



Resisting temptation and overcoming procrastination: The roles of mental time travel and metacognition

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Abstract

We tend to seek immediate gratification at the expense of long-term reward. In fact, the more distant a reward is from the present moment—the more we tend to discount it. This phenomenon is known as temporal discounting. Engaging in mental time travel plausibly enables subjects to overcome temporal discounting, but it is unclear how, exactly, it does so. In this paper, we develop a framework designed to explain the effects of mental time travel on temporal discounting by showing how the subject's temporally extended self enables mental time travel to generate appropriate emotions that, in turn, via metacognitive monitoring and control, generate appropriate behaviours. Building on existing approaches we outline an initial framework, involving the concepts of emotion and the temporally extended self, to explain the effects of mental time travel on resisting temptation. We then show that this initial framework has difficulty explaining the effects of mental time travel on a closely related phenomenon, namely, overcoming procrastination. We next argue that, in order to explain these effects, the concept of emotion needs to be refined, and the concept of metacognition needs to be added to the framework: emotions involve an action-readiness component, which, through metacognitive monitoring and control, can enable the subject to resist temptation and overcome procrastination. Finally, we respond to an objection to our account—based on the somatic marker hypothesis—such that metacognition is not necessary to account for the role of emotions in decision-making.

Keywords Mental time travel · Self-control · Temporal discounting · Temporally extended self · Metacognition

1 Introduction

Facing temptations such as eating a delicious piece of cake over dieting, one has to make *intertemporal choices*, that is, choices whose consequences play out over time (Berns et al., 2007). Typically, the choice is between getting or not an immediate pleasant reward that may lead to an undesired future outcome. *Resisting temptation* is a matter of forgoing an immediate pleasant reward (e.g., enjoying the cake) to avoid an undesired future outcome (e.g., putting on weight). When one succeeds in resisting temptation, one exercises *self-control*, which we will define, for the purposes of this paper, as the capacity to refrain from acting in accordance with an occurrent dominant impulse by focusing on one's long-term interests (see Cosentino 2020, for a more extended discussion).

Imagine, for example, that you are tempted to buy an expensive treat for yourself while considering other incoming expenses, such as the plumber's bill or a birthday gift for your father. Sometimes, of course, one fails to give due weight to the upcoming expenses and ends up buying the treat. There is, indeed, a natural tendency to devalue future rewards according to their temporal distance. Known as *temporal discounting* (Ainslie, 2001, 2005; Strotz, 1956), this tendency is associated with impulsivity and lack of self-control but can be counteracted in a number of ways. When faced with temptation, one might, for example, attempt to "cool down" by counting to ten, or one might rely on willpower to force oneself to perform a given action. Though relatively economical, these strategies are not always effective, and more effortful strategies are sometimes required in order to counteract impulsivity and achieve an acceptable level of self-control (Ainslie, 1975, 1992; Rachlin, 1974).

One such strategy depends crucially on *mental time travel*—the capacity to imaginatively project oneself into possible past and future scenarios (Michaelian, 2016; Sant'Anna, 2018; Suddendorf & Corballis, 1997, 2007). The capacity to project oneself into past scenarios can be identified with *episodic memory* (Tulving, 1972), while the capacity to project oneself into future scenarios is usually referred to as *episodic future thought* or *prospection* (Atance & O'Neill, 2001). Although episodic memory and episodic future thought have often been treated as sharply distinct, evidence suggesting that they are in fact two aspects of a single, unified capacity has accumulated from behavioural, developmental, phenomenological, neuropsychological, and neuroimaging studies (see Schacter et al., 2012 for a review of the empirical literature). Our focus in this paper is on episodic future thought. The idea that we want to explore is that, by imaginatively projecting oneself into the future, one is able to "pre-experience" the possible future consequences of one's present choices; this increases the salience of the consequences in question, increasing their perceived value and, thus, the probability of resisting the temptation of opting for an immediate reward. The idea that mental time travel plays a role in enabling us to overcome temporal discounting and exercise self-control has been suggested before (Boyer, 2008; Cosentino, 2020; Kennett & Matthews, 2009; McCarroll & Cosentino, 2020); the novelty of our paper lies in the fact that it asks, *how*, exactly, mental time travel might play this role.

In Sect. 2, we review existing approaches and merge them into an initial framework that invokes, in order to explain the effects of mental time travel on resisting

temptation, the concepts of emotion and the temporally extended self. In Sect. 3, we show that this initial framework has difficulty explaining the effects of mental time travel on a closely related phenomenon, namely, overcoming procrastination. In Sect. 4, we argue that, in order to explain these effects, the concept of emotion needs to be refined, accounting for its multidimensionality, and the concept of metacognition needs to be added to the framework to explain how motivation is managed while simulating future scenarios. In Sect. 5, we respond to an objection to the resulting revised framework.

