by A-theories of time. A-theories of time hold that there is an objective, observer-independent fact about which moment (or set of events) is present, and which moment

⁵ Or because the normatively relevant sources are not shared.

⁶ Defenders of something like this view include Kauppinen (2018) and Horwich (1987, pp. 194–196). It is developed more fully and explicitly by Maclaurin and Dyke (2002) and Suhler and Callender (2012). Latham et al (2020) found that future-bias is mitigated when agents consider cases in which they can causally influence the past, as the practical irrelevance hypothesis predicts, and Greene, Latham et al (2021) found that when people are brought to think agentively about the location of events in time, they are less inclined to be negatively future-biased, and indeed instead exhibited negative *past*-bias. However, Latham et al. still found residual future-bias, indicating that practical irrelevance is likely only one factor that gives rise to future-bias.

⁷ Greene et al (2021), Latham et al (2020) and Latham et al (2021, 2022) call this the temporal metaphysics hypothesis.

⁸ Defenders of hypotheses such as these include Prior (1959), Pearson (2018), Schlesinger (1976), and Craig (1999).

⁹ Paul (2010); Dainton (2011, 2012); Le Poidevin (2007), Norton (2010) Schuster (1986).

¹⁰ Zimmerman (2008), Smith (1994), Craig (2000) and Schlesinger (1994, 1982), Smith (1993), Gale (1968) Ludlow (1999), Williams, (1998, 2003), McTaggart (1908).

(or event) this is, changes. Robust temporal passage is just this change in which events are objectively present.¹¹ (By contrast, B-theories of time hold that moments in time only stand in *earlier than* and *later than* relations to one another, and are not ‘past’, ‘present’, or ‘future’ except from the perspective of particular observers located at particular times. Since there is no objective present, there cannot be robust passage).¹² The idea that time is dynamical, or that we experience it as such or believe that it is this way, has been suggested to explain why, (and perhaps to render as rational) our being future-biased by several philosophers.¹³

This hypothesis is motivated, in part, by an active and growing literature on metaphoric structuring: the view that “abstract conceptual domains are structured through metaphorical mappings from domains grounded directly in experience” (Boroditsky, 2000). Much of this research focuses on how our understandings of time are influenced by spatial metaphors, particularly the ego-moving metaphor, according to which we move towards future events, and the time-moving metaphor, according to which future events move towards and then past us (Gentner et al., 2002; Lakoff & Johnson, 1980; McTaggart, 1908). It has been shown that these metaphors influence how we think, represent, and reason about time (Boroditsky, 2001). It’s therefore reasonable to suppose that these different ways of thinking about, or experiencing, time can impact our temporal preferences as well.

Our goal in this paper is thus to study the dynamical explanation. The dynamical explanation has been previously studied in two papers by Latham et al (2021, 2022). The current paper goes beyond this previous work in three ways. First, in previous work the dynamical explanation itself had not been adequately formulated. As we show here, there are two distinct ways to formulate that explanation, a distinction that has not been recognised to date. These explanations differ with respect to the kind of beliefs about and/or phenomenology of time that are doing the explanatory work. Testing these explanations separately is important, as the potential conflation of the two explanations in an experimental set-up has the potential to undermine the validity of previous results.

Second, existing work on the dynamical explanation only focuses on future-bias. Near-bias is not considered, and nor is the relationship between future-bias and near-bias. The present study thus seeks to consider whether the dynamical explanation (once adequately disambiguated) can constitute a unified explanation for both future-bias and near-bias. In this respect, the explanatory target of this paper is broader than the previous studies of Latham et al.

The third innovation of the paper is methodological in nature. Almost all existing experimental work on beliefs about and/or phenomenology of time has used a specific

¹¹ Sometimes this change consists in the movement of a property of presentness across existing events, which then change from being future, to being present, (when they have the property) to being past (as in a moving spotlight model). Sometimes this change consists simply in the change of a single three-dimensional object with respect to which objects or events exist (as in presentism) and sometimes it consists in the accretion of new moments of time or events, where these new moments/events are present when they come into existence, and then become past as new moments/events come into existence.

¹² The terminology of ‘A-theory’ and ‘B-theory’ is originally due to McTaggart (1908). For an overview of the debates between A-theorists and B-theorists, see Zimmerman (2005).

¹³ See for instance Prior (1959), Pearson (2018), Schlesinger (1976), and Craig (1999).

vignette-based methodology, one that focuses exclusively on written vignettes. In this paper we use, in addition to written vignettes, both imagery and animations. The use of imagery and animation reflects a rising interest in the supplementation of written vignettes with alternative media. The studies conducted here are, so far as we know, the first to use visual imagery to study beliefs about and/or phenomenology of time. In this respect, they reflect a broader trend within psychological and social scientific research, one that we hope can provide a template for further experimental work in this area.¹⁴

The rest of the paper is structured as follows. In § 2 we outline the extant literature on near-bias and future-bias, and we present our hypotheses. Along the way we expand on the two points made above, concerning the formulation of the dynamical explanation and the trend toward using visual imagery.

In § 3 we describe our methodology and results. In § 4 we consider the implications of those results, with respect to both the explanation and the rationality of future-bias and near-bias. We found no evidence for either the moving time or moving ego hypotheses, and thus conclude that the dynamical explanation lacks evidential support in § 5.

2 The literature to date

The dynamical explanation has recently been the target of empirical investigation. In its broadest form, that explanation can be stated as follows:

Dynamical Explanation: People's (perhaps tacit) beliefs about, or phenomenology of, the moving in or of time, (partially) explains both their near-biased and future-biased preferences.¹⁵

Why think the Dynamical Explanation has any plausibility? Well, various philosophers have thought that future-bias intimately connected, in some way or other, with both the temporal value asymmetry and with tensed emotions (Cockburn, 1997; Craig, 1999; Pearson, 2018; Prior, 1959; Schlesinger, 1976).

The temporal value asymmetry refers to an asymmetry in assigning value to past and future states of affairs, in particular to the fact that people tend to assign more value to a state of affairs when it is located in the future, as opposed to being equidistant in the past (Caruso, 2010; Caruso et al., 2008; Roh & Schuldt, 2014). The idea is that future-bias is a manifestation of this temporal value asymmetry in that we prefer negative states of affairs to be in the past not the future because we accord them less

¹⁴ Given the lacuna filled by this new methodology in the present study, the authors think that any results found are interesting. That is, results that merely support or replicate the results of previous experimental work would provide even more reason to support particular views. By the same token, non-significant findings would also be noteworthy, given the growing agreement that the publication of non-significant findings represent a backdrop that is important for future related studies. See Mehler et al (2019) for discussion of this point. The authors thank an anonymous referee for highlighting this point.

¹⁵ Note that the Latham et al. studies did not test the relationship between near- and future-bias, and so explored a narrower form of the dynamical explanation. However, because we do consider the relationship between near- and future-bias, we have formulated the dynamical explanation in general terms, to include both kinds of bias.

value (and hence less negative value) if they are in the past compared to the future. By the same token we prefer positive states of affairs to be located in the future, rather than the past, because we accord them more positive value if they are in the future and not the past.

Tensed emotions are emotions that are differentially elicited depending on where in time a state of affairs is represented as being located. We *anticipate* future states of affairs, not past ones; we *regret* past states of affairs, not future ones, and we feel a certain sort of distinctive *relief* that certain negative states of affairs are ‘over and done with’ only when they are past, and not when they are future. This sort of relief is what Hoerl (2015) calls *temporal relief*. We can contrast temporal relief with *counterfactual relief*. We can experience counterfactual relief regardless of where we represent a state of affairs as being located. As Suzy sits in the faculty of arts meeting, she is not experiencing relief that it is over (since it is not); rather, she is experiencing relief *that it less dreadful than she anticipated it would be*. By contrast to counterfactual relief, the distinctive feature of temporal relief is that we only experience that kind of relief when we represent the state of affairs as being in the past.

One possibility is that we experience tensed emotions such as temporal relief because we experience ourselves as moving relative to time. We feel anticipation towards states of affairs that are in our future, and towards which we are moving (or which are moving towards us) because we recognise that they will become present. And we feel temporal relief towards states of affairs once they move into the past: once they have been experienced and we have moved past them and they are receding away from us.¹⁶

On one view of the explanatory connections between tensed emotions and the temporal value asymmetry, then, our experience of moving relative to time explains our having tensed emotions, and these tensed emotions, in turn, explain the temporal value asymmetry. We value states of affairs less, say, when we direct temporal relief towards them than when we direct anticipation towards them. Then the value asymmetry explains our being future-biased.

