**Memory, Anticipation, and Future Bias**

**Abstract**

One proposed explanation for a particular kind of temporal preference lies in a disparity between the emotional intensity of memory compared to anticipation. According to the memory/anticipation disparity explanation, the utility of anticipation of a particular event if that event is future, whether positive or negative, is greater than the utility of retrospection of that same event if it is past, whether positive or negative, and consequently, overall utility is maximised when we prefer negative events to be located in the past rather than the future, and positive ones in the future rather than the past. To have this preference is to be (at least apparently) future biased. If this explanation is correct, it would tend to confer rational justification upon these preferences. This paper empirically investigates this explanation. Our results suggest that, at most, this explanation might be a partial one of some people’s preferences some of the time, rather than a general explanation of future bias. In turn, this lends some indirect support to a competing explanation that appeals to temporal asymmetries in emotion and attention. Since that explanation would arguably tend not to confer rational justification upon (apparently) future-biased preferences, we argue that our findings provide some reason to be sceptical that these preferences are, in general, rationally justified.

**1. Introduction**

Most people tend to prefer having painful experiences located in their past rather than their future, and pleasurable experiences located in their future rather than their past. Such people have *apparently future-based preferences.* Some of these preferences are *merely apparently* future-biased, and some are *genuinely* future-biased. To see the difference, suppose that Annie prefers to eat kangaroo in the future rather than kangaroo in the past, only because she believes the future kangaroo steak is larger and juicier than the past one would have been, or because she anticipates being very hungry shortly, whereas in the past she was only moderately hungry. Suppose that were the steaks even in size and juiciness, and were Annie equally hungry whenever she receives them, and so on, then Annie’s preference would be temporally neutral. In this case, Annie is *merely apparently* future-biased. By contrast, Annie is *genuinely* future-biased if her preferences are sensitive to the temporal locations of the events themselves, as opposed to variations in uncertainty, the intrinsic value of the goods or experiences in question, etc., which result from variations in temporal location (see Lowry and Peterson 2011: 490). That is, a person is genuinely future-biased if, all else being equal, they display apparently future-biased preferences.

Previous studies have found future-bias to be widespread.[[1]](#footnote-1) People have been shown to be future-biased about both hedonic and non-hedonic events (Greene et al. 2021) and to be future-biased when it comes to the pleasures and pains of others (Greene et al. 2021). There is also some evidence that future-biased preferences are ‘strong’, i.e., that people continue to show future-bias even when the states of affairs over which they form a preference are unequal. For instance, Greene et al. (2022a) found that when it comes to negative states of affairs, people would prefer an event that is ten times worse but is located in the past, to one that is one-tenth as bad but is located in the future. When it comes to positive states of affairs, Greene et al. (2022b) also found evidence that future-bias is strong, albeit less so. Whereas participants preferred an event ten times more pleasant in the past to an event one-tenth as pleasant in the future, they nevertheless preferred an event half as pleasurable in the future to one twice as pleasurable in the past. This suggests that future-biased preferences are sufficiently strong as to generate a preference for less pleasure overall (Greene et al. 2022b).

However, results from Lee, Shardlow, O'Connor, Hotson, Hotson, Hoerl & McCormack (2020) tell against this picture of strong future bias. While a majority of Lee et al.’s adult and child participants reported future-biased preferences when presented with pleasures and pains of equal value in the future and in the past, as soon as the scales were tipped towards the past—i.e., as soon as the number of pleasures or pains in the past was increased from one to two—most children and roughly half of adult participants abandoned their future-biased preference in favour of a preference for less pain and more pleasure overall. Thus, while the Greene et al. and Lee et al. studies both support the idea that future-bias is not absolute—telling against Sullivan’s (2018) claim that no weight at all is given to past pains and pleasures in the forming of our preferences—they present different pictures regarding the strength of these preferences.[[2]](#footnote-2)

Philosophers have been particularly concerned with the normative status of these preferences, and there is an ongoing debate about whether it is rationally permissible to be future-biased (Prior 1959; Parfit 1984; Hare 2007, 2013; Dougherty 2011, 2015; Greene & Sullivan 2015; Sullivan 2018; Dorsey 2018; Brink 2011; Maclaurin & Dyke 2002; Suhler & Callender 2012; Yehezkel 2014; Pearson 2018, Bnefsi 2019, 2020, 2023, Sung 2024, Karhu 2023). Some of this debate centres around the connection between time biases and temporal metaphysics. Several authors have argued that it is because time robustly passes (that is, because there is an objectively privileged set of events that are present, and which events those are, changes) that future bias is at least rationally permissible (and possibly obligatory) (Pearson 2018, Prior 1959, Cockburn 1997, 1998; Bnefsi 2020). Others argue that the metaphysics of time is irrelevant to the question of whether future bias is rationally permissible or not (Miller 2021a, 2021b, Yehezkel 2014, Karhu 2023, Fernandes 2021, Bacharach 2022, Hoerl 2015). Another source of debate regarding normative status of future bias lies in whether there is a connection between the descriptive facts about these preferences, including under which conditions they are displayed and what explains our having them, and their normative status, with some authors arguing that these descriptive facts are relevant to the normative status of the preferences (Dougherty 2015, Greene & Sullivan 2015, Greene et al. 2021; Latham, Miller & Norton 2023; Greene, Latham, Miller, Norton, Tarsney & Tierney 2023, Latham, Oh, Miller, Shpall & Yu 2023).

Much of the debate in this area has assumed that people display genuinely future-biased preferences and has proceeded to normatively evaluate those preferences (Hare 2007, 2013; Dougherty 2011, 2015; Greene & Sullivan 2015; Sullivan 2018, Braddon-Mitchell, Latham & Miller 2023). Recently, however, several authors have raised the possibility that our apparently future-biased preferences may not be genuine (Callender 2021; Caruso, Latham & Miller 2024; Latham, Oh, Miller, Shpall & Yu 2023), since they might not be the product of sensitivity to temporal local *per se*, but rather, to some factor that is contingently connected to temporal location. Determining whether this is so involves determining in virtue of what we have those preferences.

There are two candidate explanations of our apparently future-biased preferences, each of which appeals to features of prospection and retrospection. One such explanation appeals to temporal asymmetries in emotion and attention known as the *emotion asymmetry* and the *attention asymmetry*. The emotional asymmetry refers to the fact that when people episodically *imagine* some event, the resulting imagination is less emotionally intense when the event is *imagined to be past*, compared to when it is *imagined to be future* (Caruso 2010; Ramos, Caruso & van Boven 2022; D’Argembeau and Van der Linden 2004). Since in forming preferences over the temporal locations of events (past versus future) we must imagine the targets of our preference, and so must imagine events as past, and as future (Phillips 2021), if imagining events as past induces less affect than imagining them as future, it will tend to *feel* as though past events are less (dis)utilitous than future ones, even when the intrinsic properties of these events are on a par. And so, people will tend to prefer that negative events are located in the past (where they feel less unpleasant) and positive ones in the future (where they feel more pleasant).

The attention asymmetry refers to the fact that people tend to attend more to an event when it is future compared to when it is past (Caruso, Van Boven, Chin & Ward 2013). In turn, people tend to value attended objects more (Bayliss et al. 2006; Störmer & Alvarez 2016) and are more likely to choose, amongst options, those they attend to (Bhatnagar & Orquin 2022; Fiedler & Glockner 2012; Pleskac et al. 2023) and increasing attention toward an option increases the likelihood that it will be chosen (Armel et al. 2008; Ghaffari & Fiedler 2018; Janiszewski, Kuo & Tavassoli 2012). If people more highly value the option to which they attend, then attentional biases towards the future rather than the past may cause us to more highly value an event when it is future compared to when it is past, and thus to prefer negative events to be past not future and positive ones to be future not past.

In turn, the emotion and attention asymmetries tend to interact with and promote one another, since events that are more emotionally salient tend to draw more attention, and events that are more attended to tend to be more emotionally salient (Mrkva, Ramos & Van Boven 2020). Let’s call the explanation of apparently future-biased preferences that appeals to both the emotion asymmetry and the attention asymmetry, the *emotion/attention asymmetry* explanation

One feature of the emotion/attention asymmetry explanation is that it predicts that we will find people to be more strongly future biased about negative events than positive ones. This is in line with the *negativity effect*, according to which, when events that are of equal positive or negative utility occur, the latter tend to have a greater effect on people’s psychological states than do the former. There are various mechanisms posited to explain this effect, of which several are relevant here. First, evidence suggests that people direct more attention towards negatively valenced events than positive or neutral ones (Fiske 1980; Ohira, Winton & Oyama 1998; Baumeister, Finkenauer, & Vohs 2001). Second, evidence suggests that negative events are more affect inducing than positive ones (Kanouse & Hanson 1972). Given this, we would expect people to direct more attention and affect towards negative events than positive ones, and hence differentially direct *more* such attention and affect towards future negative events than past ones, and so to be more strongly future biased when it comes to negative events than positive ones.