2 Mental time travel and resisting temptation: the state of the art

There is ample evidence that mental time travel can help to counteract temporal discounting (e.g., Peters & Büchel 2010; Benoit et al., 2011; Liu et al., 2013). In a review paper, Scholten and colleagues (2019) note that twenty out of the 24 experiments (83%) employing an episodic future thinking manipulation confirmed the expected reductions in delay discounting in the episodic future thinking manipulation compared with the control condition. We nevertheless want, before attempting to answer the question of how engaging in episodic future thought might enable one to resist temptation, to address an important inconsistency in the empirical literature. The inconsistency in question derives from studies involving patients affected by episodic amnesia. Despite their deficit to engage in mental time travel,¹ they seem to be able to systematically give weight to the value of future rewards in line with control subjects, thus suggesting that other strategies beyond mental time travel are possible to make decisions about the future.

The idea that episodic prospection tends to counteract temporal discounting supports the prediction that amnesic patients will manifest different discounting rates than unimpaired subjects.² Kwan et al., (2012), however, found that, when tested

¹ Such patients are impaired both in their capacity to remember the events of their personal pasts and in their capacity to imagine the events of their personal futures (e.g., Andelman et al., 2010; Kwan et al., 2010, 2013; Race et al., 2013; Tulving, 1985; but see Hurley et al., 2011; Squire et al., 2010, reviewed in Rosenbaum et al., 2014). This impairment is specific to events of a personal nature, and the patients' capacity to imagine generic future events (e.g., events involving public figures) appears to be intact (Klein et al., 2002); Szpunar et al., (2014, 2016) have developed a taxonomy of forms of future thought that distinguishes between episodic and semantic forms of prospection. Episodic prospection concerns specific autobiographical events (e.g., a meeting that one plans to attend next week), whereas semantic prospection concerns general or abstract states of the world (e.g., an upcoming election). The dissociation in amnesic patients between personal and impersonal future thought is consistent with this taxonomy.

² As noted by Kwan and colleagues, the specific prediction that one makes regarding the behaviour of amnesic patients in intertemporal choice situations will depend on one's underlying hypothesis about which aspects of future events are imagined. Boyer (2008) has hypothesized that mental time travel enables the subject to imagine future *rewards*, in which case it should counteract temporal discounting and increase the tendency to choose future rewards. Luhmann and colleagues (Luhmann, 2009; Luhmann et al., 2008), in contrast, have argued that mental time travel enables the subject to anticipate the *unpleasantness* of waiting for future rewards, in which case engaging in mental time travel should bias one towards choosing immediate rewards. Given Boyer's view, amnesic patients, being unable to imagine future experiences, should consistently choose the immediate reward. Given Luhmann and colleagues' view, amnesic patients should consistently choose the future reward. Either way, however, they

using a standard discounting task involving hypothetical monetary rewards, K.C., a much-studied amnesic patient, systematically discounted the value of future rewards in a way that did not differ significantly from control subjects (see also Kwan et al., 2013).

In a further study of six amnesic individuals, Kwan et al., (2015) replicated this finding and extended it using a version of the task in which subjects were cued to imagine personal events temporally contiguous with the receipt of delayed rewards. This cueing procedure has been demonstrated to reduce discounting in healthy individuals, suggesting that mental time travel is involved in intertemporal choice in such individuals (Benoit et al., 2011; Peters & Büchel, 2010). Despite their impaired capacity for mental time travel, the same effect was, surprisingly, found in Kwan et al.'s amnesic subjects. Kwan and colleagues interpreted these results as suggesting that mental time travel is not necessary for the cueing effect and that other strategies—based, for example, on semantic prospection relying on generic event schemas or scripts—may suffice to enable amnesics to make decisions about the future similar to those made by healthy individuals despite their inability to produce detailed event simulations.³ This interpretation is consistent with a multiple systems approach to intertemporal choice according to which mental time travel may be just one among several systems underlying future-oriented decision-making and may thus not be necessary for such decision-making (Peters & Büchel, 2011).

The literature on the cueing effect in amnesics, however, contains a number of discrepancies and further research is required to establish whether alternative strategies can indeed obviate the need for prospection in temporal discounting tasks.⁴ Future research will also need to consider potential effects of the type of reward used.⁵ Consistent with a multiple systems approach, we argue that mental time travel is more

should adopt a non-temporal decision-making strategy; that is, delay should not have a systematic effect on their choices.

³ Bechara et al., (2000) review evidence for the somatic marker hypothesis and suggest that emotions may support decision-making without the need of forming any explicit concept of risky choices. This hypothesis is consistent with the idea that emotions may support future decision-making without engaging in mental time travel. We discuss further the somatic marker hypothesis in Sect. 5.