One alternative picture is that the direction of explanation goes the other way around, and tensed emotions are a manifestation of the temporal value asymmetry. On this view, it is because we prefer to have negative states of affairs located in the past rather than the future, that we experience temporal relief when they are so located (see for instance Bacharach, 2022 for discussion of this view). On this picture, the temporal value asymmetry explains our having tensed emotions *and* our being future biased.

Various aspects of these explanations are controversial. Hoerl (2022) has voiced some scepticism about the idea that future-bias is a manifestation of the value asymmetry. He points to the fact that people only show a value asymmetry in *between-subject designed experiments* and not in *within-subject designed experiments*. In a between-subject design each participant sees a single vignette: that vignette either describes future boring work, or past boring work. In a within-subject design participants get to see both vignettes and decide on compensation. This effectively allows them to

¹⁶ Indeed, some philosophers have argued that our tensed attitudes are fitting because time is dynamical and, in turn, that future bias is fitting because time is dynamical (Cockburn, 1997; Craig, 1999; Pearson, 2018; Prior, 1959; Schlesinger 1976).

compare their compensation rates. The fact that they found no temporal value asymmetry in the within-subjects design was taken by Caruso et al (2008) to be evidence that people do not take it to be justified to differently value past over future states of affairs, and so they tend to bring their judgements in line with one another. As Hoerl points out, since people probably do think it is justified to prefer pains to be in the past, and pleasures in the future, this suggests that future-bias may not simply be a manifestation of the value asymmetry.¹⁷

The connection between future bias and tensed emotions has also been subject to dispute. Both Hoerl (2022) and Bacharach (2022) offer accounts of temporal relief that do not locate it as a manifestation of the temporal value asymmetry.

According to Bacharach, aversions and appetites are motivational states induced by stimuli, where the behaviours these states motivate are actions. On this view, aversive and appetitive desires are dynamical phenomena that unfold in time, so that the introduction of a stimulus triggers the onset of the desire, leading to pursuance or avoidance behaviour which, if successful, leads to the cessation of the desire. Thus, Bacharach argues, temporal relief is experienced only when a negative state of affairs is in the past, because the experience is tied to a point in the motivational process that follows the satisfaction of an aversive desire, and the satisfaction of this desire is contemporaneous with the event that satisfies it (i.e. its cessation). Thus, Bacharach argues that our phenomenology of the moving ego or of time's passage ground our experience of tensed emotions and attitudes that are symbolic of, but not reducible to, the temporal value asymmetry or future-biased preferences.

Hoerl (2015, 2022) argues that temporal relief has evolved in order to motivate us to put ourselves through unpleasant experiences by exploiting the motivating power of anticipation. Hoerl hypothesises that the fact that you can *anticipate* being *relieved* that some unpleasant experience is over, can act as a motivation for having that experience, and since sometimes our wellbeing is maximised by undergoing unpleasant experiences (think here of the unpleasant dental check-up) the presence of temporal relief can have an evolutionary benefit. In light of this, Hoerl (2022) suggests a different explanatory picture on which future-bias is explained by the *combination* of the value asymmetry and tensed emotions.

Finally, one might think that the Dynamical Explanation is plausible in part because beliefs about, or phenomenologies as of, a movement in or of time, may be connected with beliefs about the reality of past, present, and future. That is, you might think that there is a connection between temporal attitudes (attitudes characterised by a concern (or lack thereof) about future and past events) and beliefs about temporal ontology (beliefs about the existence of future and past events) and temporal preferences (preferences regarding where in time events are located). In particular, you might think that people tend to be time-biased because they believe that while present events exist, past and future events do not (i.e., a belief in presentism), and because future events will come to exist, while past ones will not (although they did once exist). Thus, the Dynamical Explanation may also be motivated by the thought that people's beliefs

¹⁷ Lee et al (2022) also raise concerns about the idea that future bias is a manifestation of the value asymmetry. They note that a preference for pain to be located in the past rather than the future has been shown to emerge considerably earlier, developmentally, than does the value asymmetry. If that is right, it's difficult to see how future bias could simply be a manifestation of the value asymmetry.

about, or phenomenology as of, movement in or of time, are connected to their beliefs about, or phenomenologies as of, a change in temporal ontology. Our studies do not explicitly test this idea. It is, however, worth noting that the only empirical investigation of the connection between temporal ontology and time-bias found no association between people's beliefs about temporal ontology and a display of *present*-bias (Deng et al., [forthcoming](#)) which gives us some reason to be sceptical that such beliefs explain future-bias.

Regardless, this paper does not aim to investigate the connection between tensed emotions or attitudes and time-biased preferences, nor between the aforementioned and the temporal value asymmetry, though we think that this is fruitful work for future investigation. Nor does it attempt to investigate the connection between the Dynamical Explanation and beliefs about temporal ontology. Exactly how one sees the explanatory connections between these phenomena is important. But we focus entirely on the connection between people's time-biased preferences and their beliefs/phenomenologies regarding movement of, or in, time. This leaves open that such beliefs/experiences might (partially) explain the temporal value asymmetry, which in turn explains future-bias and tensed emotions, or that it might explain tensed emotions, which in turn explain the temporal value asymmetry and future-bias, or that it might partially explain *both* tensed emotions and the value asymmetry, which in turn explain future-bias. Also left open is the connection between people's beliefs about movement in, and of time, and their beliefs (and phenomenologies) regarding temporal ontology. Regardless of exactly how we see the explanatory connections here, though, we would expect to see a connection between people's tacit beliefs, or phenomenology as of moving in or of time, and their future-biased preferences if the Dynamical Explanation (or indeed its converse) is true.

Moving on, then, previous studies have teased apart several aspects of the dynamical explanation: our *beliefs*, on the one hand, and our *phenomenology*, on the other. Call the claim that it's our beliefs that partially explain future- and near-bias, the *dynamical belief explanation*, and call the claim that it's our phenomenology that partially explains these biases, the *dynamical phenomenology explanation*. While no studies to date have investigated the role of beliefs and/or phenomenology in *jointly* explaining future-bias and near-bias, several have investigated their role in explaining future-bias alone.

Latham et al (2021) tested the dynamical beliefs explanation. Their study failed to find any association between people's dynamical beliefs and future-bias. They did, however, find that participants were more future-biased when presented with dynamical vignettes as compared to static vignettes. This was so regardless of whether participants believed that our world is the way it was presented as being in that vignette (i.e., whether they had the dynamical belief or not). Latham et al. (2021) hypothesised that the dynamical description in the vignettes generated, or made salient, a dynamical phenomenology and this, rather than people's beliefs, is what impacted future-bias. If that were true, it would provide support for the idea that dynamical phenomenology partially explains future-bias.

In a follow up study, Latham et al (2022) aimed to test the dynamical phenomenology explanation. They presented participants with vignettes that described dynamical phenomenology, and found that participants were not significantly more future-biased

when they saw the dynamical phenomenology vignette rather than the static phenomenology vignette. Nor were participants who said that things seem to them as described by the dynamical phenomenology vignette more likely to be future-biased than those who said that things seem to them as described by the static phenomenology vignette. These previous studies thus found no evidence to support the claim that it is dynamical phenomenology which explains future-bias.

As discussed briefly above, this previous work on the dynamical explanation does not fully take account of the ways in which that explanation might be formulated. According to one version of the dynamical explanation, it is our belief that *time* moves (that is, that time robustly passes,¹⁸ and/or our having a temporal phenomenology as of time moving)¹⁹ which explains our future-biased preferences. If we believe, or it seems to us as though, future events are ‘coming towards us’ and then receding ever further away from us into the past, then we might expect to prefer that negative events are ‘behind us’ and ‘over and done with’ by having moved past us, (negative future-bias) and that positive events are ‘ahead of us’ and are moving towards us (positive future-bias). This explanation can be expanded to account for near-bias as well. If we believe, or it seems to us as though, future events are ‘coming towards us’ and then receding ever further away from us into the past, then we might expect to prefer to reach positive events sooner rather than later (positive near-bias) and negative events later rather than sooner (negative near-bias). Call the claim that our belief that time moves and/or our phenomenology as of time moving (partially) explains both near- and future-bias, the *moving time explanation*.

Moving Time Explanation: People’s (perhaps tacit) beliefs about, or phenomenology of, time moving (partially) explains both their near-biased and future-biased preferences.