At least on the face of it, if our preferences are explained by the emotion/attention asymmetry this would appear *not* to confer warrant on those preferences. If we have such preferences because when we imagine an event as past, it is imagined as less emotionally intense than when we imagine it as future, then this would seem to *mislead* us. After all, a painful event was as painful an event in the past, as it will be in the future. If this feature of our imaginative system misleads us into thinking that an event has less utility when it is past compared to future, and our preferences are formed on this basis, these preferences would thereby seem to be unjustified.

A second candidate explanation for apparently future-biased preferences lies in a disparity in strength between two effects: the *memory effect* and the *anticipation effect.* The memory effect tends to promote apparently past-biased preferences. An individual is apparently *past-biased* if they tend to prefer that positive events are located in their past, not their future, and negative ones in their future, not their past (see Greene et al. 2022c). The memory effect occurs because the act of recollecting a past event can itself, at the time of memory recall, be a positive or negative hedonic event (Elster & Loewenstein, 1992; Morewedge, 2015). Hence, taking into account the (dis)utility of the recollection of events will tend to promote people’s preference for positive events to be located in the past, such that they can from now on be recalled, and negative ones in the future as opposed to the past. After all, all else being equal, in any given moment it is more pleasant to bask in the glow of nostalgia than to revisit memories of suffering. Hence, the memory effect tends to promote past-bias.

The anticipation effect, by contrast, tends to promote apparently future-biased preferences. The anticipation of a future experience can contribute positively (e.g., savouring) or negatively (e.g., dreading) to utility (Elster & Loewenstein 1992; Lowenstein 1987). The anticipation of positive events is itself an experience with positive utility, and of negative events negative utility (disutility). Hence, taking into account the (dis)utility of the anticipation of events will tend to promote people preferring positive events to be in the future, and negative ones in the past. This is the anticipation effect (Morewedge, 2015).[[3]](#footnote-3)

Since the memory effect tends to promote apparent past-bias, and the anticipation effect tends to promote apparent future-bias, if the anticipation effect is stronger than the memory effect, this alone could explain why people are apparently future-biased. Call this *the memory/anticipation disparity explanation.*

Importantly, the memory/anticipation disparity explanation also predicts that people will be more strongly future biased when it comes to negative events than positive ones. That is because evidence suggests that, via the negativity effect, memory is impacted by whether the stimulus to be remembered is positive or negative. People tend to recall negative events more than positive ones (Dreben, Fiske & Hastie 1979; Skowronski, Carlston & Donal 1987; Robinson-Riegler, Gregory & Winton 1996). As a consequence, if the memory/anticipation disparity explanation is an explanation of future bias, we would expect people to be more strongly negatively than positively future biased. To the extent that thememory/anticipation disparity explanation explains apparent future-bias, two important things seem to follow. First, it would not be clear that people are genuinely future-biased at all, since people’s preferences would not seem to be sensitive to the temporal location of events *per se*, but rather, to the positive and negative utility of the events in question, alongside the utility of remembering and anticipating those events. Second, it would be plausible that the resulting pattern of preferences is rational. For people would simply be maximising overall utility, taking into account the utility of recollection and of anticipation.

Even if the memory/anticipation disparity explanation is not the *complete* explanation of our preferences, understanding its role in promoting those preferences is important. As Kahneman (1999) notes, the pleasures and pains of recalling one’s past experiences should contribute to our preferences about what we experience at various temporal locations. So, understanding the extent to which our apparently future-biased preferences are the product of the memory and anticipation effects is important in determining to what extent these preferences are grounded in factors that confer rational justification upon those preferences.

This paper explores the memory and anticipation effects to evaluate the plausibility of the memory/anticipation disparity explanation and, in turn, shed light on these normative questions.

In §2, we briefly survey the relevant literature and motivate our study and hypotheses. In §3 we set out the methodology and formally spell out our hypotheses. Next, in §4 we present the results of the study, followed by a discussion of the implications of these results in §5.

**2. Background and Hypotheses**

There is evidence for the emotion/attention asymmetry explanation, with several studies finding that affect and attention are temporally asymmetric (Caruso et al. 2009; Caruso 2010, van Boven & Ashworth 2007; Ramos, Caruso, & van Boven 2022; D’Argembeau & Van der Linden 2004). Recent work also provides some such evidence for the memory/anticipation disparity explanation. Lee, Hoerl, Burns, Fernandes, O’Connor & McCormack (2022) found evidence in favour of the memory effect. Lee et al. (2022) ran a series of studies in which they manipulated the memory loss the participants were imagining themselves to undergo. Lee et al. modelled their study on an influential thought experiment from Parfit (1984), who imagines that he is in hospital for a painful surgery, during which he must, unfortunately, be conscious and unanaesthetised. After the surgery, however, patients are administered a drug that erases the memory of the surgery. He wakes in hospital, wondering whether he has had the operation. The nurse says that there is one patient in the ward who had the surgery yesterday, which was a particularly lengthy 10-hour operation, and another patient due to have the surgery tomorrow, which will only take one hour. The nurse goes to check which patient he is. While in a state of ignorance, however, Parfit reports that he would prefer to find out that he is the patient who had the longer painful surgery yesterday rather than the patient who will experience the less painful surgery tomorrow. He would, in other words, prefer to experience more pain in his life, as long as the pain is in the past, and he thinks that this preference is widespread.

Crucial to Parfit’s thought experiment is that the surgery is not, and will not be, remembered since the act of recollecting an aversive event is itself an unpleasant one and one that will occur in the future (see Elster & Loewenstein 1992; Morewedge 2015).

Lee et al.’s (2022) experiment 1a closely follows the structure of Parfit’s thought experiment. Participants imagine that they have experienced a week-long infection of ‘Denboravirus’, a fictitious and unpleasant (but not particularly awful) disease which causes “1 week of memory loss and bad headaches during the illness, but no other symptoms”. They are then told that there are two ways in which future infections can be avoided. One involves a series of ten “really painful” injections (or unanaesthetised operations) that occur during the course of the illness itself. The other involves a single really painful injection (or unanaesthetised operation) that occurs the week after they recover. The treatments are equally effective and do not result in any ongoing pain. Yet again, an unhelpfully forgetful nurse is unsure which schedule of preventative interventions the participant is on. While she goes to check, participants are asked what they hope the nurse will say. Adult[[4]](#footnote-4) participants were inclined to prefer the series of ten painful events that were in the past and would not be remembered, over a single painful event in the future that would be remembered. This is in line with Parfit’s prediction—and indeed with Greene et al.’s (2022a) results, even though their study included no long-term amnesia regarding the unpleasant experiences in question.

Of particular relevance are Lee et al.’s experiment 2a and experiment 3, which explicitly explore the role of the memory effect. Participant were in these experiments randomly allocated into an Amnesia condition or a No Amnesia condition. In the Amnesia condition, participants responded to roughly the same scenario as in experiment 1a. In the No Amnesia condition participants were told that the memory loss induced by Denboravirus was temporary, and their memories would return quickly. As a result, if they were on the more painful schedule of preventative treatments that occurred last week, the memory of this ordeal would return and stay with them thereafter. As in experiment 1a, in the Amnesia condition, participants preferred to have experienced tenfold more pain in the past which they cannot remember over one-tenth the amount of pain in the future. However, in the No Amnesia condition, participants were split between preferring more (remembered) pain in the past, and less (but also remembered, of course) pain in the future. Moreover, participants in the Amnesia condition were significantly *more* likely to prefer the ten past pains than participants in the No Amnesia condition. Finally, and tellingly, when offered the opportunity to explain the reasons for their preference, most participants in the No Amnesia condition who preferred a single future pain to ten past pains “gave as their reason for doing so that having to undergo one painful event was better than having to remember 10 painful events” (Lee et al. 2022:1203-4).

These results suggest that people do place some weight on the memories associated with various events when determining their preferences about the temporal locations of pleasures and pains. In particular, eliminating the role of memory leads people to present as more future-biased; conversely, making memory salient appears to mitigate the extent to which people present as future-biased, just as the memory effect predicts. Indeed, Lee et al. (2022:1204, emphasis added) go so far as to suggest that for at least some adults, “the consumption of experiential memory may play a *primary role* in [people’s] considerations when expressing preferences regarding hedonic goods.”

Lee et al. (2020) also note that the memory effect might explain the different results reported by Greene et al. (2021a, 2021b) and Lee et al. (2020) regarding the strength of future bias. As Greene, Latham, Miller, Norton, Tarsney & Tierney (2022) note, in Lee et al.’s experiments it is left open whether the past pains and pleasures are remembered, whereas in the Greene et al. studies, it is made explicit that the participant is temporarily unable to remember these events. This difference could be responsible for the more strongly future-biased preferences found by Greene et al. (2022b).

So far, however, this research only provides evidence for the memory effect when it comes to negative events. In order to fully evaluate the memory/anticipation disparity explanation, we need to determine whether there is evidence of a memory effect for positive events, and whether there is evidence of a more powerful anticipation effect for both positive and negative events. In what follows this is our aim. In the following section, we outline our experimental design, materials, and analyses (https://osf.io/bw35s/?view\_only=003e864c4815478b865c851f6f43fa32)[[5]](#footnote-5). In the course of doing so, we present with greater precision the hypotheses sketched above.