⁴ Palombo et al., (2015), for example, found that cueing amnesic patients to imagine future events did *not* attenuate temporal discounting. The discrepancy between this study and that carried out by Kwan and colleagues may be due to the fact that they employed different cueing procedures. In Kwan and colleagues' study, subjects generated their own cues (e.g., the subject's fortieth wedding anniversary), which might refer to existing plans, and they were not asked to imagine doing anything specific in the given scenario. In Palombo and colleagues' study, in contrast, subjects were required to imagine future events based on cues drawn from a set of standard scenarios (e.g., attending a street fair, going to a bar). It may be that these different types of cue activated different processes, facilitating the use of alternative strategies not based on subjects' compromised prospection ability in the former study but not the latter.

⁵ In Kwan and colleagues' studies, the delay discounting tasks involved hypothetical monetary rewards. It may be that mental time travel plays no role in this specific type of intertemporal choice; in choices involving relatively small monetary rewards, a purely economic strategy may be sufficient. There is evidence for this suggestion in the literature. Kwan et al., (2013) tell us that one subject with episodic amnesia, D.A., demonstrated temporal discounting rates that were in line with those of healthy controls. Interestingly, D.A. "reported using a strictly economic strategy, specifically estimating inflation and interest rates, but did not expand on how he made his calculations. This strategy capitalized on his pre-morbid professional background and did not require episodic thought. He did not spontaneously engage in episodic considerations for spending" (2013: 1362).

likely to be necessary in types of intertemporal choice in which the perceived value of the future reward depends on how vividly it is anticipated (e.g., obtaining a promotion, living in a nice house). We will assume in what follows that episodic future thought does indeed contribute, at least in cases of this sort, to self-control. We turn now to the question of exactly how it does so.

Kennett & Matthews (2009) suggest that episodic future thought grounds a self-regulatory strategy that enables the subject to overcome temporal discounting. The strategy amounts to exercising attentional control in tempting situations. Relying on the work of Ayduk & Mischel (2002, 2004) and MacCoon et al., (2004), Kennett and Matthews argue that, in order to resist temptation and delay gratification, the subject diverts her attention from the tempting features of the present item, redirecting it towards the potential negative consequences of her actions. The subject is thus supposed to voluntarily manipulate her own motivational state via attentional control by representing a decision situation as one that requires her to resist temptation.

An important limitation of Kennett and Matthews' proposal is that it does not account for instances of self-control in which the agent is unaware that the situation calls for her to control her desires. Suppose, for example, that a friend invites you out for a drink. You are tempted to accept her invitation but equally tempted to go home and relax after a long working day. In this situation, you are unable to adopt an intentional strategy for resisting temptation, simply because you have not yet determined what is best for you. In this situation, one must first decide what to do; only then can one attempt to manipulate one's internal state in order to enhance one's motivation to perform the behaviour that one judges to be best. Clarifying how one decides which behaviour is best seems necessary for any valid account of self-control.

Boyer (2008) has suggested that simulating possible future scenarios aids the subject in weighing her options and that the *emotions* generated by simulating these scenarios guides her final decision. He has argued that mental time travel allows one not only to simulate possible future events but also to "pre-experience" such events by activating emotion circuitry in addition to visual and auditory imagery.⁶ Simulation of future events can thus produce immediate hedonic effects: as one considers a prospective course of action, emotions associated with imagined future events constitute an immediate counter-reward that offsets the effects of temporal discounting. For example, eating a piece of cake now might be tempting because the positive consequences are immediate, whereas the negative consequences are situated in the future and thus are time-discounted; negative emotions associated with imagined future events (e.g., not being able to wear a certain outfit for a party) give them greater motivational force, allowing one to put a brake on one's impulsiveness (cf. Liu et al., 2013).

This proposal moves beyond traditional models of decision-making, which align with the common view on which a hot, emotional, "go" system triggers impulsive behaviours, while a cool, cognitive, "know" system generates strategic behaviours (Loewenstein, 1996). An important feature of the proposal is that it emphasizes that emotions can be triggered by one's imagined future circumstances and can thus play a role in generating strategic behaviours.

⁶ See Sect. 5 for further discussion on the role of emotions.

The question arises, however, of *why* one is emotionally moved by imagined future outcomes. Given that the future is uncertain, temporal discounting might be seen as a component of a rational strategy, a strategy according to which one ought to try to secure goods that are immediately available rather than waiting to obtain potentially larger but also more uncertain delayed rewards, even if doing so might in principle maximize benefits in the longer term (Stevens & Stephens, 2008). It is by no means obvious why imagining future events should be capable of activating emotions and thus counteracting the tendency to act in accordance with this strategy. Though Boyer's framework is a valid starting point, in order to address this question, another component must be added to the framework: the temporally extended self.