Social scientists have noted that many languages include moving time metaphors.²⁰ The moving time metaphors are a suite of expressions which suggest that time itself moves. These expressions employ motion verbs such as ‘his birthday is *approaching*’. Latham et al (2020b) found that across various moving time expressions many (in some cases most) people at least weakly agree that things are as described by those expressions. According to this version of the dynamical explanation, our (likely tacit) belief that the future is moving toward us or its seeming to us, in experience, as though the future is moving toward us, explains our future-biased and near-biased preferences.

According to another version of the dynamical explanation, it is not the movement of time that explains our preferences, but rather, our movement relative to time. If we believe, or it seems to us as though, we are ‘moving towards future events’ and ‘moving away from past events’ then we might expect to prefer that we have moved away from

¹⁸ By ‘robust temporal passage’, we mean the kind of passage posited by A-theories of time. A-theories of time hold that there is an objective, observer-independent fact about which moment (or set of events) is present, and which moment (or events) this is changes. Robust temporal passage is just this change in which events are objectively present.

¹⁹ A ‘phenomenology as of temporal passage’, then, is a phenomenology whose content represents that the world contains robust passage, whether or not the world is in fact the way it is represented to be (hence the *as of*).

²⁰ Sinha and Gardenfors (2014).

negative events (negative future-bias) and that we are moving towards positive events (positive future-bias). Likewise, if we believe, or it seems to us as though, we are ‘moving towards the future and away from the past’, then we might expect to prefer to reach positive events sooner rather than later (positive near-bias) and negative events later rather than sooner (negative near-bias). Call the claim that our belief that the ego moves and/or our phenomenology as of the ego moving (partially) explains both near- and future-bias, the *moving ego explanation*.

Moving Ego Explanation: People’s (perhaps tacit) beliefs about, or phenomenology of, the ego moving (partially) explains both their near-biased and future-biased preferences.

Moving ego metaphors are a suite of expressions which suggest that the ego moves through time. These expressions employ motion verbs such as ‘he is *nearing* his birthday’. Social scientists have found significant use of such metaphors, and hypothesise that they reflect people’s tendency to believe, or for it to seem as though, the self or ego is moving through time.²¹ More recently, Latham et al (2020b) reported that for a range of moving ego expressions, a majority of people agreed that things seemed as described by the moving ego expressions, suggesting that people do have a moving ego phenomenology. Thus, according to the moving ego explanation, our (likely tacit) belief that we move away from the past, and towards the future, or its seeming to us, in experience, as though we move away from the past and towards the future, explains our future- and near-biased preferences.

Previous work on the dynamical explanation has not always clearly differentiated between the two versions of the dynamical explanation introduced above. For instance, while the vignettes used in Latham et al (2021) are probably best thought of as describing moving time rather than a moving ego, the vignettes used in Latham et al (2022) do not distinguish between moving time and moving ego phenomenology. This is a limitation on those studies, since, on the face of it, these are two distinct types of phenomenology. Accordingly, it may be that only *one* is linked to time-bias, or that both are but in different ways. Thus, failing to differentiate these two aspects of phenomenology when studying time-bias introduces a potential confound. Part of our goal here is to control for this potential confound by separating out the two types of phenomenology.

Of course, distinguishing between the two phenomenologies is not straightforward. This is because both involve a notion of self and time, and both phenomenologies are characterised in terms of the relative motion of these two aspects, albeit in different ways. One may even be sceptical that there is a genuine phenomenological difference here; or that the difference is too slight to be testable. Part of what motivates the current study, then, is to see if these phenomenologies can be pulled apart, and in a way that elicits different responses from participants. To this end, we appeal to diagrams and animations, on the grounds that we appear to be able to represent two different ways for the self and time to move relative to one another, which has the potential to capture some salient difference in phenomenology (more on this in a moment). If we find that there are no differences in participant responses to these diagrams

²¹ Sinha and Gardenfors (2014).

and animations, then that may suggest a need to rethink the way in which these putatively distinct phenomenologies are probed, or indeed the purported distinctness of the phenomenologies at issue. But that remains to be seen.

In order to study the dynamical explanation, then, we empirically investigate both the moving ego and moving time explanations. We also aim to investigate both the belief and phenomenology versions of each. We aim to determine whether it is moving ego beliefs and/or moving ego phenomenology that partially explain our future-biased and near-biased preferences. We also aim to determine whether it is moving time beliefs and/or moving time phenomenology that partially explain our future-biased and near-biased preferences. We assume, then, that moving ego beliefs/phenomenology are distinct from moving time beliefs/phenomenology. This may prove not to be the case. Social scientists have noted that many languages include one or both of what are known as moving time or moving ego metaphors. Latham et al (2020b) found a correlation between people agreeing that things seem to them as though time moves and agreeing that it seems to them as though the ego moves. It could be, then, that these are just two different ways of describing the same underlying dynamical beliefs/experiences. However, since we do not know whether or not this is the case, we want to separately test the moving time and moving ego versions of the dynamical explanation.

As noted in § 1, a further limitation of previous work on the dynamical explanation is that the methodology relied primarily on written vignettes. This is in line with a broader tendency to use only written vignettes within a range of experimental studies on time. Our studies go beyond written vignettes with the inclusion of visual imagery. The interest in visual imagery is based on two trends. First, it is recognised that written vignettes provide no way to control for different levels of literacy or comprehension from written materials (Facciani et al. 2022; Hu et al. 2022; Philips et al. 2015). Since it is plausible that both literacy and comprehension vary within the general population, there is at least some pressure to try to control for this factor. Alternative media provide a straightforward way to do so. Visual images and animations do not require written literacy or comprehension, and so can provide a useful means of avoiding potential confounds introduced by these factors.²² Second, written vignettes are associated with a higher cognitive load than visual imagery, and thus can be associated with lower degrees of understanding. The use of visual imagery as a supplement to written vignettes can thus be a useful to scaffold understanding of difficult material by participants. In short, as Eifler (2007, p. 306) puts it “visual stimuli used in vignette analyses lead to more realistic responses than verbal stimuli”.

Providing alternative media is especially important for experimental work on the philosophy of time. The use of visual imagery as a supplement to written vignettes is thought to be particularly important for studies that examine experience. In the study of pain experience, for example, there are thought to be “inherent advantages of using imagery to elicit beliefs and personal experiences of pain” (Bendelow, 1993b). In particular, visual imagery is used because it can “increase the quality of representation by providing a bridge between experience and recall” (Berends 2011, p. 2), which is helpful in the case of pain experience (Bendelow, 1993a). In short, visual imagery provides

²² For example, by using visuals to represent moving ego and moving time phenomenology, we can avoid having to describe these experiences with words like ‘seems’ and ‘feels,’ which could inadvertently function as phenomenal underminers (Latham et al., 2022).

a potentially powerful way to examine experience. Since the dynamical explanation draws on experience as an explanatory resource, visual imagery seems especially important to testing this explanation. Moreover, since the concept of moving time and of the moving ego are ones that lend themselves to fairly simple diagrams and animations that are plausibly easier to comprehend than long descriptive vignettes, in this study we made use of such diagrams in explicating the metaphysically complex notions of moving time and moving ego.

A further reason for focusing on visual imagery in experimental philosophy of time relates to comprehension more generally. In many of the existing studies, a large number of participants are typically excluded for failing to pass comprehension checks on written vignettes. This is plausibly because many of the vignettes being used are complex and difficult to understand. It is thus reasonable to worry that even for the participants remaining in such studies—those who do pass comprehension checks—some difficulties in comprehension remain. The use of visual imagery provides one natural way to overcome these difficulties. The use of visual imagery can improve participant's understanding, and give us more confidence that participants genuinely understand the scenarios being presented to them. This helps to make the widespread failure of comprehension checks seem less problematic. Note, however, that we still use vignette-based methodologies to probe people's preferences, however, since this cannot be achieved via diagrams, and since these vignettes are quite straightforward to understand (and previous studies such as that of Greene et al (2021; 2022) did not generate high rates of comprehension failure).

3 Hypotheses

In order to study the dynamical explanation, we ran two studies. In experiment 1 we investigate whether there is an association between people believing that, or it's seeming as though, the ego moves, and people being both near-biased and future-biased, and whether there is an association between people believing that, or it's seeming as though, time moves, and people being both near-biased and future-biased. To test people's near/future-biased preferences, we presented them with a modified vignette from Greene et al (2021). In order to test their beliefs/phenomenologies we presented participants with several moving pictorial representations and asked them which of these best describes how they believe things are, and which best describes how things seem to them to be. We call one of these a *moving ego depiction*, one a *moving time depiction*, and one a *static depiction*.