**3. Methodology**

**3.1 Experiment 1: Memory**

In this study, we examined the effects of memory on people’s (apparently) future-biased preferences for experiences. To be clear, the type of memory under investigation was episodic memory, or memory for personally experienced past events (Tulving 1985). As the mental simulation involved in episodic recollection can be more or less vivid and detailed, participants were randomly assigned to either a simulation-aided (Experiment 1a) or non-simulation-aided (Experiment 1b) condition. Since we sought to understand how the utility/disutility of experiential memories might modulate future-bias, we operationalised both positive and negative experiences in terms of taste, so as to ensure that the results would be comparable regardless of valence. The designs and procedures for Experiments 1a and 1b were similar. However, in Experiment 1a, participants were (in the preceding questions about demographics) asked to first specifically report their most liked (Positive Conditions) or disliked (Negative Conditions) food. The reported item was then used in the vignettes subsequently presented to them. By contrast, in Experiment 1b, participants were simply informed that they would experience a generic, unspecific taste found to be overwhelmingly liked (Positive Conditions) or disliked (Negative Conditions) by others. This difference between Experiment 1a and Experiment 1b manipulates the depth of imagination by providing more resources to facilitate vivid imagining in Experiment 1a than in Experiment 1b. The change in vividness depended on the difference between “being given a medication which tastes like your most liked/disliked food, (filled in from participant’s own choice) and the more general and vague description of “being given a medication that leaves a taste in the mouth which 99.9% of people who take the medication find extremely pleasant/unpleasant”.

**Participants**. 850 people participated in Experiment 1a and 881 people participated in Experiment 1b. Participants were U.S residents, recruited and tested online using Prolific and compensated £1.07 for 7 minutes of their time (£9 per hour)[[6]](#footnote-6). Our study included a range of comprehension as well as attention check questions. 43 participants had to be excluded from Experiment 1a and 37 participants from Experiment 1b for failing to follow task instructions. This means that they either failed to correctly answer at least three of the comprehension questions, failed to (correctly) answer the attention check question, or in other ways did not finish the study (for questions see ‘Supplementary Materials’ §1.3). This resulted in a remaining sample of 807 participants for Experiment 1a (age: 19-83; mean age: 38.43; SD: 12.84; Gender: 449 “Female”, 336 “Male”, 19 “Trans/Non-Binary”, 3 “I would prefer not to answer”) and 844 participants for Experiment 1b (age: 18-84; Mean age: 42.28; SD: 13.17; Gender: 412 “Female”, 417 “Male, 12 “Trans/Non-Binary”, 3 “I would prefer not to answer”)[[7]](#footnote-7). Ethics approval for this 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.

**3.1.1 Experiment 1a: Permanent versus Temporary Simulation-aided Memory**

**Design, materials and procedure**.

The experiment began with an initial demographic survey in which a question about one’s most disliked (Negative Conditions) or most liked (Positive Conditions) food was embedded. Participants were then presented with a vignette, in which they were told they themselves have experienced a week-long illness called Denboravirus (adopted, with modifications, from Lee et al. 2022). Participants were told that Denboravirus causes one week of memory loss during the illness, but typically no other symptoms.

Crucially, participants assigned to one of the two Permanent Amnesia conditions (Negative and Positive) read that, once recovered, they will permanently be unable to remember anything from the week during which they had the illness. By contrast, those in the Temporary Amnesia conditions were told they will slowly regain their memory, though immediately after waking up in the hospital, they would undergo a momentary state of confusion and loss of memory. As such, a total of four vignettes were used (Permanent Amnesia Positive, Temporary Amnesia Positive, Permanent Amnesia Negative, Temporary Amnesia Negative; full vignettes can be read in our ‘Supplementary Materials’ §1.1). Participants were randomly assigned to read and respond to one and only one of these four vignettes.

Next, participants were informed of there being two equally effective courses of treatment that can prevent a person from ever getting Denboravirus again. Each treatment involves being given a medication that tastes like one’s self-reported most disliked (Negative) or most liked food (Positive), and the medication leaves the taste of that food in one’s mouth for about 5 minutes afterwards. Participants were told that some people receive a course of 10 of these medications during the week in which they are ill, whereas others receive one medication the week after they get better.

Importantly for Experiment 1a, in the vignettes, the taste of the medication was adjusted for each participant depending on the answer given to the previous food preference question. For instance, if the participant had answered “Watermelon” as their most liked food, that answer would be reflected in the vignette presented to them. This was to help facilitate participants’ active imagination of the experience, which they were asked to do.

Participants then read that they had just now recovered and had woken up in the hospital but cannot yet remember the last week. They are now fine and are not experiencing any taste in their mouths. But since they don’t have any memory of the last week, they don’t know whether 10 medications *had* already been administered while they still had the illness, or whether one medication *will* be administered now that the illness has passed. When they ask the nurse which of these is the case, the nurse goes off to find out.

After answering a series of comprehension and attention check questions, participants were asked about what they hope the nurse will say upon returning and were presented with three options:

(a) I hope to find out that I had ten medications last week.

(b) I hope to find out that I will have one medication when the nurse returns.

(c) ⁠I do not have any preference regarding what I find out.

**3.1.2 Experiment 1b: Permanent versus Temporary Non-simulation Aided Memory**

**Design, materials and procedure**.

The design of Experiment 1b is structurally identical to that of Experiment 1a, except that where Experiment 1a specifically describes the taste of the medication as corresponding to that of participants’ self-reported most liked/disliked food, Experiment 1b’s vignettes state that the medication leaves a taste in one’s mouth which 99.9% of people who take the medication find to be extremely pleasant/unpleasant, without further specifying what that taste is like. This was to provide less specific stimulus information on which participants might draw to imagine the experience, compared to Experiment 1a.

As in Experiment 1a, a total of four vignettes were used in experiment 1b (Negative Permanent Amnesia, Negative Temporary Amnesia, Positive Permanent Amnesia, and Positive Temporary Amnesia conditions; full vignettes can be read in our ‘Supplementary Materials’ §1.2). Again, the two Permanent Amnesia conditions (Negative and Positive) stated that, once recovered, they will permanently be unable to remember anything from the week during which they had the illness. By contrast, those in the Temporary Amnesia conditions were told they will slowly regain their memory, though immediately after waking up in the hospital, they would undergo a momentary state of confusion and loss of memory. Participants were randomly assigned to read and respond to one and only one of these four vignettes.

**3.1.3 Hypotheses**

We can now state our hypotheses more precisely.

**H1:** People in the Permanent Negative Amnesia Condition, in both Experiment 1a and Experiment 1b, will be more apparently future-biased than those in the Temporary Negative Amnesia condition. (Replicating Lee et al., 2022.)

**H2:** People in the Permanent Positive Amnesia Condition, in both Experiment 1a and Experiment 1b, will be more apparently future biased than those in the Temporary Positive condition. (Extending the results from Lee et al., 2022.)

H1 and H2 jointly constitute the memory effect hypothesis.

**H3:** People will be more apparently future biased in negatively-valenced conditions than positively-valenced ones.

H3 is motivated by prior research which shows greater apparent future-bias in negative than positive conditions (Greene et al., 2022a; Greene et al., 2022b).

Finally, we want to know whether simulation-aided memory has a more potent effect on future bias via the memory effect, than does non-simulation-aided memory. So, we added the following exploratory hypothesis.[[8]](#footnote-8)

**H4:** People will be more apparently future biased in the simulation-aided memory condition than in the non-simulation-aided memory condition.

**3.2 Experiment 2: Thick and Thin Anticipation Versus no Anticipation**

In this study, we examined the effects of anticipation on people’s (apparently) future-biased preferences. In particular, the type of anticipation under investigation was experiential anticipation, or prospection, which involves mentally simulating future events (Gilbert & Wilson 2007). As in Experiment 1, we operationalised both positive and negative experiences in terms of taste, to ensure that the results would be comparable regardless of valence. The designs and procedures for Experiments 2a and 2b were similar~~.~~

However, unlike Experiment 1, which investigated the differential effect of permanent versus temporary memory loss, here we were particularly interested in whether the vividness of one’s mental imagery in *future* simulation differentially affects the anticipation effect. We explored this question by manipulating participants’ ability to mentally simulate an event in more or less detail in two ways. First, we manipulated the *object* of anticipation.

Just like in Experiment 1a, participants in Experiment 2a were (in the preceding questions about demographics) asked to first specifically report their most liked or disliked food. The reported item was then used in the vignettes subsequently presented to them. We call this condition “thick anticipation”. By contrast, in Experiment 2b, participants were simply informed that they would experience a generic, unspecific taste found to be overwhelmingly liked (Positive Conditions) or disliked (Negative Conditions) by others. We call this “thin anticipation”. As in Experiment 1 this was to manipulate the depth of imagination, by providing more resources to facilitate vivid imagining in thick anticipation conditions in Experiment 2a than in thin anticipation conditions in Experiment 2b (as per Experiments 1a and 1b).