The concept of the *temporally extended self* is meant to account for the fact that each of us experiences herself as the same, diachronically continuous subject through time, despite changes to her body, thoughts, desires, personality, and behaviour (Cosentino, 2011). Having a temporally extended self enables one to understand that a present state or experience of the self is causally connected to a *past* state or experience of the same self (McCormack & Hoerl, 2007; see Povinelli et al., 1999 for a developmental perspective). Similarly, having a temporally extended self enables one to understand that the *future* self is a direct extension of the present self. The temporally extended self thus enables the subject to appreciate the link between her current choices and her future circumstances.

Cosentino (2020) has suggested that episodic future thought can counteract temporal discounting because it allows one to identify with one's future self and thus to take this imagined future self's goals as one's own (see also Crippen 2018; Crippen & Schulkin, 2020 for an empirically-informed discussion of this philosophical point). Only given this identification does it make sense to sacrifice the immediate gratification of one's current needs in order to avoid undesired future outcomes. In line with Boyer's account, Cosentino (2020) has maintained that, because emotions triggered by simulated future scenarios constitute a counter-reward that offsets the effects of temporal discounting, voluntary control over one's motivational state, while it can occur, is not required for the exercise of self-control. However, she has also added a further component to the model, namely, the temporally extended self, by means of which the outcomes experienced by the future self are connected to the present self and thus generate emotions, enabling them to be perceived as relevant to the subject's current decisions.

Based on the arguments above, we consider an initial framework meant to apply specifically to situations in which a subject must refrain from an immediate pleasant action in order to avoid an undesired future outcome. In such situations, roughly the following sequence takes place. One imagines a future outcome, connects that outcome, via the temporally extended self, to the present self, and thus experiences appropriate negative emotions. If all of these steps are executed, the imagined future outcome acquires stronger motivational force and can guide present actions.

As an illustration, consider again the case of wanting to buy yourself an expensive treat. When you are tempted to enter the shop, you imagine the future consequences of your action, such as not having enough money to buy a birthday present for your father. Thanks to the temporally extended self, this elicits negative emotions appropriate to that outcome, perhaps guilt or shame over your selfishness. As a result, you

refrain from buying the treat now in order to avoid the negative consequences that you would face in the future if you were to succumb to impulsivity.⁷

We consider this initial framework to be a plausible account of the relationship between mental time travel and self-control insofar as it provides an accurate description of cases in which the subject must refrain from a pleasant action in order to avoid negative future consequences. However, there may be cases that cannot be accounted for within the framework as it stands. The next section deals with a puzzle that derives from this framework, which, we suggest, requires integrating the initial framework.

3 Mental time travel and overcoming procrastination: a puzzle

Our focus so far has been on self-control as it manifests itself in the form of the capacity to *resist temptation*. But mental time travel and the temporally extended self may also play important roles in a distinct form of self-control, namely, *overcoming procrastination*. While resisting temptation and overcoming procrastination are clearly closely related, we will argue in this section that there are differences between them and that these differences give rise to a puzzle. In brief: if, in order to overcome procrastination, the subject imagines a desired future outcome and therefore experiences a positive emotion appropriate to the outcome, it seems that doing so should reduce rather than increase her motivation to perform the relevant action. We will argue in the next section that this puzzle requires us to modify the framework introduced in the previous section.

The phenomenon of overcoming procrastination is familiar from everyday life. A student would prefer to go out with friends tonight and is inclined to put off until tomorrow the tedious task of studying for next week's exam; somehow, she is able to muster up the willpower to stay in and study. Following a New Year's resolution to start working out, a would-be exerciser would prefer to continue in her old routine and is inclined to put off until later her first trip to the gym, which she expects to be thoroughly painful; somehow, she is nevertheless able to bring herself to go to the gym today. And so on in other familiar cases: despite preferring to put an unpleasant task off until later, we manage to perform it now.

⁷ Because there are multiple points at which things might go wrong with this process, the framework based on the role of emotions and the temporally extended self generates predictions about how and why failures of self-control might occur. First, the subject might be incapable of imagining the potential consequences of her actions. Patients known as H.M. (Scoville & Milner, 1957) and D.B. (Klein et al., 2002), for example, are unable to imaginatively project themselves into potential personal futures. Second, the subject might fail to identify her present with her future self. Although this sort of failure may be more difficult to document, an example is arguably provided by patients described by Klein (2014, 2015), who, despite being able to mentally travel in time, do not experience the past and future events that they represent as belonging to themselves. Third, a subject might be capable of imagining the consequences of her actions but fail to experience the appropriate emotional response to the imagined consequences. That this is possible is suggested by models of psychopathy, which have focused on deficits in emotion processing, emphasizing, in particular, the inability of psychopathic individuals to experience negative emotions (Patrick, 2007). These paths to failure suggest ways of testing the framework and might be used to guide empirical research on this topic.