If there is a shared explanation for both near- and future-bias (even if partial) we should expect to find an association between people being future-biased and being near-biased. This is the association hypothesis, (H1).

H1 There will be an association between people being future-biased and being near-biased.

If people's belief that time moves partially explains why they are both future- and near-biased (the moving time belief hypothesis) then we should find that more people who believe that the moving time depiction captures how they think our world is will be

future-biased and near-biased compared to those who believe that the static depiction best depicts how they think our world is. This is our second hypothesis, H2.

H2 More people who believe that the moving time depiction captures how they think our world is, will be future-biased and near-biased compared to those who believe that the static depiction best depicts how they think our world is.

If people's belief that the ego moves partially explains why they are both future- and near-biased (the moving ego belief hypothesis) then we should find that more people who believe that the moving ego depiction captures how they think our world is, will be future-biased and near-biased compared to those who believe that the static depiction best depicts how they think our world is. This is our third hypothesis, H3:

H3 More people who believe that the moving ego depiction captures how they think our world is, will be future-biased and near-biased compared to those who believe that the static depiction best depicts how they think our world is.

If people's phenomenology as of time moving partially explains why they are both future- and near-biased (the moving time phenomenology hypothesis) then we should find that more people who have this moving time phenomenology will be future-biased and near-biased compared to those who have static phenomenology. This is our fourth hypothesis, H4:

H4 More people who judge that things seem to them to be as presented by the moving time depiction will be future-biased and near-biased compared to those who judge that things seem to them as depicted by the static depiction.

Finally, if moving ego phenomenology partially explains why they are both future- and near-biased (the moving ego phenomenology hypothesis) then we should find that more people who have this moving ego phenomenology will be future-biased and near-biased compared to those who have static phenomenology. This is our fifth hypothesis, H5:

H5 More people who judge that things seem to them to be as depicted by the moving ego depiction will be future-biased and near-biased compared to those who judge that things seem to them as depicted by the static depiction.

More generally, if support is found for H2 or H4, then this in turn will provide support for the moving time explanation. If the moving time explanation is correct, then we would expect there to be an association with either beliefs about, or experiences of, time moving and either near- and future-bias. Similarly, if support is found for H3 or H5, then this will provide support for the moving ego explanation. If the moving ego explanation is correct, then there should be an association between either beliefs about, or experiences of, the ego moving through time and either future- and near-bias. In experiment 2 we investigate whether we can manipulate the degree to which people exhibit future-bias by priming them with just one of the temporal depictions considered in experiment 1 (moving ego vs. moving time vs. static). We predicted that people who saw one of the dynamical depictions would be more likely to show future-biased

preferences than people who saw the static depiction, because seeing a dynamical depiction would tend to make salient, or promote, the relevant beliefs/phenomenology. We hypothesised that:

H6 More people who see the moving ego depiction will be future-biased and near-biased compared to those who see the static depiction.

H7 More people who see the moving time depiction will be future-biased and near-biased compared to those who see the static depiction.

If support is found for H6, then that would provide support for the moving ego explanation in a manner that is analogous to H3/H5. Similarly, if support is found for H7, then that would provide support for the moving time explanation in a manner that is analogous to H2/H4.

These predictions were pre-registered at <https://osf.io/fjx9p/>.²³

4 Methodology and results

4.1 Experiment 1 methodology

4.1.1 Participants

391 people participated in the study. Participants were U.S. residents who were tested online using Amazon Mechanical Turk and compensated \$1.25 for their time. 166 participants had to be excluded from the analyses. That is because they failed to answer all the questions (42), failed an attentional check (55) or failed to correctly answer 3 out of 4 comprehension questions (69). The remaining sample was composed of 225 participants (72 female, 4 trans/non-binary; mean age 36.72 (SD = 10.02)). Ethics approval for the study was obtained from the University of Sydney Human Research Ethics Committee. Informed consent was obtained from all participants prior to testing. The survey was conducted online using Qualtrics.²⁴

4.1.2 Materials and procedure

Participants were split into two conditions: positive and negative. In the positive condition, participants reported the extent of their future-biased and near-biased preferences in response to a vignette about a positive hedonic event (ingesting a pill that cures disease but causes the side-effect of 3 days of extreme pleasure). In the negative condition, participants reported the extent of their future-biased and near-biased preferences in response to a vignette about a negative hedonic event (ingesting a pill that cures disease but causes the side-effect of 3 days of extreme pain).

The vignettes used are amended versions of Greene et al (2021) positive and negative hedonic vignettes. They are amended in such a way as to try to control for two

²³ The link is disabled while the paper is under blind review.

²⁴ 68% of the remaining sample correctly answered all the comprehension questions.

factors that might lead people to express merely apparent future-biased or near-biased preferences. These factors are more pronounced for near-bias than for future-bias and controlling for them adds some complexity to the vignettes, which explains why they were not controlled for in Greene et al (2021) study.

The first factor our vignettes aim to control is the subjective probability of the event occurring (regardless of its temporal location). We controlled for this factor by stipulating that the pill has already been taken, and that it is certain to cause the relevant side-effects. All that is uncertain is *when* those side-effects will occur. The second factor our vignettes aim to control is the intrinsic value of the goods received to the self that receives them. This factor was controlled for by specifying that the pill's side-effect causes pain/pleasure *to the self that experiences the side-effect*. Since the positive and negative vignettes differ only minimally, we can present them together:

Imagine that 3 months ago you had a genetic test and the results showed that you are very likely to develop a fatal disease in 10 years. Luckily, just after the results of the test came in, the doctor gave you a pill that prevents this disease from developing. You took the pill in his office, and so you will not develop that disease.

The pill is very safe, and is certain to have no long-term side effects. The medication does, however, have one short-term side effect. At some time during the 12 months after you have ingested the pill, it causes the brain to misinterpret certain signals, and as a result causes three consecutive days of intense [pain]/[pleasure] after which these side-effects cease and you return to normal.

You wake up one morning after a restless night, and for a moment cannot remember whether you have already experienced these side effects.²⁵

After reading the vignette, participants responded to four comprehension questions. In this vignette you were asked to imagine that:

- (a) 3 months ago you had a genetic test, which shows you are likely to develop a fatal disease in 10 years time.
- (b) Having taken the pill, you will avoid developing the fatal disease.
- (c) You wake up one morning and remember that you already experienced the pill's side effects yesterday.
- (d) The pill will cause you to experience 3 consecutive days of high fever.

After each question, participants were given the option of (a) True or (b) False. Participants who failed to correctly answer 3 out of 4 comprehension questions correctly were excluded from the study.

Participants then saw two sets of questions: one probing whether, and the extent to which, they have prospective near-biased preferences, and one probing whether, and the extent to which, they have future-biased preferences. The order in which participants saw these questions was randomised. Participants were asked:

Please indicate your preference using one of the following statements:

²⁵ One might worry that it is not possible, or very unlikely, to experience such intensely pleasurable/painful days only to wake up one morning and not immediately remember having had these experiences. While we think such waking events are clearly possible, it would be worthwhile to ask participants in future research how likely they think such events are. This would allow us to determine whether participants' judgments of plausibility or likelihood impact their temporal preferences.

- (a) I would prefer to learn I will start to experience the side-effects of the pill tomorrow, and not in 8 months time.
- (b) I would prefer to learn that I will start to experience the side-effects of the pill in 8 months time and not tomorrow.
- (c) I have no preference between learning that I will start to experience the side-effects of the pill in 8 months time and learning that I will start experiencing them tomorrow.

Please indicate your preference using one of the following statements:

- (a) I would prefer to learn that I will start to experience the side-effects of the pill tomorrow, and did not start experiencing them 3 days ago.
- (b) I would prefer to learn that I started experiencing the side-effects of the pill 3 days ago, and will not start experiencing them tomorrow.
- (c) I have no preference between learning that I will start to experience the side-effects of the pill tomorrow and learning that I started experiencing them 3 days ago.

Participants were presented with three pictorial representations. One depicts moving time, one depicts a moving ego, and one depicts a static scene. These can be found at <https://osf.io/fjx9p/>. The moving time depiction shows an image of a person, and the event of experiencing the side-effects of the pill. Participants who see the positively valenced version of the vignette see an image that depicts the positive side-effects of the pill, and those who see the negatively valenced version see an image that depicts the negative side-effects of the pill. In those images, the event of experiencing those side-effects comes closer to a stationary person and then recedes into the past. The moving ego depiction depicts the same events, but this time the person moves from a time before the side-effects are experienced, to a time after they are experienced. The static representation simply shows the relative location of the events. We then ask participants the following forced choice question:

Which diagram do you think is most like the way you believe our universe is?