Second, in both experiments, 2a and 2b, we further manipulated the *extent* to which participants were explicitly instructed to imagine the future event. This difference consisted in participants either being presented with a vignette that discouraged anticipatory imagination or one that encouraged anticipatory imagination. Participants presented with the latter vignette are prompted to actively anticipate the taste in ways that the participants presented with the former vignette are not. This in total gives rise to four different conditions in Experiment 2a and four different conditions in Experiment 2b (full vignettes can be read in our Supplementary Materials §2).

**Participants**. 851 people participated in Experiment 2a and 880 people participated in Experiment 1b. Participants were U.S residents, recruited and tested online using Prolific, and compensated £1.07 for 7 minutes of their time (£9 per hour)[[9]](#footnote-9). Our study included a range of comprehension as well as an attention check question. 87 participants had to be excluded from Experiment 2a and 90 participants from Experiment 2b for failing to follow task instructions. This means that they either failed to (correctly) answer at least three of the comprehension questions, failed to (correctly) answer the attention check question, or in other ways did not finish the study (see ‘Supplementary Materials’ §2.3). This resulted in a remaining sample of 764 participants for Experiment 2a (Age 18-82; Mean age: 40.31; SD: 14.19; Gender: 417 “Female”, 318 “Male”, 24 “Trans/Non-Binary”, 5 “I would prefer not to answer”) and 790 participants for Experiment 2b (Age: 18-86; Mean age: 38.47; SD: 13.05; Gender: 477 “Female”, 282 “Male”, 30 “Trans/Non-Binary”, 1 “I would prefer not to answer”).[[10]](#footnote-10) Ethics approval for this 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.

**3.2.1 Experiment 2a: Thick Anticipation Versus No Anticipation**

**Design, materials and procedure**.

The procedure for Experiment 2a was the same as for Experiment 1a except that about half of the participants read the following additional description.

The hospital’s computers have crashed, and when the nurse returns all she is able to tell you is that your file has you marked as being healthy, but that you will need to return to hospital in a week for a quick check-up. As a matter of fact the computers will not reboot for a week, and only then will you learn about the Denboravirus. At that point, if you are on the second course of treatment you will be given the single medication.

These details were intended to tacitly *discourage* participants from simulating the future event, by introducing uncertainty and artificial delay of the eventual outcome, since having now recovered, they *will* not know if the medication is still needed until a week later. These participants were placed in what we call No Anticipation conditions (Negative and Positive).

After answering a series of comprehension and attention check questions, participants were asked about what they hope the nurse will say upon returning and participants were presented with three options: (a) I hope to find out that I had ten medications in the past. (b) I hope to find out that I will have one medication at my checkup. (c)⁠ ⁠I do not have any preference regarding what I find out.

By contrast, the remaining half of the participants were placed in what we call Thick Anticipation conditions (Negative and Positive), and read the following description:

While you are waiting for the nurse to come back, you think about what you hope they will say. If the nurse tells you that you are on the first course of treatment, you will soon be discharged. If you are on the second course of the treatment, you will take the medicine in a week. You spend some time thinking about taking the medicine, and you wonder how [bad/good] it will taste.

After answering a series of comprehension and attention check questions, participants were asked about what they hope the nurse will say upon returning and were presented with three options: (a) I hope to find out that I had ten medications last week. (b) I hope to find out that I will have one medication in one week. (c) ⁠I do not have any preference regarding what I find out.[[11]](#footnote-11) As such a total of four vignettes were used (Positive Thick Anticipation, Positive No Anticipation, Negative Thick Anticipation, and Negative No Anticipation; full vignettes can be read in our ‘Supplementary Materials’ §2.1). Participants were randomly assigned to read and respond to one and only one of these four vignettes.

**3.2.2 Experiment 2b: Thin Anticipation Versus no Anticipation**

**Design, materials and procedure**.

The design of the experiment was structurally identical to that of Experiment 2a except for two differences. The first difference is in how the taste of the medication was described in the vignettes, and how this was tested in one of the comprehension questions. Instead of people specifying their most (dis)liked food (as in the thick anticipation conditions), the vignettes in Experiment 2b only allowed for thin anticipation, merely stating that the medication leaves a taste in one’s mouth which 99.9% of people who take the medication find to be extremely (un)pleasant, without further specifying what that taste is like. This change from thick anticipation to thin anticipation was to reduce the room for which participants could imagine the experience, especially regarding its valence component. The second difference is that in the anticipation conditions, we left *some* room for participants to simulate the future event without explicitly instructing them to do so. This resulted in two Thin Anticipation conditions, which did not discourage or prevent participants from simulating the future event, either, unlike in the No Anticipation conditions (see ‘Supplementary Materials’ §2.2).

As in Experiment 2a, a total of four vignettes were used (Negative Thin Anticipation, Negative No Anticipation, Positive Thin Anticipation, and Positive No Anticipation conditions; see Vignettes in ‘Supplementary Materials’ §2.2). Participants were randomly assigned to read and respond to one and only one of these four vignettes.

**3.2.3 Hypotheses**

We can now state our hypotheses for Experiment 2 more precisely.

**H5**: People in the anticipation conditions (both Thick and Thin Anticipation) will be more apparently future-biased than those in the no-anticipation conditions.

**H6**: People in the Thick Anticipation condition will be more apparently future-biased than those in the Thin Anticipation condition.

H5 and H6 jointly constitute the anticipation effect hypothesis.

**4. Results**

**4.1.** **Experiment 1a and 1b: Memory**

Before presenting the data from experiments 1a and 1b, we will summarise our results with respect to each of our hypotheses. Our first two hypotheses were that people in the permanent negative amnesia condition (H1) and permanent positive amnesia condition (H2) would be more apparently future biased than people in the temporary negative amnesia condition (H1) and temporary positive amnesia condition (H2), respectively. We found limited evidence in favour of H1 and no evidence in favour of H2. In experiment 1b, people in the permanent amnesia condition were more apparently future biased than time neutral, but only in negatively-valenced conditions. Next, we predicted that people would be more apparently future-biased in negatively-valenced conditions than positively-valenced conditions (H3). H3 was vindicated. We found evidence in both experiments 1a and 1b that people in negatively-valenced conditions were more future-biased, than time-neutral, than people in positively-valenced conditions. Finally, we found no evidence in favour of H4. Exploratorily rerunning analyses including Experiment as a factor found no effect of that factor on future bias.

Table 1 below summarises the descriptive data of people’s reported temporal preferences in each condition in experiment 1a.

*Table 1. Participants’ reported temporal preferences in Experiment 1a. Counts are shown in parentheses.*

|  |  |  |  |
| --- | --- | --- | --- |
| **Condition** | **Future-Bias** | **Past-Bias** | **Time-Neutral** |
| **Negative Valence** |
| **Permanent Amnesia (n = 216)** | 59.7% (129) | 14.4% (31) | 25.9% (56) |
| **Temporary Amnesia (n = 194)** | 54.1% (105) | 14.4% (28) | 31.4% (61) |
| **Positive Valence** |
| **Permanent Amnesia (n = 215)** | 24.2% (52) | 24.7% (53) | 51.2% (110) |
| **Temporary Amnesia (n = 182)** | 26.4% (48) | 25.8% (47) | 47.8% (87) |

Table 2 below summarises the descriptive data of people’s reported temporal preferences in each condition in experiment 1b.

*Table 2. Participants’ reported temporal preferences in Experiment 1b. Counts are shown in parentheses.*

|  |  |  |  |
| --- | --- | --- | --- |
| **Condition** | **Future-Bias** | **Past-Bias** | **Time-Neutral** |
| **Negative Valence** |
| **Permanent Amnesia (n = 205)** | 57.1% (117) | 17.6% (36) | 25.4% (52) |
| **Temporary Amnesia (n = 222)** | 44.6% (99) | 23.0% (51) | 32.4% (72) |
| **Positive Valence** |
| **Permanent Amnesia (n = 180)** | 18.9% (34) | 30.6% (55) | 50.6% (91) |
| **Temporary Amnesia (n = 237)** | 25.7% (61) | 30.0% (71) | 44.3% (105) |

To test whether there was any association between the type of amnesia present in negative conditions and valence, and people’s reported temporal preferences, we performed separate multinomial logistic regressions for experiments 1a and 1b.

Beginning with experiment 1a, the model including vignette valence and type of amnesia was significant, χ2(6, *N* = 410) = 88.513, *p* < .001. For future-biased preferences compared to time-neutral, only vignette valence was a significant predictor, Wald χ2(1) = 22.226, *p* < .001, OR = 3.120, 95%CI [1.944, 5.007]. In the negative valence condition, participants were much more likely to report being future biased than time neutral. In contrast, for past-biased preferences, compared to time-neutral, there was no significant effect of valence (*p* > .455).

Next, for experiment 1b, the model once again was significant, χ2(6, *N* = 427) = 81.412, *p* < .001. For future-biased preferences compared to time-neutral, the interaction between vignette valence and type of amnesia was a significant predictor, Wald χ2(1) = 7.386, *p* = .007, OR = 2.544, CI [1.297, 4.990], as well as the main effect of vignette valence, Wald χ2(1) = 14.873, *p* < .001, OR = 2.367, CI [1.528, 3.667]. As with experiment 1a, when valence was negative, participants were more likely to report being future biased than time neutral, but this was more so in the permanent amnesia condition. Further, just like experiment 1a, for past-biased preferences, compared to time-neutral, there were no significant effects (*p* > .625).