While familiar, overcoming procrastination is not, of course, nearly as familiar as most of us might wish. Some have attempted to view procrastination in a positive light (Perry, 2012), but the conventional view is certainly that procrastination is thoroughly negative—both for those affected by the procrastinator’s actions (or rather her inaction) and for the procrastinator herself. Procrastination often occurs with respect to important goals such as health (Sirois, 2004; Stead et al., 2010) and education (Schouwenburg et al., 2004). Procrastination also appears to be extremely widespread (Steel, 2007), with 15–25% of adults being chronically affected (Harriott & Ferrari, 1996; Ferrari et al., 2007) and, while there may be differences in rates of procrastination among different populations (e.g., Steel & Ferrari 2013), virtually everyone is guilty of it at least occasionally (see Steel 2007 and Klingsieck 2013 for reviews). This should come as no surprise: as Ainslie remarks, “it always feels better to defer costs” (2010: 12; cf. Tice & Bratslavsky, 2000).⁸ The question that concerns us here is thus not why procrastination often occurs (see Ainslie 2001; Steel & König, 2006; Steel, 2007 for general theoretical models); it is, rather, why sometimes it does not. Given that it does indeed always feel better to defer costs—to study tomorrow, to start going to the gym next week—how do we manage to overcome procrastination, when we do manage to do so?

In intuitive terms, the structure of the cases of resisting temptation discussed above appears to be inverted in cases of overcoming procrastination. In cases of resisting temptation, one must overcome a desire to perform a pleasant action in the present (e.g., buying an expensive treat) in order to avoid obtaining an undesired outcome in the future (not having sufficient funds for one’s father’s birthday present). In cases of overcoming procrastination, in contrast, one must overcome a desire not to perform an unpleasant action in the present (e.g., studying for an exam) in order to obtain a desired outcome in the future (passing the exam). A natural hypothesis is thus that the mechanism identified in the previous section—one imagines a future outcome, attributes the outcome to the future self, who is connected and identified with the present self via the temporally extended self, and experiences negative emotions appropriate to the imagined future outcome—as providing a pathway to resisting temptation can, with minor modifications, likewise provide a pathway to overcoming procrastination.

We might suspect, in fact, that it can provide such a pathway even without modification, for cases of overcoming procrastination can also be viewed as having precisely the same structure as cases of resisting temptation. Consider the case of the student faced with the task of studying for her exam. We described this as a case in which the subject must overcome a desire not to perform an unpleasant task in the present in order to obtain a desired outcome in the future. But it might just as well be described as a case in which the subject must overcome a desire to perform a pleasant task in the present (*not* studying for the exam, i.e., doing something other than

⁸ One might object that the costs of not procrastinating (e.g., the loss of the minor pleasure that one would obtain by watching a television programme rather than competing an important work-related task) are often low, whereas the costs of procrastinating (e.g., the pain entailed by the harm done to one’s career by one’s failure to complete the important task) are often high. The point, however, is that it feels better to defer costs *at the time at which they are deferred*. As one chooses whether to complete the work-related task or, instead, to watch the television programme, the choice that one faces is between accepting the pain of doing the task now or deferring it to a later date.

studying) in order to avoid obtaining an undesired outcome in the future (*not* passing the exam, i.e., failing). Similarly, resisting temptation might be seen as requiring the subject to overcome a desire not to perform an unpleasant task in the present (refraining from buying an expensive treat) in order to obtain a desired outcome in the future (having sufficient funds for her father's birthday present).

However, while resisting temptation and overcoming procrastination may indeed be equivalent from a formal point of view, they are not necessarily equivalent from a subjective point of view. From the point of view of the subject who attempts to exercise self-control, it is one thing to imagine a negative outcome and to try to bring oneself to refrain from performing an action that would bring that outcome about; it is another thing to imagine a positive outcome and to try to bring oneself to perform an action that would bring that outcome about. Thus the fact that the subject represents a given decision situation as one that requires her to overcome procrastination, as opposed to resisting temptation, may have an impact on her behaviour.

This is a special case of a general point made by Berns et al.:

Economic analysis assumes that how a choice is represented is an objective matter. But, in fact, it is possible to mentally represent the same situation in a variety of different ways. People use a wide range of choice heuristics to make the decisions they face and which heuristics come into play depends crucially on how they construe these decisions. As a result, differences in context or in the way that a decision is "framed" or cognitively construed can have an impact on the intertemporal tradeoffs that people make. (2007: 485)

It need not be the case that instances of resisting temptation only involve representing the link between a present pleasant action and a future negative outcome and that instances of overcoming procrastination only involve representing the link between a present unpleasant action and a future positive outcome; the difference might, instead, be one of framing—emphasis or focus. Both in cases of resisting temptation and in cases of overcoming procrastination, the subject has a choice between, first, performing a pleasant action now and obtaining a negative outcome in the future and, second, performing an unpleasant action now and obtaining a positive outcome in the future. Plausibly, in cases of resisting temptation, the subject represents the link between the pleasant present action (e.g., buying an expensive treat) and the negative future outcome (not having sufficient funds) and therefore performs the unpleasant present action (not buying the treat), thereby obtaining the positive future outcome (having sufficient funds); the link between the unpleasant present action (not buying the treat) and the positive future outcome (having sufficient funds) is represented but not in focus. In cases of overcoming procrastination, in contrast, the subject represents the link between the unpleasant present action (studying) and the positive future outcome (passing) and therefore performs the unpleasant present action (studying), thereby obtaining the positive future outcome (passing); the link between the pleasant present action (not studying) and the negative future outcome (failing) is represented but not in focus.