- (a) Diagram 1
- (b) Diagram 2
- (c) Diagram 3

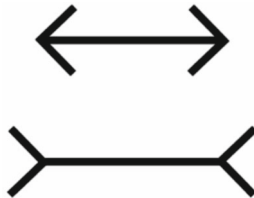
Finally, participants were then told: We can distinguish between what you *believe* about the way our universe is, and how the universe *seems* to you to be, as you experience it. For instance, sometimes things seem to you to be the way that you believe them to be. Below are two shapes.



They will probably *seem* to you to be the same size; you probably also *believe* that they are the same size. That's because they are the same size.

Table 1 Descriptive data from all conditions of participants' responses to the near-bias prompt

Condition	NB	FrB	NP
Positive (n = 114)	53 (46.5%)	32 (28.1%)	29 (25.4%)
Negative (n = 111)	25 (22.5%)	62 (55.9%)	24 (21.6%)



Participants were then asked the following question: Bearing this in mind, which diagram do you think is most like the way our universe seems to you?

- Diagram 1
- Diagram 2
- Diagram 3

4.1.3 Results

Experiment 1 Table 1 below summarizes the descriptive data of participants' responses regarding their near- and far-biased preferences. The 'NB' column represents the number of participants who report positive and negative prospective near-biased preferences. The 'FrB' column represents the number of participants who report positive and negative prospective far-biased preferences. The 'NP' column represents the number of participants who report a time-neutral preference (i.e., people who report having no preference regarding when in time (near future or far future) the side-effects are experienced).

To check whether there was any association between people's near-biased preferences and condition (positive or negative) we ran a chi-squared test of homogeneity. This test revealed that there was a significant association between valence and people's reported preference ($\chi^2(2, N = 225) = 20.061, p < .001, V = .299$). Post-hoc comparisons with a Bonferroni correction showed that people were more prospectively near-biased ($p < .001$) and less prospectively far-biased ($p < .001$) in positive conditions than in negative conditions. There was no significant association between valence and the numbers of people who reported having no preference.

Table 2 below summarises the descriptive data of participants' responses regarding their future- and past-biased preferences in experiment 1. The 'FB' column represents the proportion of participants who report positive or negative future-biased preferences. The 'PB' column represents the proportion of participants who report positive or negative past-biased preferences. The 'NP' column represents the proportion of participants who report time-neutral preferences (i.e., people who report having no preference regarding when in time (future or past) the side-effects are experienced).

Table 2 Descriptive data from all conditions of participants' responses to the future-bias prompt

Condition	FB	PB	NP
Positive	55 (48.2%)	34 (29.8%)	25 (21.9%)
Negative	62 (55.9%)	31 (27.9%)	18 (16.2%)

Table 3 Descriptive data from all conditions of participants' beliefs about which depiction is most like our world and which depiction seems most like our world

Judgment	Condition	Static	Moving time	Moving ego
Belief	Positive	27 (23.7%)	58 (50.9%)	29 (25.4%)
	Negative	31 (27.9%)	53 (47.7%)	27 (24.3%)
Seeming	Positive	29 (25.4%)	48 (42.1%)	37 (32.5%)
	Negative	31 (27.9%)	48 (43.2%)	32 (28.8%)

Once again, to check whether there was any association between people's future- and past-biased preferences and valence we ran a chi-squared test of homogeneity. The test revealed that there was *no* significant association between valence and people's reported future-biased preferences ($\chi^2(2, N = 225) = 1.657, p = .437, V = .086$). That is, there was no evidence of association between the valence of the vignette people were asked to consider and the proportions of people who reported being future-biased, past-biased, and time-neutral.

Next, to test whether there was any association between people's reported prospective near-biased preferences and future-biased preferences we ran a chi-square test of independence. The results of this test revealed a significant association between prospective near-biased preferences and future-biased preferences ($\chi^2(4, N = 225) = 84.950, p < .001, V = .434$). However, when we removed the time-neutral responses from the analyses the result became non-significant, ($\chi^2(1, N = 162) = .022, p = .882, V = .012$). Thus, we found no robust evidence of there being an association between people's near-biased and future-biased preferences.²⁶

Table 3 below summarizes the descriptive data of participants' beliefs about whether the world is most like the moving time, moving ego, or static time depiction, and whether the world seems to be most like one in which time moves, the ego moves, or time is static, for all conditions.

To check whether there was any association between, on the one hand, people's beliefs about which depiction is most like our world, and which depiction seems most like our world, and, on the other hand, valence, we ran separate chi-squared tests of homogeneity. The results of those tests revealed that there was *no* significant association between valence and people's reported belief ($\chi^2(2, N = 225) = .533$,

²⁶ Given the earlier association between valence and near-biased preferences, some readers might wonder whether there is an association between near-biased and future-biased preferences but that the association differs according to valence. Results of a Breslow-Day test (Breslow & Day, 1980) found *no* evidence that the association between near-biased and future-biased preferences differs across valence conditions ($\chi^2(1, N = 225) = .646, p = .421$). It is important to note that in order to perform this test, we had to combine far-biased and no-preference responses into a single new category: *non-near biased*. We also had to combine past-biased and no-preference responses into a single new category: *non-far biased*.

$p = .766$, $V = .049$) or between valence and people's reported seeming ($\chi^2(2, N = 225) = .389$, $p = .823$, $V = .042$).

Finally, we ran separate chi-squared tests of independence to test for an association between, on the one hand, people's beliefs about whether the world is most like the moving time, moving ego, or static time depiction, and whether the world seems to be one in which time moves, the ego moves, or time is static, and, on the other hand, their near-biased and future-biased preferences. There was *no* significant association between participants' reported beliefs and their near-biased preferences ($\chi^2(4, N = 225) = 5.358$, $p = .252$, $V = .109$) or their future-biased preferences ($\chi^2(4, N = 225) = 3.273$, $p = .513$, $V = .085$). There was also *no* significant association between participants' reports about how the world seems and their near-biased ($\chi^2(4, N = 225) = 3.802$, $p = .434$, $V = .092$) or their future-biased preferences ($\chi^2(4, N = 225) = 6.954$, $p = .138$, $V = .124$). Thus, we found no evidence in support of the moving time or moving ego belief hypotheses, nor the moving time or moving ego phenomenology hypotheses.²⁷

4.2 Experiment 2 methodology

4.2.1 Participants

1141 people participated in the study. Participants were U.S. residents who were tested online using Amazon Mechanical Turk and compensated \$1 for their time. 449 participants had to be excluded from the analyses. That is because they failed to answer all the questions (156), failed an attentional check (133) or failed to correctly answer 3 out of 4 comprehension questions (160). The remaining sample was composed of 692 participants (281 female, 14 trans/non-binary; mean age 39.21 (SD = 11.65)). Ethics approval for the study was obtained from the University of Sydney Human Research Ethics Committee. Informed consent was obtained from all participants prior to testing. The survey was conducted online using Qualtrics.²⁸

4.2.2 Materials and procedure

Participants were split into six conditions, which were every combination of valence (positive vs. negative) and depiction (moving ego, moving time, static). Participants first saw the same vignette (positive or negative) as in experiment 1 and answered the same comprehension questions. Participants who failed to correctly answer 3 out of 4 comprehension questions were excluded from the analyses. Participants in both positive and negative conditions then either saw the moving ego, moving time, or static depiction.

²⁷ Removing time-neutral responses does not change the reported results. Again, some readers may wonder given the association between near-biased preferences and valence, whether there is an association between people's reported beliefs and seemings, and their near-biased preferences but that it differs according to valence. Results of separate Breslow-Day tests found *no* evidence that the association between beliefs and near-biased preferences ($\chi^2(x2, N = 225) = 0.892$, $p = .892$) and between seeming and near-biased preferences ($\chi^2(x2, N = 225) = 1.414$, $p = .493$) differed across valence conditions.

²⁸ 70% of the remaining sample correctly answered all the comprehension questions.

Table 4 Descriptive data from all conditions of participants' responses to the near-bias prompt

Condition	NB	FrB	NP
Positive			
Static (n = 111)	51 (45.9%)	24 (21.6%)	36 (32.4%)
Moving ego (n = 122)	46 (37.7%)	36 (29.5%)	40 (32.8%)
Moving time (n = 112)	54 (48.2%)	35 (31.3%)	23 (20.5%)
Negative			
Static (n = 119)	31 (26.1%)	68 (57.1%)	20 (16.8%)
Moving ego (n = 114)	30 (26.3%)	58 (50.9%)	26 (22.8%)
Moving time (n = 114)	25 (21.9%)	66 (57.9%)	23 (20.2%)

Participants were then asked the same prospective near-bias preference and future-bias preference probe questions as in experiment 1.