**4.2.** **Experiment 2a and 2b: Anticipation**

Once again, before presenting the data from experiments 2a and 2b, we will summarise our results with respect to each of our hypotheses. Our first hypothesis was that people in anticipation conditions (both thick and thin) would be more future-biased than people in no-anticipation conditions (H5). We found no evidence in favour of H5; in fact, people in the positive thick anticipation condition were observed to be more past-biased. Consequently, H6 (people in thick anticipation conditions will be more future-biased than people in thin anticipation conditions) was also not vindicated.

Table 3 below summarises the descriptive data of people’s reported temporal preferences in each condition in experiment 2a.

*Table 3. Participants’ reported temporal preferences in Experiment 2a. Counts are shown in parentheses.*

|  |  |  |  |
| --- | --- | --- | --- |
| **Condition** | **Future-Bias** | **Past-Bias** | **Time-Neutral** |
| **Negative Valence** |
| **No Anticipation (n = 194)** | 59.3% (115) | 14.9% (29) | 25.5% (50) |
| **Thick Anticipation (n =198)** | 61.6% (122) | 13.1% (26) | 25.3% (50) |
| **Positive Valence** |
| **No Anticipation (n = 177)** | 28.8% (51) | 20.3% (36) | 50.8% (90) |
| **Thick Anticipation (n = 195)** | 25.1% (49) | 40.5% (79) | 34.4% (67) |

Table 4 below summarises the descriptive data of people’s reported temporal preferences in each condition in experiment 2b.

*Table 4. Participants’ reported temporal preferences in Experiment 2b. Counts are shown in parentheses.*

|  |  |  |  |
| --- | --- | --- | --- |
| **Condition** | **Future-Bias** | **Past-Bias** | **Time-Neutral** |
| **Negative Valence** |
| **No Anticipation (n = 201)** | 58.7% (118) | 17.4% (35) | 23.9% (48) |
| **Thin Anticipation (n = 208)** | 53.8% (112) | 16.3% (34) | 29.8% (62) |
| **Positive Valence** |
| **No Anticipation (n = 186)** | 14.0% (26) | 33.9% (63) | 52.2% (97) |
| **Thin Anticipation (n = 195)** | 16.4% (32) | 35.4% (69) | 48.2% (94) |

First, to test whether there was any association between the type of anticipation and people’s reported temporal preferences, we performed separate multinomial logistic regressions for experiments 2a and 2b.

Beginning with experiment 2a, the model including vignette valence and type of anticipation was significant, χ2(6, *N* = 764) = 110.559, *p* < .001. For future-biased preferences, compared to time-neutral, vignette valence was a significant predictor, Wald χ2(1) = 22.851, *p* < .001, OR = 3.336, 95%CI [2.036, 5.468]. In negative valence conditions, participants were much more likely to report being future biased than time neutral. For past-biased preferences, compared to time-neutral, the interaction between type of anticipation and vignette valence was a significant predictor, Wald χ2(1) = 7.896, *p* = .005, OR = 3.288, CI [1.433, 7.542], as well as the main effect of vignette valence, Wald χ2(1) = 7.789, *p* = .005, OR = 0.441, CI [0.248, 0.784], and type of anticipation, Wald χ2(1) = 17.581, *p* < .001, OR = 0.339, CI [0.205, 0.562]. Participants in negative valence conditions were more likely to report being time neutral than past biased, regardless of type of anticipation. However, in positive valence conditions, participants were more likely to report being time neutral than past biased in the no anticipation condition and were more likely to report being past biased than time neutral in the thick anticipation condition.

Next, for experiment 2b, the model once again was significant, χ2(6, *N* = 790) = 153.641, *p* < .001. For future-biased preferences compared to time-neutral, vignette valence was a significant predictor, Wald χ2(1) = 41.605, *p* < .001, OR = 5.306, CI [3.196, 8.811]. Once again, in negative valence conditions, participants were much more likely to report being future biased than time neutral. In contrast, to experiment 2a, for past-biased preferences, compared to time-neutral, there were no significant effects (*p* > .273).

With our results thus reported, it is worth commenting on the fact that significant portions of the participants had time-neutral preferences in positive valence conditions across our two experiments.[[12]](#footnote-12) First and foremost, providing our participants with the option of indicating time neutrality as an alternative to the preferences they might indicate marks a notable difference between our study and that of Lee et al. (2022), in which participants indicated their preferences between dichotomous options. Given that having time-neutral preferences is clearly logically possible—and, as shown in our results, is a common preference—we think that our results are more likely to be representative of the patterns of people’s preferences over the temporal locations of hedonic events. Indeed, we think this is reason for future research to incorporate a time-neutral option as well.

Second, it might be thought that the presence of the time-neutral option introduces a new interpretive difficulty. For, while participants might have chosen this option because they were genuinely temporally neutral, some may have chosen the time-neutral option because they were hesitant to indicate a future- or past-biased preference. This may have been because they were unsure of how to respond, or because they simply failed to fully understand the vignettes and the questions that followed. While we cannot rule out the latter possibility, we find it unlikely. First, our vignettes were only slightly modified from those used in Lee et al.’s (2022) study, and also included a series of comprehension questions for all the vignettes used for quality control purposes. Second, more tellingly, across all the conditions in our studies, participants were not *uniformly* time neutral; instead, they were *more* time neutral in the positive valence than negative valence conditions (see Tables 1-4). One would not have expected to observe this pattern if the participants who chose the time-neutral option did so due to a lack of adequate comprehension.

**5. Discussion**

Our studies delivered three notable results. First, we replicated the results of several previous studies which found that (apparent) future bias is stronger for negative events than positive ones (Greene et al. 2022a, 2022b; Latham, Oh, Miller, Shpall & Yu 2023). Second, our results provide at best limited support for the memory/ anticipation disparity explanation of apparent future bias. That is because at best, we found limited support for the memory effect, and no support for the anticipation effect. As regards the former, we observed that people in the permanent amnesia condition were only more apparently future-biased in negatively valenced conditions, and only then in experiment 1b. As regards the latter, we simply found no effect at all.

**5.1 Memory and Anticipation Effects**

Consider, first, the anticipation effect. To our knowledge, our study is the first to explicitly test the anticipation effect as it relates to future-bias. We noted at the outset that if the (dis)utility associated with simulating future events were factored in people’s preferences over the temporal locations of hedonic events, this would tend to promote apparently future-biased preferences since the anticipation of positively-valenced events is itself a positively-valenced experience, and *mutatis mutandis* for anticipations of negatively-valenced events. That we found no evidence for the anticipation effect is thus noteworthy. This finding of null result, however, should be interpreted with caution.

To see this, recall that in Experiment 2, we found no evidence that people in anticipation conditions were more future -biased than people in no-anticipation conditions. This could be because there is no such effect. But there are several other potential explanations of these results.

First, it could be that the manipulations we employed to encourage/discourage anticipatory imagination were not as effective as they should have been. If this were the case, then it would be unsurprising that people in anticipation conditions were not more future-biased than those in no-anticipation conditions. Recall that we tried to manipulate the object of anticipation, and also the extent to which participants were explicitly instructed to imagine the future event, by introducing an uncertainty and temporal delay. With regard to the former, it could be that even when the participants in Experiment 2b were given vignettes describing a generically (un)pleasant taste, in their mental simulations they simply substituted it with a specific (un)pleasant taste familiar to them, possibly bringing the contents of their mental simulations much closer to those of the participants in Experiment 2a who saw vignettes describing bespoke specific (un)pleasant tastes. Second, we cannot point rule out the possibility that despite our explicit instructions embedded in the vignettes, our participants simulated the future hedonic events in a way that ignored the added uncertainty and temporal delay. Third, it could be that, given the novel and somewhat complex vignettes, participants failed to simulate the events in sufficient detail and vividness across both experiments for any of our manipulations to make a notable difference in the outputs of their anticipation. We take this to be an area where future research can be beneficial, and we see our work as taking a first pass at investigating the anticipation effect.[[13]](#footnote-13)

Next, consider the memory effect. Contrary to the findings of Lee at al. (2022) we found no robust evidence for the memory effect. Even when evidence of an effect of memory was observed it was only found in one study and then in the opposite direction to the direction hypothesised.[[14]](#footnote-14) This is striking since we used versions of their vignettes that were minimally modified so as to allow us to both replicate the effect for negatively valenced events and test it for positively valenced events. The fact that shifting from a painful injection to an unpleasant-tasting medicine yielded results showing no robust evidence for the memory effect suggests that either (a) whether there is such an effect is sensitive to the particular content of the negatively-valenced memory that participants in the temporary amnesia conditions will carry with them, or (b) the strength, and perhaps even existence, of the memory effect varies across individuals.[[15]](#footnote-15)

With respect to the former, one possibility is that not only is future-bias stronger with respect to negative than positive events, but also that it is correspondingly stronger the *worse* the event in question.[[16]](#footnote-16) That might explain why Lee et al. (2022) find such an effect, on the assumption that an injection is relevantly worse than an unpleasant tasting medicine. While interesting, we think this hypothesis unlikely. First, we know from prior studies that the prospect of unpleasant meals is sufficient to elicit strong future-bias (Greene et al. 2022a). We also know from prior studies that differences in the modality of the experience (smell, taste, touch, etc) have no effect on levels of future-bias (Latham, Miller, Shpall & Yu 2023). Even setting this aside though, even if future-bias is stronger when it comes to worse events, if future-bias is partially or entirely the product of the memory/anticipation disparity, we would still expect to see *some* memory effect when there is future-bias displayed, even if that preference is less strong.