Thus, resisting temptation and overcoming procrastination may require the subject to deviate from standard patterns of temporal discounting in similar ways, but

a somewhat different mechanism may be at work in each case. Two possibilities are particularly salient here. First, simulations of positive future events appear to be better remembered than simulations of negative future events (Szpunar et al., 2012), which may affect behaviour when ongoing (as opposed to one-off) self-control is required. Second—and this is the possibility that will be of concern to us here—the valence of the emotion that is produced by imagining a positive future outcome differs from that produced by imagining a negative future outcome and thus may have a different impact on the subject’s motivation to act in the present.

While most definitions of procrastination tend to emphasize a negative rather than a positive future outcome, this is arguably because they are framed from a third-person perspective rather than a first-person perspective. Steel (2007: 66), for example, says that “to procrastinate is to voluntarily delay an intended course of action despite expecting to be worse off for the delay”. Similarly, Wieber & Gollwitzer (2010: 185) define procrastination as follows: “A person has to (1) commit to the goal in question, (2) have the opportunity to act on the goal, (3) expect to be worse off later in the case of a delay, and (4) voluntarily decide to put off the intended action or inaction until a later point”. We suggest, however, that, when the subject understands the goal as one of overcoming procrastination, she typically considers both the positive and the negative possible outcomes: when the student overcomes procrastination, she is typically thinking not only of the possible negative outcome (failing the exam) but also of the possible positive outcome (passing the exam). Another feature that is salient from the first-person perspective is the negativity of the present task: when the student procrastinates, she is thinking of the unpleasantness (boringness, difficulty) of performing the action required to obtain the positive future outcome. Thus a better definition, at least for our purposes here, is one that emphasizes these two features: procrastination can be defined (roughly) as occurring when the subject voluntarily delays the performance of an action that is unpleasant but nevertheless intended by her because she appreciates that it is necessary in order to obtain a desired future outcome.⁹ This definition may not be adequate with respect to all cases of procrastination; it may be that in some cases the subjective emphasis is on an undesired rather than a desired future outcome. But it appears to pick out an interesting class of cases, and it is on these that we focus here.

Moving on from these definitional concerns, the natural thought is that mental time travel, in conjunction with the temporally extended self, should facilitate the overcoming of procrastination. Of course, just as multiple strategies are available for resisting temptation, multiple strategies are available for overcoming procrastination, not all of which need involve mental time travel or the temporally extended self in any interesting way. For example, the formation of implementation intentions—intentions that link potential occasions for procrastination to goal-directed responses by specifying the “what, where, and how” of goal-directed behaviours to

⁹ While some definitions (e.g., Silver & Sabini 1981; Andreou, 2007) characterize procrastination as being necessarily irrational, neither ours nor those on which it is modelled do so. Like Stroud (2010), we define procrastination without using normative terms such as rationality; unlike Stroud, we do so not because we think that procrastination might under certain circumstances be rational—we take no stand on this here—but rather because our aim is to provide a purely descriptive framework for understanding how subjects overcome procrastination.

be performed if and when certain conditions arise (e.g., “if I feel tempted to play video games instead of studying, then I will go to the library”); see Gollwitzer 1999; Gollwitzer & Sheeran, 2006)—may sometimes be helpful. Similarly, imposing voluntary but costly deadlines on oneself may sometimes enable one to overcome procrastination (see Ariely & Wertenbroch 2002). But we are interested here specifically in the idea that mental time travel and the temporally extended self together provide a pathway to this form of self-control.