4.2.3 Results

Table 4 below summarizes the descriptive data of participants' responses regarding their near- and far-biased preferences across all conditions.

To check whether there was any association between people's near-biased preferences and valence (positive or negative) we ran a chi-squared test of homogeneity. This test revealed that there was a significant association between valence and people's reported preference ($\chi^2(2, N = 692) = 55.963, p < .001, V = .284$). Post-hoc comparisons with a Bonferroni correction showed that people were more likely to be prospectively near-biased ($p < .001$) and less likely to be prospectively far-biased ($p < .001$) in positive conditions than in negative conditions. People were also more likely to report having no preference in positive conditions ($p = .007$).

Next, to test whether there was any association between people's near-biased preferences and the depiction of time they were asked to consider (static or moving ego or moving time) we ran a chi-squared test of homogeneity. This test revealed that there was *no* significant association between which depiction of time people were presented with and their reported near-biased preference ($\chi^2(4, N = 692) = 4.048, p = .400, V = .054$).²⁹

Table 5 below summarizes the descriptive data of participants' responses regarding their future- and past-biased preferences across all conditions.

Once again, to check whether there was any association between people's future-biased preferences and valence we ran a chi-squared test of homogeneity. The test revealed that there was a significant association between valence and people's reported future-biased preferences ($\chi^2(2, N = 692) = 13.196, p = .001, V = .138$). Post-hoc comparisons with a Bonferroni correction showed that people were more likely to be

²⁹ Removing time-neutral responses does not change the reported results. And results of a Breslow-Day test revealed *no* evidence that the association between the condition people were asked to consider and near-biased preferences differs across valence conditions ($\chi^2(2, N = 692) = 2.710, p = .258$).

Table 5 Descriptive data from all conditions of participants' responses to the future-bias prompt

Condition	FB	PB	NP
Positive			
Static (n = 111)	51 (45.9%)	34 (30.6%)	26 (23.4%)
Moving ego (n = 122)	61 (50.0%)	31 (25.4%)	30 (24.6%)
Moving time (n = 112)	47 (42.0%)	48 (42.9%)	17 (15.2%)
Negative			
Static (n = 119)	74 (62.6%)	33 (27.7%)	12 (10.1%)
Moving ego (n = 114)	68 (59.6%)	25 (21.9%)	21 (18.4%)
Moving time (n = 114)	65 (57.0%)	32 (28.1%)	17 (14.9%)

future-biased in negative conditions than in positive conditions ($p < .001$). There was no significant association between valence and the proportions of people who reported being past-biased and having no preference.

Next, to test whether there was any association between people's future-biased preferences and the depiction of time they were asked to consider (static or moving ego or moving time) we ran a chi-squared test of homogeneity. This test revealed that there was *no* significant association between which depiction of time people were presented with and their reported future-biased preference ($\chi^2(4, N = 692) = 9.175, p = .057, V = .081$).³⁰

Finally, we were interested in re-testing (H1). To test whether there was any association between people's reported prospective near-biased preferences and future-biased preferences we ran a chi-square test of independence. The results of this test revealed a significant association between prospective near-biased preferences and future-biased preferences ($\chi^2(4, N = 692) = 126.871, p < .001, V = .303$). However, once again, when we removed the time-neutral responses from the analyses the result became non-significant, ($\chi^2(1, N = 479) = .387, p = .534, V = .028$). Thus, as before we found no support for an association between people's near-biased and future-biased preferences.³¹

5 Discussion

No support was found for the association hypothesis (H1) in either experiment. We did not find evidence of a robust association between people being near-biased and future-biased. No support was found for the moving time belief hypothesis (H2) nor the moving ego belief hypothesis (H3). We did not find evidence that more participants who believe that the moving time or moving ego depiction best captures how our

³⁰ Again, removing time-neutral responses does not change the reported results. And results of a Breslow-Day test revealed *no* evidence that the association between the condition people were asked to consider and future-biased preferences differs across valence conditions ($\chi^2(2, N = 692) = .578, p = .749$).

³¹ Results of a Breslow-Day test found *no* evidence that the association between near-biased and future-biased preferences differs across valence conditions ($\chi^2(1, N = 692) = 2.310, p = .129$).

world is, are more near-biased or future-biased relative to those who believe that the static depiction best captures how our world is. No support was found for the moving time phenomenology hypothesis (H4) nor the moving ego phenomenology hypothesis (H5). We did not find evidence that more participants who judged that our world seems as if time moves, or as if the ego moves, are more near-biased or future-biased relative to those who judged that the world seems static. Finally, our results did not support H6 or H7. We did not find evidence that participants who saw either the moving time or moving ego depiction were more near-biased or future-biased relative to those who saw the static depiction. That said, we did find some evidence that moving time and moving ego expressions are tracking different phenomenologies. We can see this in the way that participants were generally split between the three options (if we include the static option), rather than clustering around just one.

Although we found no support for any of our hypotheses, there are several notable aspects of our results. First, our results support the results of earlier work which found that people were significantly more strongly future-biased regarding negative events (Greene et al., 2021) than positive events (Greene et al., forthcoming). Interestingly, the results of the current study suggest that the opposite is true of near-bias, since we found more near-bias in positive conditions compared to negative ones.

Unlike Latham et al (2023), however, we did not find an association between future-bias and near-bias (at least, once people who had no preference were removed from the sample). This is puzzling given that Latham et al (2023) found a moderately strong association. One potential explanation for this is the difference in the relative proportions of people reporting being future-biased and near-biased across the two studies. Latham et al (2023) found a larger proportion of people reporting both future-biased and near-biased preferences than we did in the current study. The difference in proportions may, in turn, be explicable in terms of the differences between the vignettes that participants saw.

Latham, Miller and Norton used a vignette that was amended from Greene et al (2021) in which participants are asked to imagine they are astronauts on a (very safe) 10-year voyage between planets. The ship's food dispenser usually produces only bland meals, but on one day dispenses either a favourite (positive valence) or most disliked (negative valence) meal. It is also stipulated that the meal is the favourite/most disliked to the self that receives it (in case tastes change) and that the machine is extremely reliable (so the probability of receiving the meal is the same whether it was received in the past, or will be received in the future). By contrast, in the current study we controlled for the probability of the outcomes by stipulating that the pill, which gives rise to the side effects (negative or positive) has already been taken, and that the side effects cause the brain to misfire (producing pain/pleasure for the self who experiences them).

We would have predicted that Latham, Miller and Norton's study would find *lower* levels of future-bias and near-bias than in the current study. Even though it is stipulated in Latham, Miller and Norton's study that space travel is very safe and one is certain to receive one's future meal, it would be reasonable for participants to think that the future meal is less probable than the past meal, and perhaps also that the far-future meal is less probable than the near-future meal (after all, insofar as participants did not accept that space travel was entirely safe, they might reasonably have thought that

their probability of surviving for the next 5 years was less than their probability of surviving a few days and hence that they would be more likely to receive their future meal if it were temporally closer rather than further away).

By contrast, in the current study the pill has already been taken, and will lead to the side-effects. The only question is *when* those side effects occur. Moreover, since the side-effects seem to be more potent in the current study (1 or 3 days of pleasure or pain vs. one favourite/most disliked meal) we would, again, have expected to find higher levels of future- and near-bias. That, however, is not what we found.

Two things stand out to us as key differences between the vignettes. First, in the current study participants have discovered that they had a fatal disease, which has been cured, and that the pill that they have already taken is crucial to maintaining that cure. Second, in the Latham, Miller and Norton study, the favourite/most disliked meals are contrasted with 10 years of otherwise bland meals. In the current study, we do not contrast the pain/pleasure with any period of time in which there are having, say, bland experiences. These factors might singly or jointly explain the lower levels of future- and near-bias. It may be that the side-effects of the pill (good or bad) are to some extent overshadowed by the fact that the pill is a necessary component in preventing the fatal genetic disease. Perhaps the relief people feel at having the disease cured via the pill to some extent swamps their emotional reactions to the side-effects of the pill, dampening their tendencies towards near- or future-bias. It may also be that the painful/pleasurable side effects of the pill are also somewhat muted because they occur against the backdrop of having been diagnosed with a potentially fatal disease, and against a backdrop of a life which presumably contains both pains and pleasures. By contrast, in the Latham, Miller and Norton study, the favourite/most disliked meal occurs against a backdrop of 10 years of bland meals, in which the relative benefit of the favourite meal, and disbenefit of the most disliked meal, may be starker.