A related suggestion, however, is that the memory effect may only manifest when the (dis)utility of the memory reaches a certain threshold of salience. Perhaps, for instance, the value of a memory is only factored into such preferences when its value is significant. This seems quite plausible. After all, we have a lot of memories, and most of them will have at least some very minor positive or negative valence. It may be that the very low utility or disutility associated with some memories, however, is simply not salient enough to be factored into preferences. Since arguably, at least, an injection is more negatively valenced than an unpleasant tasting medicine, it may be while the former reached that threshold for many people, the latter did not, and this explains why we attained different results than did Lee et al. (2022). It would be useful to perform follow up studies that probe whether there is more evidence of the memory effect when it comes to experiences that can be expected to lead to more saliently (dis)utilitous memories.

There are several ways to flesh out suggestion (b), that the strength, and perhaps even existence, of the memory effect varies across individuals. It could be that some individuals *value* memory more than others, and hence differently factor in the role of memory in forming preferences. It could also be that the threshold for when a memory is salient as regards its (dis)utility varies across individuals. Finally, it could be that differences in the degree to which people *revisit* their memories plays a role in the extent to which memory is factored into temporal preferences. If these differences across individuals are significant, then this could also explain different findings across different studies.

Indeed, such differences could also reinforce the differences we find in the extent to which people are future biased about positive versus negative events. Recall we noted earlier that the memory/anticipation disparity could explain why future bias is stronger for negatively valenced events than for positive ones; namely because people tend to remember negative events more than positive ones. In addition, when asked to recall an emotional event, people tend to report negative events more often than they report positive events (Robison-Riegler, Gregory & Winton 1996) and to more often forget positive emotional experiences than negative emotional experiences (Thomas & Diener 1990). Given this, if the value of a memory is part of what shapes people’s preferences, we would expect to find that people are more strongly negatively future biased given that they are more likely to remember a negative event than a positive one.

Finally, what about simulation-aided memory? Recall that we hypothesised (H4) that people will be more apparently future biased in the simulation-aided memory condition than in the non-simulation-aided memory condition. That is, when presented with a vignette naming their own most favourite or most disliked meal, people will be more likely to be future biased than when presented a vignette about a generic liked or disliked meal. We found no evidence in favour of H4. First, visual comparison of Table 1 and Table 2 shows that rates of apparent future-bias across the conditions that we tested remained remarkably consistent across Experiment 1a and Experiment 1b. Second, exploratorily rerunning analyses including Experiment as a factor found no effect of that factor on future bias. Perhaps this is unsurprising. People could be expected to be able to readily and reliably recall their most favourite and most disliked meal regardless of whether it is directly named by the vignette they are assigned. That is, if my most favourite food is lasagne, then perhaps there is no real great benefit to simulation performance that it be named in the vignette. Of course, having *my* most favourite food or most disliked food might convey a performance benefit in terms of response time, but being able to respond more rapidly is unlikely to affect people’s reported temporal preferences.

**5.2 The Explanation of Apparent Future Bias and its Normative Upshot**

Taken jointly, these results, in conjunction with those of prior studies, paint an interesting picture of the grounds of apparently future-biased preferences.

This picture suggests that the memory/anticipation disparity is likely not a *complete* explanation of future bias. Of course, this is not to say that it does not explain some people’s preferences on some occasions. So, it is worth thinking about what, if any, implications this view has for the normative status of future-bias. We noted earlier that one might think that insofar as future-bias is the product of the memory and anticipation effects, this would tend to confer rational justification on those preferences because it is rational to factor in the (dis)utility of memory and anticipation in forming preferences: this is simply to be sensitive to overall utility (Kahneman 1999). However, this is too swift. Suppose that the memory/anticipation disparity explains why people tend to be more strongly negatively future biased than positively so, and does so because people tend to attend more, and to have more affect directed towards, negative things than positive ones, and hence tend to direct more affect and attention towards negative memories than positive ones (thus influencing the memory effect) and tend to direct more affect and attention towards negative anticipations than positive ones (thus influencing the anticipation effect), and thus tend to be more strongly negatively than positively future biased. It is not at all obvious that this pattern is rationally permissible, since it is not clear that we are *justified* in attending to, and directing more affect towards (and so on) negative events compared to positive ones. So, it might still turn out that the way in which we factor in the utility of memory and anticipation is not one that grounds the resulting preferences being rationally permissible.

It is also worth noting that the extent to which the memory/anticipation disparity explanation is plausible depends on whether it is interpreted as the view that people *consciously* factor into their preference the positive/negative value of memories and anticipations. Interpreted in that manner, the view posits quite complex cognition. It requires that individuals form preferences by considering the value of the objects of the preference not just as direct experiences, but also indirectly re-experienced or pre-experienced as memories or anticipatory states. Thus, in this case, it requires that people consider, when forming their preferences, that some past event *will be remembered* by their later selves and, further, that if the event remembered is negative, the experience of remembering will be negative, and if it is positive, then the experience of remembering will be positive. The individual must then factor in the (dis)value of that memory over time and *mutatis mutandis* for anticipations.

Understood in this way, however, the explanation is not terribly congruent with developmental findings. Lee et al. (2020) found that children as young as four display apparently future-biased preferences when it comes to negative hedonic events.[[17]](#footnote-17) Yet it seems relatively unlikely that such children have the cognitive capacity to reason that past negative hedonic events will produce negatively-valenced memories whose experience is itself negative (and *mutatis mutandis* for negatively-valenced anticipations) and will then factor in those experiences in forming preferences over the temporal locations of events. So, it seems unlikely that interpreted as a claim about conscious reasoning, the memory/anticipation disparity explains the preferences of children at this age.[[18]](#footnote-18) Of course, this does not show that the memory/anticipation disparity does not explain some (or all) future bias in adults. It could be that there are different mechanisms subserving future-biased preferences in children compared to adults, although we might expect to find some continuity in this regard. But at a minimum, these results show that memory and anticipation effects are not the *only* factor in explaining future-bias.

However, an alternative interpretation of the memory/anticipation disparity explanation is that people are sensitive to the value/disvalue of memories, but that this is not via conscious reasoning (or at least, often or sometimes not). For instance, it could be that at least sometimes, this sensitivity is the product of sub-personal mechanisms. Conceived of in this way, it could be that the memory/anticipation disparity explains future bias in both young children and adults, but that it is grounded entirety in sub-personal processes in children, and is, perhaps, sometimes the product of conscious reflection in adults. We think that future research could profitably target the question of whether, insofar as memory and anticipation effects play a role here, they do so via conscious or unconscious processes.

So far, then, we think there is reason to doubt that the memory/anticipation disparity is a complete explanation of future-biased preferences. Equally, we think there is also reason to doubt that that emotion/attention asymmetry is a complete explanation of apparently future-biased preferences. Burns, McCormack, Jaroslawska, Fitzpatrick, McGourty, & Caruso (2019) found that the emotion asymmetry was displayed in children from six to seven onwards, while Lee et al. (2020) found apparently future-biased preferences regarding negative experiences in children as young as four years old. The fact that these four-year-olds only displayed apparent future-bias when it came to negative events is particularly interesting given robust evidence, including in our current studies, that adults display much more apparent future-bias with regard to negative than to positive events (Greene et al. 2022a, 2022b; Latham, Oh, Miller, Shpall & Yu 2023).

One appealing explanation of this data is that there is an additional factor at play in explaining these preferences. We have already suggested that this factor might be connected to the negativity bias. Negative events tend to draw more attention and affect than do positive ones. Thus, the asymmetry between positive and negative future-bias might reflect an interaction effect between (a) an asymmetry of attention/affect between past and future events and (b) an asymmetry of attention/affect between positive and negative events.

There may also be a further factor at play: temporal relief. Temporal relief is the distinctive relief that some event is over and done with (Hoerl 2015). Temporal relief is both temporally asymmetric and valence asymmetric: individuals are only temporally relieved when some event is past (but not future) and they are only temporally relieved when the event is negative (but not positive). Temporal relief might partly explain why people prefer negative events to be in the past rather than the future, since only when they are in the past can they produce temporal relief. If this is right, then we would expect apparent future-bias to be stronger when it comes to negative events than to positive ones, since negative events are impacted both by temporal relief and by the emotion/attention asymmetry, while positive events are only impacted by the emotion/attention asymmetry.