There is considerable support in the literature for this idea. Blouin-Hudon & Pychyl (2015: 51), for example, point out that research on the role of future self-continuity with respect to procrastination suggests that “procrastinators almost exclusively adopt a present-focused perspective and rarely project themselves into the future. Since future self-continuity is important for guiding appropriate emotional responses and daily goal-oriented behaviors, it follows that procrastination might be explained in part by a fragmented relationship between a person’s present and future self” (see also Sirois & Pychyl 2013; Ferrari & Diaz-Morales, 2007; Jackson et al., 2003; Specter & Ferrari, 2000). In a more philosophical vein, Tappolet (cf. Gerrans, 2018) suggests that our relation to our futures selves is like our relation to others and argues that it is therefore plausible that we do the same thing in order to overcome procrastination as we do to overcome a lack of concern for others: “In both cases, one has to increase one’s concern. In the moral case, it is agreed that a good strategy for this is to imaginatively identify with the other. [...] This will help because such an empathic engagement with others tends to come with an increased concern for others. Thus, the coping strategy I propose to the procrastinator consists in the imaginative identification with the fate of her future selves” (2010: 128–129). Thus, again, we might suppose that the mechanism identified in the previous section as providing a pathway to resisting temptation can be modified so as to provide a pathway to overcoming procrastination: one imagines a future outcome, attributes the outcome to the future self, who is connected and identified with the present self via the temporally extended self, and experiences positive emotions appropriate to the future outcome, thus providing oneself with the motivation necessary to perform the unpleasant present task. For example, the student imagines passing the exam, attributes the passing of the exam to her future self, and therefore experiences pride, a sense of accomplishment, and so on; this provides her with the motivation necessary to get on with the unpleasant task of studying.

A puzzling question immediately arises, however: if, when the subject imagines a desired future outcome, she experiences the positive emotion appropriate to the outcome, why should this translate into increased motivation to perform the unpleasant action in the present? Should it not, instead, translate into *reduced* motivation to perform the action? After all, she has already obtained at least part of the emotional reward that would have been obtained from the realization of the outcome and thus has less, rather than more, reason to act so as to obtain that reward. Consider, again, the student deciding whether to study for an exam. She imagines passing the exam, therefore experiences pride, a sense of accomplishment, and so on; intuitively, it seems that, since she has already received part of the positive emotional payoff associated with studying, her motivation for studying should be reduced. Depending on how much of the payoff she has received (how intensely she has experienced the

emotions) and on how unpleasant she finds the present action to be, she may, in fact, no longer have sufficient motivation to perform the action. In other words, the framework developed in the previous section suggests that engaging in mental time travel might actually tend to encourage procrastination.

Of course, we are not suggesting that the subject would normally consciously rehearse this reasoning. Our question, instead, is about why the subject is not pushed by the motivational force of her desires and emotions to behave in accordance with the reasoning even when she does not rehearse it. As Ainslie (2010: 21) puts it, “[w]e humans notoriously live inside our heads. ... Most of our reward comes from expectations we construct of the future, our rehearsal of the past, and occasions for emotion that we have in the present, which are not necessarily connected to physical rewards. And to shape current choices, all of these categories must boil down to just the third: occasions for present emotion”. The question, then, is why the present pleasant emotion does not sap the subject’s motivation to perform the unpleasant action. The analogous question does not arise, or does not arise with the same force, in the case of resisting temptation, because the emotion felt in that case is unpleasant rather than pleasant. It thus, at least in typical cases, has an immediately motivating character: the subject imagines an undesired outcome, experiences an appropriate negative emotion, and is therefore motivated not to perform the pleasant action that would bring about the outcome. The positive emotions at issue in the case of overcoming procrastination do not have this immediately motivating character.¹⁰ Hence our insistence above on the importance of taking the subject’s point of view into account.¹¹

The question arises, of course, only given that imagining a possible future event can give rise to the same emotions that would occur—or emotions similar to those that would occur—if one were experiencing the event in the present, i.e., that the mentally time travelling subject genuinely experiences an emotion as a result of imagining experiencing an event, as opposed to merely imagining experiencing an emotion as one component of imagining experiencing an event. But it is indeed plausible that mental time travel genuinely gives rise to emotions, that it does not merely involve simulated or imagined emotions. As Debus (2007) points out, the emotions to which episodic remembering gives rise need not correspond to the emotions (if any) that one remembers oneself having at the time of the remembered event. One might,

¹⁰ It is not immediately obvious why there should be such an asymmetry between resisting temptation and overcoming procrastination with respect to the motivating force of the emotion triggered by imagining future outcomes; our suspicion is that there is a difference between our satisficing behaviour when it comes to negative experiences and when it comes to positive experiences. In the case of resisting temptation, if we are right, the subject has a negative experience now and therefore acts so as to avoid having a similar negative experience in the future. Since the disvalue of both experiences taken together is greater than the disvalue of the present experience, the subject will tend to act so as to avoid having the future experience. In the case of overcoming procrastination, the subject has a positive experience now and therefore acts so as to have a similar positive experience in the future. The value of both experiences taken together is greater than the value of the present experience, but the value of the present experience may nevertheless be sufficient from the subject’s point of view. To put it bluntly: one will always want to avoid additional pain, but at some point one may have had enough pleasure.