If something like this is right, then it suggests that the extent to which people manifest these biases may be quite sensitive to, *inter alia*, small differences in the overall affect of the situation on the individual and/or to the difference between the target of the preference and background conditions. Accordingly, time-neutralists—those who argue that both near- and future-bias are rationally impermissible—may be able to use the results of the current study to defend their position.

Critics of both near- and future-bias have argued that these preferences are irrational because they are arbitrary, or are sensitive to normatively irrelevant factors.³² If it could be shown that these preferences are subject to small differences in the overall affect of a particular situation and thus to what seem to be irrelevant factors, then perhaps time-neutralists are right that near- and future-biases are arbitrary, in so far as they are themselves subject to more or less arbitrary differences between cases.

³² See, for instance, Sidgwick (1884, Chap. 13) and Rawls (1971, pp. 293–294) as well as Parfit (1984), Brink (2011), Dougherty (2011) and Greene and Sullivan (2015). For instance, it has been argued that people exhibit future-biased preferences for hedonic events but not for non-hedonic events (Brink, 2011 p. 378; Dougherty, 2015; Hare, 2013; p. 3, fn. 4). It has also been argued that people exhibit future-biased preferences only with respect to their own experiences but not the experiences of others (Brink, 2011, pp. 378–379; Dougherty 2015, p. 3; Greene & Sullivan 2015, p. 968; Hare, 2007, 2013, pp. 509–510; Parfit, 1984, p. 181) and that they exhibit them more strongly for negative than positive events (Greene et al (2022)). However, these first two predictions have not been empirically supported. See Greene et al (2021).

In turn, this suggests the need to control for a greater variety of factors. For instance, it may be that the pleasure or displeasure of anticipating and recollecting certain events that are pleasurable or painful interacts with time-biases. While studies have sought to control for various factors, including the probability of the relevant events, their subjective value to the person who experiences them, and so on, no studies have aimed to diminish negative or positive anticipation or retrospection.

To be sure, many of these studies appeal to amnesia (though the Lee et al. (2022) study does not mention any amnesia). In Parfit's original thought experiment you wake up in hospital and cannot remember whether you just had a painful operation or are still to have it. In Greene et al.'s (2021) experiment you wake up and *for a moment* cannot remember whether you already ate your favourite/most disliked meal. In most of these experiments while there is no retrospection of the event in question at the time the preference is being adduced, there is likely anticipation of the event (if it will be future) and there may also be anticipation *of* retrospection at a later time.

Our study did not control for the pleasure or displeasure of anticipation or recollection. Indeed, as Latham et al (2023) note, it may not even possible to do so. They note that it may be impossible to form a temporal preference involving future events without anticipating the future event *at all*. And the same is true of anticipation. Thus, eliminating anticipation/retrospection in such tasks may be impossible. One might instead try to make anticipation and retrospection equally present and let them 'cancel out' each other. However, it's difficult to make anticipation and retrospection of equal emotional intensity since people tend to experience stronger emotions when anticipating (Caruso et al. 2008; D'Argembeau and Van der Linden 2004; Van Boven and Ashworth 2007), and their intensity also depends on the temporal distances of the events and many other factors.³³

What emerges is the need for further consideration of whether, and how to, control for such factors in experimentally probing time-biases.³⁴

In addition to shedding some light on near- and future-biases, experiment 1 provides an interesting picture of people's temporal beliefs and temporal phenomenologies.

Consider, first, people's beliefs. We found that ~ 50% of people believed that our world was most like the moving time depiction, with ~ 25% believing that it was most like the moving ego depiction and ~ 25% believing that it was most like the static depiction. As Latham et al (2019) note, it has been standard in the philosophy of time to claim that dynamical theories of time better accord with how the folk conceptualise and/or experience time. A series of earlier studies including that of Latham et al (2019, 2020a) investigated this contention using written descriptions of dynamical worlds and static worlds.³⁵ They found, across several studies, that ~ 70% of people reported that our world was most like a dynamical world (of some sort or other) and ~ 30% reported that it was most like a static world. The current study is a useful follow up to this work, since it targets people's beliefs in a way that does not require that people are able to understand fairly metaphysically demanding vignettes (although the current

³³ For discussion of the connection of time biases and anticipation and retrospection see Latham et al (forthcoming).

³⁴ We are grateful to an anonymous referee for this suggestion.

³⁵ For a helpful overview of many studies in this area see part I of Baron et al (2022).

study does not, unlike that of earlier work, allow us to distinguish different dynamical views). Notably, our results show that ~ 70% of people think our world is most like either the moving time or moving ego depiction, which is very similar indeed to the percentage of people who Latham, Miller and Norton found to believe our world to be dynamical. We take the current work, then, to be a useful partial replication of those earlier studies. Roughly 70% of people do indeed believe that our world is *dynamical in some sense or other*.

That being said, we need to be careful here as it may be a bit quick to take the ~ 25% of people who judge that the ego moves as evidence for belief in a dynamical picture of reality. It is possible that moving ego depictions are just another way of judging that our world is dynamical. So, it may be that the right conclusion to draw is that 70% of people believe that our world is one in which time robustly passes. Equally, however, it might be that participants who judge that our world is most like the moving ego depiction are not best categorised as believing that time robustly passes. Even if as a matter of metaphysical fact there is no difference between time passing and the ego moving (which perhaps is arguable) it could still be that people who represent that time moves are genuinely representing something different from those who represent that the ego moves.

If the latter possibility is the case it should be of particular interest to B-theorists. Previous research has shown that people do not believe that time is essentially dynamical (Latham et al., 2020b). That is, they do not believe that worlds that lack dynamism thereby lack time. Still, as already noted, previous work suggests that a majority of people represent our world as containing robust passage. This poses a potential problem for B-theorists, as it seems to provide a body of data that A-theorists can use to support their view (perhaps by using the data to support an argument from experience to the truth of the A-theory). If, however, the ~ 25% of people who represent that the ego moves do not also represent that time robustly passes, then this suggests that although 70% of people do represent our world to be in some manner dynamical, that 70% may not represent time as strictly speaking robustly passing. Thus, B-theorists might try to argue that the 25% of people who believe that the ego moves have a representation of time that is *as close* to that of a static representation as to a genuinely temporally dynamical representation. And if that were so, then it would not be true that a majority of people represent time as robustly passing, and so it would not obviously be true that most people represent time in a way that is friendlier to the A-theory than to the B-theory.

The results just discussed relate to people's beliefs about how the world really is. Unsurprisingly, we find very similar results when we look to people's judgements about how things *seem* to them to be. Of course, it is notoriously difficult to get people to clearly distinguish between how things seem to them to be, experientially, and how they believe them to be.³⁶ That is, it could be that for some participants the depictions only prompted reflection on their beliefs about their experiences, rather than how things seem to them experientially. This is why the current study includes prompts that help people understand the difference between these two notions. This of course doesn't eliminate the problem of getting participants to distinguish between beliefs and

³⁶ For work in this area see Sytma and Machery (2009), Fischer et al (2018) and Arico (2010).

phenomenology, but we hope that explaining such differences succeeded in prompting participants to reflect on their experiences in a way that reveals these differences. After all, the results about participants' beliefs do not exactly mirror the results of people's experience, and we expected there to be a high degree of similarity between people's beliefs about how things are and the way things seem to them to be: after all, you might expect people's relatively naïve (i.e., philosophically and scientifically untutored) beliefs about time to be largely the product of how things seem to them to be, especially since we know from prior research by Latham et al (2019) that people's knowledge of science has little impact on their beliefs about time.³⁷ Still, we should acknowledge a limitation, here, to this study: it may be that we failed to probe people's phenomenologies and therefore that our data does not speak to the phenomenological hypotheses. We see no good reason to suppose this to be so, but we cannot rule it out.