This might also explain why very young children only display negative apparent future-bias. If the mechanisms that ground temporal relief are distinct form the mechanisms that ground the emotion/attention asymmetry, then very young children might only experience temporal relief and not the emotion/attention asymmetry (as per Burns et al. 2019), thus explaining why they are only apparently *negatively* future-biased. Indeed, a recent study by Johnston, McCormack, Lorimer, Corbett, Beck, Hoerl, & Feeney (2024) found evidence that children as young as four years of age begin to make adult-like temporal relief judgments about how others feel at the cessation of negative events (see also Johnston, McCormack, Graham, Lorimer, Beck, Hoerl, & Feeney 2022). Interestingly, it was also found that children were less likely to make adult-like temporal disappointment judgments about how others feel at the cessation of positive events. To be clear, these results do not directly show that very young children themselves *experience* temporal relief, much less so that they form their preferences based on anticipated temporal relief. Nevertheless, the existing evidence is consistent with our suggestion that temporal relief may be a factor at play. Future research could profitably investigate the extent to which temporal relief explains future bias, both in adults and in children.

So, it may be that the emotion/attention asymmetry in combination with the negativity effect, in conjunction with temporal relief, at least partially explains people’s apparently future-biased preferences, and that the memory/anticipation disparity might *also* partially explain *some* such preferences.

A view in this vicinity has been suggested by Caruso, Latham & Miller (2024), though what they suggest (but do not defend) is that apparently future-biased preferences are the product of temporal relief and the temporal value asymmetry (the tendency to more highly value an event when it is past compared to when it is future). A related suggestion is made by Hoerl (2022), who suggests that apparent future-bias is an ‘amalgam’ of the temporal value asymmetry and temporal relief. Notably, though, on this basis Hoerl concludes that there is no unified phenomenon that is the tendency to prefer positive events to be in the future and negative ones in the past, which is measured by asking people their preferences in scenarios of the sort we present in this paper.

If so, what does this tell us about the normative status of these preferences? We noted in the introduction that, at least on the face of it, the emotion/asymmetry explanation does not seem to confer warrant on the resulting preferences. The mere fact that in imagining some event we *imagine* it as less emotionally arousing when we imagine it as having happened, as opposed to imagining it as going to happen, does not give us any reason to think that we *should* prefer to have that event located in the past if it is negative and in the future if it is positive. That would be so only if we had some reason to think that our emotional response was a good guide to some normatively relevant feature of the event when it is past compared to when it is present. But this explanation gives us no reason to think so. Rather, it seems that we are misled by our emotion/attentional systems into forming preferences that are not rational. After all, a pain is just as painful whether it is in the past or in the future. In addition, it is hard to see how the negativity effect could be rationally justified. If two events e and e\* have the same amount of (dis)utility, then it is hard to see why it would be rational for one of them to attract more affect and attention than the other. So, if future-bias is the product of the functioning of the interaction of the affect/attention asymmetry and negativity effect, then one might be inclined to think that it is not rationally permissible.

Perhaps, though, this is too swift. Even if the negativity effect is not rationally justified, perhaps the reason we are subject to the emotion/attention asymmetry is that this asymmetry is the product of some adaptive mechanisms that leave us better off, and if so, perhaps we should conclude that at least insofar as our preferences are the product of *that* asymmetry they are rationally justified. To see if that might be so, we need to think more about what explains the emotion/attention asymmetry and indeed, what explains temporal relief. Let’s begin with the former.

The emotion/attention asymmetry explanation has been argued to be the product of three more fundamental cognitive asymmetries: the control, direction, and uncertainty asymmetries (Ramos, Caruso, and Van Boven 2022). According to this view, future events seem to us to be approaching and hence to be *closer* (the direction asymmetry), to be more *controllable* (the control asymmetry), and to be less *certain* (the uncertainty asymmetry) than the same events located equidistant in the past, and this explains both why people *attend* more (the attention asymmetry) and have more *affect* directed at (the emotion asymmetry) future events compared to those equidistant past ones.[[19]](#footnote-19)

Here’s how the explanation goes. First, future events are less certain than past ones (the uncertainty asymmetry), and people tend to feel more affect towards uncertain states of affairs than more certain ones (Bar-Anan, Wilson, & Gilbert 2009; Wilson, Centerbar, Kermer & Gilbert 2005; Kurtz, Wilson & Gilbert 2007). Consequently, people will tend to direct more intense affect towards an event when it is imagined to be future compared to when it is imagined to be equidistant in the past, thus (partly) explaining the emotion asymmetry. Second, it is often supposed that it seems as though future events are moving closer, while past ones are moving further away. Since the affective system responds more strongly to stimuli that appear to be moving closer to the self (Mühlberger, Neumann, Wieser & Pauli 2008; Davis, Gross & Ochsner, 2011), that system will respond more strongly to events when they are future compared to when they are equidistant in the past because it will seem as though the future events are closer than the equidistant past events (Caruso, Van Boven, Chin & Ward 2013). Thus, the direction asymmetry also partly explains the emotion asymmetry. Finally, events over which we have control tend to elicit stronger emotional responses than those over which we lack control (Frijda 1986; Frijda, Kuipers & Ter Schure 1989; Lazarus 1991). Since we have more control over events when they are future compared to when they are past (the control asymmetry) people will direct more intense affect towards an event when it is future compared to when it is equidistant in the past.

The direction and control asymmetries also explain why we tend to direct more attention towards an event when it is future compared to past (the attention asymmetry). The direction asymmetry at least partly explains the attention asymmetry because people typically attend more to things that appear to be approaching (Löw, Lang, Smith, and Bradley 2008). So, if events appear to be approaching when they are future compared to past, then people will tend to attend to those events more when they are future compared to past. The control asymmetry also partly explains the attention asymmetry. Attention tends to be allocated towards stimuli that are relevant to attaining one’s goals (Aarts, Dijksterhuis & De Vries 2001; Dijksterhuis & Aarts 2010). Since people can causally influence an event when it is future but not when it is past, in order to attain their goals people will tend to attend to events when they are future compared to past (the attention asymmetry).

Then it might be argued that insofar as the emotion/attention asymmetry explains these preferences, they are justified because they are the product of mechanisms each of which is an evolutionary adaptation. We surely overall do *better* if we attend to future events over past ones. The gazelle that is as attentive to yesterday’s lion as tomorrow’s is more likely to get eaten than the gazelle that directs all (or most) of its attention towards tomorrow’s lion. Likewise, we overall do better if future events are more emotionally salient to us than are past ones. The gazelle that is as worried by yesterday’s lion as tomorrow’s is more likely to get eaten than the gazelle that is more worried by tomorrow’s lion than yesterday’s. We also overall do better if we are motivated to act with respect future events rather than past ones. That is, we do better if we are motivated to act in such a way that we bring about future events, rather than past ones. That is because of course, given the asymmetry of causation, our current actions (and indeed our future ones) can causally affect future outcomes, whereas those actions cannot causally affect past outcomes. Thus, we overall do better to be motivated to act in ways that are oriented towards the future rather than the past. The gazelle that attempts to bring it about that *yesterday*, a member of the gazelle herd was not taken by the lion, will tend to do worse than the gazelle that attempts to bring it about today, a member of the herd is not taken by the lion. In general, then, organisms prudentially *should* orient themselves towards the future. So, it seems plausible that the attention and emotion asymmetries are adaptations.[[20]](#footnote-20)

Having said that, even if these asymmetries are adaptations, it may not be that in our current environment, people who display those asymmetries overall do better in their lives (Sullivan 2018). After all, first, the environment in which those traits were selected for is somewhat different from our current environment (though, we think, likely not different in most ways that count), but more than that, even if these asymmetries of attention and affect are fitness enhancing, it hardly follows that they promote wellbeing (Miller 2024 also makes this point). So, insofar as we have reason to promote wellbeing, we may have reason not to have some traits that are fitness enhancing. Interestingly though, there is some recent empirical work that targets this issue. Caruso, Latham, Miller & Yu (ms) used a range of measures of happiness (as a proxy for wellbeing), and found that across several such measures, people who are future biased had higher levels of happiness (and did not have lower levels across any measures). They concluded that this association between wellbeing and future bias mostly likely was a function of an underlying association between asymmetries of attention/affect and wellbeing, on the one hand, and asymmetries of attention/affect and future-bias, on the other.

Even if we grant, however, that the attention/emotion asymmetries are adaptations and, not only that, but that having them in fact promotes wellbeing, it still does not (without a good deal of further argumentation) show that the resulting preferences are rational (Miller 2024). While it might be fitness enhancing for individuals to attend to future events over past ones, and to be more emotionally engaged with future events than with past ones, it does not follow that it is rational to prefer that negative events lie in the past not the future, and positive ones in the future nor the past; still less does it make it rational to prefer *more* negative events over *fewer*, so long as they are past, and *fewer* positive events to *more*, so long as they are in the future. Rather, it seems plausible that apparent future bias might be an unfortunate *by-product* of these mechanisms. To see this, notice that it is possible for an organism to attend more to future than past events, and to be more motivated by future events than past ones, and to feel more affect towards future events than past ones, without it being the case that the organism prefers a life with more disutility, so long as that disutility is in the past. Indeed, this would seem to be a by-product of these mechanisms that, in our environment, is not selected against simply because as a matter of fact we *cannot* causally influence the past, and so organisms cannot act so as to satisfy those preferences. If organisms could act so as to satisfy those preferences there would be evolutionary pressure against having such preferences, since having them satisfied would fail to maximise utility. Or so one might think. The general point here, is that even if we accept that directing attention and emotion in this way is rational, it does not follow that the resulting preferences we form as a causal consequence of this are rational. As we see it, then, the emotion/attention asymmetry explanation, if true, does not tend to justify apparently future-biased preferences.

What of temporal relief? Since temporal relief seems to be fitting, it might be argued that it tends to justify the preferences that it explains. Prior (1959) and Cockburn (1997, 1998), for instance, argue that temporal relief is fitting, and is rendered fitting by its being the case that the present moment is metaphysically special, and past events are past in some absolute, non-relational manner. That is what makes it fitting to be relieved that pains are over and done with. Whether the presence of a metaphysically special present would justify such preferences is, however, controversial (Yehezkel 2014; Miller 2021b, 2024, Fernandes 2021). The mere fact that some event is metaphysically absolutely past, as opposed to merely relationally past (i.e., in the past relative to the individual who is forming the preferences) does not obviously seem to make any difference to how that individual should value that event.

Another suggestion is that temporal relief itself might be adaptive. This, too, is controversial, largely because it is not obvious what sort of behaviours temporal relief could generate. Hoerl (2022) defends a view on which temporal relief is adaptive and has evolved to motivate us to put ourselves through unpleasant experiences by exploiting the motivating power of anticipation. His idea is that there are plenty of unpleasant experiences such that undergoing those experiences makes one better off in the longer term, at the cost of short-term discomfort. Some motivation is required to undergo that current discomfort. Hoerl hypothesises that the fact that you can *anticipate* being *relieved* that the negative event is over, can act as a motivation for undergoing the negative event, and this explains why we evolved to experience temporal relief.

This is not the place to evaluate that account. However, even if it is adaptive to feel temporal relief, it does not follow that apparently future-biased preferences are rational, for roughly the same sorts of reasons we adduced earlier. In general, it does not follow from the fact that some mechanism is an adaptation, that all the behaviours/preferences it generates are prudentially rational. It may be that temporal relief motivates us to schedule unpleasant events. And that may indeed be fitness-enhancing. But it does not follow that preferring more disutility, so as long it is past, is rational simply because it’s the causal product of temporal relief. Again, it seems plausible that even if temporal relief is adaptive for the reasons that Hoerl gives, it is an unfortunate consequence of this relief that it promotes apparently future-biased preferences, and especially strong future-biased preferences when it comes to negative events. These preferences might be best thought of as spandrels, whose existence is explained by the functioning of some adaptive mechanisms, but which are not themselves adaptive. While if we could act on them, there would be evolutionary pressure brought to bear to eliminate them, these spandrels are retained only because they cannot be acted on, and thus are not subject to evolutionary pressure.

At the very least, we think, those wishing to argue that apparently future-biased preferences are rational because they are the product of adaptive mechanisms need to say much more to show why this conclusion follows in this instance.

**5 Conclusion**

Our results are important for two reasons. First, they suggest that the memory/anticipation disparity is likely not a complete explanation of apparently future-biased preferences. In turn, this is important for evaluating the normative status of those preferences, since if that disparity were a complete explanation, it would tend to justify the resulting preferences. Second, our results, taken in conjunction with prior research, suggest that insofar as the emotion/attention asymmetry is an explanation for these preferences, it too is likely at best a partial one. We have suggested that temporal relief likely also plays a role here. In all then, the resulting picture of future bias may be quite complicated, with all of the aforementioned playing a role in explaining future-biased preferences at least some of the time. Given this picture of the likely explanation for these preferences, it does not seem that appealing to what explains such preferences will tend to confer justification on those preferences.

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1. Lee, Shardlow, O'Connor, Hotson, Hotson, Hoerl & McCormack 2020, Greene, Latham, Miller & Norton 2021, 2022a, 2022b; Latham, Miller & Norton 2023, Latham, Miller, Norton & Tarsney 2020; Latham, Miller, Tarsney & Tierney 2021a, 2021b; Latham, Oh, Miller, Shpall & Yu 2023; Greene, Latham, Miller & Nielsen 2024; Baron, Everett, Latham, Miller, Tierney & Oh 2023. [↑](#footnote-ref-1)
2. For some discussion of differences between these studies see Greene, Latham, Miller, Norton, Tarsney & Tierney (2022). [↑](#footnote-ref-2)
3. Here we present the memory and anticipation effects in intentionally preliminary and general terms. Our claim is that, all else equal, the memory effect and the anticipation effects will tend to promote apparent past bias and apparent future bias, respectively. Here we leave open many nuanced and interesting questions regarding, e.g., whether these effects are best understood at the level of conscious deliberation or sub-personal psychological processes, and how, if at all, these effects are modulated by other psychological factors. We return to some of these questions and their normative significance in §4. [↑](#footnote-ref-3)
4. As our focus is on adult preferences and not on the development of these preferences, for concision we will set aside the results of the studies conducted on children. [↑](#footnote-ref-4)
5. This is a read-only page for the purposes of anonymous review, which will be replaced by the full link which includes preregistration details, once the paper is no longer under review. [↑](#footnote-ref-5)
6. Participants are paid according to estimated study completion time. [↑](#footnote-ref-6)
7. We used G\*Power to conduct a power analysis. For experiment 1a, with a sample size of 807 we have .84 power to detect a small effect size at .05 alpha error probability. For experiment 1b, with a sample size of 844 we have .86 power to detect a small effect size at .05 alpha error probability. [↑](#footnote-ref-7)
8. Which was not originally listed in the OSF documents. [↑](#footnote-ref-8)
9. Participants are paid according to estimated study completion time. [↑](#footnote-ref-9)
10. We used G\*Power to conduct a power analysis. For experiment 2a, with a sample size of 764 we have .82 power to detect a small effect size at .05 alpha error probability. For experiment 2b, with a sample size of 790 we have .84 power to detect a small effect size at .05 alpha error probability. [↑](#footnote-ref-10)
11. Unlike the other conditions, the Positive Thick Anticipation Condition did not specify anything about there being a persisting aftertaste. That is, participants were only told “Each [treatment] involves being given a medication which tasks like your most like food.” [↑](#footnote-ref-11)
12. We thank an anonymous reviewer for pushing us to speak on this issue. [↑](#footnote-ref-12)
13. Another suggestion, due to a reviewer, is that at least in experiment 2a and 2b, participants might have read the vignette as implying that if the medication was to be administered in a week, they would need to remain in hospital for that week. Then they would not be comparing 10 past medications with one future one, but 10 past medications to one future one, plus a week-long stay in hospital. While we think it unlikely that people interpreted the vignette in this way (it’s not usual to need to remain in hospital to take a pill) this could also have affected the results. [↑](#footnote-ref-13)
14. So too regarding the effect of anticipation. However, it is possible that in this case it might be an artifact of the Positive Thick Anticipation condition not specifying anything about the length of the aftertaste of the medicine. Given that the comprehension questions mention the length as being 20 minutes, some people may have inferred that the after taste is of that length, and this inference might explain the different results in this condition. [↑](#footnote-ref-14)
15. An anonymous reviewer suggests that another—not necessarily competing—explanation for the discrepancy between our results and those of Lee et al.’s (2022) regarding the memory effect has to do with the fact that our study provided participants with the additional time-neutral option. This is certainly possible, but it needs to be considered in conjunction with our suggestion made at the end of §4 that there may be good methodological reason to provide participants with such an option. As we note there, we see no real reason to think that providing this option increases confusion, rather than allowing people to express the preferences that they in fact have. [↑](#footnote-ref-15)
16. With thanks to an anonymous referee for suggesting this. [↑](#footnote-ref-16)
17. Although very young children also preferred pleasures to be in the past. [↑](#footnote-ref-17)
18. We note that since reflecting on one’s preferences *is* a deliberate, conscious process, once adults’ preferences are formed, it is not surprising for them to subsequently report, if enquired, that their reasoning has to do with the (dis)utility of memory and anticipatory states, especially when the relevance of these states is made salient. This is not to say, however, that post-hoc introspection-based reports are accurate representations of how the preferences are formed in the first place. [↑](#footnote-ref-18)
19. There is a broader emotion asymmetry, which refers to the fact that we direct different emotions towards events depend on whether they are past or future. For instance, we feel relief that something is over, only if it is past, and anticipation only if it is future. Such emotions are often known as tensed emotions. For present purposes, the emotion asymmetry we have in mind only refers to the asymmetry in affect. [↑](#footnote-ref-19)
20. Suhler & Callender (2012), Mclaurin & Dyke (2002) and Horwich (1987) make similar points, as does Miller (2024). [↑](#footnote-ref-20)