Assuming that we did succeed in probing people's phenomenologies, though, what do our results tell us? Well, temporal phenomenology has been important in theorising about the metaphysics of time. Dynamists have often offered *the argument from temporal phenomenology* (Baron et al., 2015) according to which we have reason to think our world is temporally dynamical because this is how it seems to us to be, in perceptual experience. Recently, some B-theorists have responded to this argument by denying that it does seem this way to us in experience (Bardon, 2013; Deng, 2013, 2018; Hoerl, 2014; Miller, 2019; Miller et al., 2020; Miller forthcoming; Prosser, 2016). Defenders of this view are known as deflationists. Some deflationists have noted that even if our world is a B-theoretic world, we would expect it to seem a way that we might describe by saying that we are moving away from the past and towards the future. That is because at later times we gain new memories, and we find that options that were once open, are now closed. A natural way to describe this seeming would be in terms of a moving ego (Deng, 2013; Ismael, 2012). Previous work in this area suggests that the phenomenology in question might in fact be better conceived of in this manner. For instance, Latham et al (2020b) and Shardlow et al (2020) presented participants with a range of moving time and moving ego expressions and asked them how much they agreed that things are how they seem. Both studies found that people tended to weakly agree that things seem as described by the moving time expressions, and that they more strongly agree (and more of them do so) that things seem as described by the moving ego expressions. Latham et al (2020b) took this to be evidence against the idea that we have a strong, pervasive, phenomenology as of time robustly passing, and that instead this phenomenology is better described in terms of moving ego locutions. If so, this would be good news for deflationists who, remember, deny that we have a phenomenology as of time robustly passing.

Interestingly, in the current study we found that *more* people judged that things seem as if time moves, than as if the ego moves. It may be, then, that standard purely vignette-based methods that use certain kinds of movement expressions (which are common in

³⁷ Of course, one might think that even if Latham et al (2019) showed that people's beliefs and knowledge of science has little impact on their beliefs about time, it could still be the case that their knowledge of *science fiction* does. That is, one might think that even if the target population have relatively untutored scientific views, many would have been exposed to science fiction, and that this may affect their beliefs about time. We did not test this possibility in the present study, though it would be an interesting factor to consider for future work. We thank an anonymous referee for pointing this out.

psychology) yield somewhat different results to those which use animated depictions. Perhaps these animated depictions prompt participants to reflect on different aspects of their phenomenology. That said, it is worth noting that the animations, and indeed the diagrams, were followed by forced choice questions, whereby participants were required to select exactly one response. Forced choice questions of this kind may have a distorting effect, insofar as they require participants to take up a position, when they may be more inclined not to. It would be interesting to see whether participant responses significantly change if they are given the option not to select a preference between moving ego / moving time diagrams and animations, or to select multiple preferences. A design that is not built around forced choice questions is well worth exploring, and one that we hope to develop in future work.³⁸

Still, if we take the forced-choice design at face value, then the results of the present study may suggest that there is an aspect of temporal phenomenology that is better described as being one in which it seems as though time, rather than the ego, is moving. The thought here is not that being shown these animated descriptions results in participants somehow having a new phenomenology, but rather enabling access to a more salient example with which to compare to their experience. Of course, given the aforementioned difficulties in getting people to clearly distinguish between how things seem to them to be and how they believe things to be, our claim is only a suggestion. Nevertheless, it strikes us as plausible that being shown animated depictions of moving time and moving ego enabled participants to better judge that it seems as though time, and not the ego, is moving. That is not such good news for deflationists.

Having said that, it is notable that more people, in total, judged that it seems as though either time is static or the ego moves, than judged that it seems as though time moves. This is an important result. As just noted, many deflationists think that we have a phenomenology that we might be tempted to describe as being one in which the ego moves, and that our having that phenomenology and its being veridical, is entirely consistent with our world being B-theoretic. These B-theorists, then, might point out that if the results of our study are accurate, then more people have a phenomenology on which it does *not* seem as though time robustly passes, than people who do, and that on their view all of these people can be understood as having a veridical phenomenology. In this regard, then, the results are not all bad news for deflationists.

Let us now consider the implications of our research for investigation of near- and future-bias. Recall that we found no evidence in favour of either the moving ego or moving time hypotheses. This result is consistent with earlier work by Latham et al (2021, 2022). In their 2022 they found no effect of temporal phenomenology on future-bias using vignette-based methods. We replicated this finding with respect to future-bias. Although they go on to hypothesise that the presence of veridical moving time phenomenology *might* tend to promote future-bias, there was no direct evidence of this in their 2021 except for the observed correlation between the vignette people saw (dynamical vs. static) and future-biased preferences. They found no evidence of an effect of people's actual beliefs on future-bias. The present study replicates that finding as well. What we might have expected to find, however, in light of their 2021 results, is that priming people with a dynamical depiction would make them more

³⁸ We are grateful to an anonymous referee for this suggestion.

future-biased than those primed with the static depiction. We did not find evidence for this. We are unsure what explains this lack of evidence, but perhaps it is the product of the different vignettes used across the two studies. Regardless, when we look at the totality of evidence here across these 6 studies, we can see that there is no evidence that would support the view that people's beliefs about time moving or about the ego moving, nor their relevant phenomenologies, explain (even partially) their being near- or future-biased.

Defenders of future-bias have often appealed to temporal metaphysics to argue that such preferences are rationally permissible, or indeed obligatory (Craig, 1999, 2018; Pearson, 2018; Prior, 1959; Schlesinger, 1976). Since these authors often acknowledge that near-bias is not rationally permissible, they aim to show that there is some normatively relevant difference between past and future, and hence between the well-being of past and future person-stages, and that our preferences are sensitive to that feature, which both explains and makes rationally permissible our having those preferences. They often do so by arguing that our beliefs about and/or experiences of time are what explain and justify our future-biased preferences. According to these views, our experiences of robust temporal passage are veridical, and the belief that time robustly passes is justified. Moreover, the presence of robust passage justifies future-biased preferences because past events are 'over and done with', and receding from the present, while future events are still due to become present. So, we are suitably sensitive to these features of time, and these features render our future-biased preferences permissible.³⁹

In order for some structure in the world to render rationally permissible some preference it needs to be that the preference is appropriately sensitive to that structure. For instance, the fact that there is a dog in this room is the right kind of thing to justify one's belief that there is a dog in the room. But it only does so on the assumption that the belief is appropriately connected to there being a dog in the room. If there is no association between one's having the belief that there is a dog in the room and there being a dog in the room, then the way the world is does not in fact make it rationally permissible for one to believe that there is a dog present because the belief is not appropriately tracking the way the world is. We found no association between people's beliefs about time or the moving ego, or their experiences thereof, and their preferences. So, the idea that whether people are future-biased or not is not sensitive to what they believe about time, or the moving ego, or to their experiences regarding whether time, or the ego, moves lacks evidential support. So even if the presence of robust passage were the *kind* of thing that would make such preferences rationally permissible or obligatory, even if time did robustly pass, or the ego did move, we

³⁹ Contra these authors, it is not clear that even if there *were* robust temporal passage, that this would furnish any reason for caring more about the future than the past. For instance, Yehezkel writes: '[T]he failure to offer any substantial justification for the asymmetry in our attitudes based on the flow of time stems from the inability to offer any non-trivial account of the flow of time. It is difficult to see what difference is made by the claim that "future events are moving closer to reality," given that all that is meant by this claim is that "in the future, future events will be closer to the present." This is a mere truism, as evident by the analogous claim, regarding the past, according to which "in the past, past events were closer to the present." The attempt to justify the asymmetry between past and future based on the flow of time *per se* thus seems to collapse into triviality' (2013, pp. 6–7). For a similar conclusion see Miller (2021). Discussion of these issues is also to be found in Maclaurin and Dyke (2002) and Suhler and Callender. (2012).

found no evidence of the kind of association between robust passage and temporal preferences that would render such preferences rationally permissible.

Of course, that does not show that future-bias is not rationally permissible. Its permissibility could be grounded in something else. Our point here is just that one purported account of in what their rationality consists is not supported by the evidence gathered in the studies we conducted.

6 Conclusion

The purpose of this study was to examine the dynamical explanation: the claim that both near- and future-bias are to be explained in terms of one's beliefs about, or phenomenology as of, there being movement of, or in, time. In contrast to previous work, we considered two versions of the dynamical explanation: the moving time and moving ego explanations. The moving time explanation focuses on beliefs about the movement of time itself, and associated phenomenology. The moving ego explanation focuses on beliefs about the movement of an individual through time, and associated phenomenology. We failed to find support for either explanation. Thus, whether or not time or the ego moves, our study found no evidence that it is the movement of either that explains why we have the time-biased preferences we do, and hence we found no evidence to support the view that this is what renders these preferences rationally permissible (if indeed they are). Finally, the current study is unique in the way it uses non-vignette-based methodologies to probe beliefs about and/or experiences of time. In this way, the study provides a template for future experimental work on time.

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Declarations

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