¹¹ For the sake of simplicity, we assume here and throughout that pleasant emotions are experienced as positive and unpleasant emotions are experienced as negative. In practice, of course, there may be cases where this does not hold.

for example, remembering feeling love for another person but presently feel anger at him, or vice versa. The same thing clearly goes for episodic future thinking. In many cases, the emotions to which mental time travel gives rise do in fact correspond to the emotions that one imagines oneself having at the time of the imagined event. But even when this is so, the former emotions do not reduce to the latter: they are not mere imagined emotions but genuine emotions produced as a result of imagining. In the next section, we therefore consider a modified framework designed to apply both to resisting temptation and to overcoming procrastination.

4 Mental time travel and self-control: a new proposal

That our initial framework cannot explain why imagining the realization of a future goal does not reduce the subject's motivation to realize that goal suggests that a component is missing from the framework. In this section, we argue that the missing component is *metacognition*.

At the most general level, metacognition refers to “thinking about thinking” (Koriat, 2000). Cognition involves, in many cases, two interrelated levels, a *meta* level and an *object* level, which are connected by monitoring and control relations defined by the direction in which information flows between levels (Nelson and Narrens, 1990; see also Michaelian 2016; Arango-Muñoz, 2011). When monitoring occurs, “the meta-level is informed by the object-level. This changes the state of the meta-level’s model of the situation, including ‘no change in state.’ ... However, the opposite does not occur, i.e., the object-level has no model of the meta-level” (Nelson & Narrens, 1990: 127). When control occurs:

the meta-level modifies the object-level. In particular, the information flowing from the meta-level to the object-level either changes the state of the object-level process or changes the object-level process itself. This produces some kind of action at the object-level, which could be (1) to initiate an action, (2) to continue an action..., or (3) to terminate an action. (Nelson & Narrens, 1990: 127)

We will argue that forms of both metacognitive monitoring and control, so understood, have a crucial role to play when one engages in episodic future thought in situations of intertemporal choice.

Before we turn to that role, however, we need to say more about emotion than we have said so far. The puzzle described in the previous section arose because we assumed that engaging in episodic future thinking can lead one to experience a genuine emotion in the present. We do not now want to deny that assumption, but it may be an oversimplification because there are different ways that emotion can be involved in future thinking. Baumgartner et al., (2008) distinguish between two types of affective reactions to future events: *anticipatory* emotions, which are currently experienced due to something that might happen in the future (e.g., I fear the impending talk that I have to give at an important conference) and *anticipated* emotions, in which one imagines experiencing certain emotions in the future in relation to particu-

lar future events (e.g., I imagine feeling joy or pride at having given a well-received talk).¹² Both types of affective reaction can motivate future behaviour, although “the motivational effects of anticipated emotions are stronger than those of anticipatory emotions” (Baumgartner et al., 2008: 694).

It is the notion of anticipated emotion that tends to be invoked in the literature on mental time travel, emotion, and decision-making (McCarroll, 2019), and that is our focus here. Anticipated emotion may play a role in intertemporal choice in two ways, and both are importantly related to the two aspects of metacognition—monitoring and control. On the one hand, anticipated emotions may be merely “virtual”, in the sense that they amount to predictions or representations of future emotions. These virtual emotions are not real, in that they do not typically give rise to the thoughts, feelings etc., that accompany genuine emotions. One might predict that one will feel joy or pride in the future without actually experiencing the emotion in the present. In cases of virtual emotion, metacognitive monitoring tags the emotion as belonging to the future self, thus linking a present choice with a future reward and ensuring that the subject’s behaviour is directed towards the fulfillment of a goal beyond the immediate present. The subject is able to overcome procrastination because of metacognitive control—the meta level modifies the object level so as to initiate an unpleasant action in the present in order to achieve a desired outcome in the future.

On the other hand, anticipated emotions can give rise to genuine emotions experienced in the present due to imagining something that might happen in the future. One might, for example, now really feel joy or pride when one imagines having given a well-received talk in the future. In such cases, anticipated emotions lead to real emotions in the present, whereby “the affective forecast leads to the feelings, thoughts, emotional goals, and action tendencies that accompany actual emotions” (Baumgartner et al., 2018: 695). In cases in which anticipated emotions lead to genuine emotions, metacognition plays another important role in terms of both monitoring and control. In cases of these genuine anticipated emotions, we suggest, metacognitive monitoring enables the subject to recognize that the emotions are appropriate only in relation to events that have not yet occurred, and indeed that might not occur. Further, metacognitive control enables the subject to “bracket” these emotions, treating them as being in a sense not real, and thus preventing them from sapping her motivation to bring about the imagined event.

If this suggestion is right, however, a further puzzle immediately arises: given that the emotion is bracketed and thus prevented from *decreasing* motivation, why should engaging in mental time travel *increase* motivation? The solution to this puzzle lies, we argue, in the fact that there is more to emotions than mere feelings. In our discussion so far, we have supposed that emotions constitute rewards in themselves. We have supposed, in particular, that *feelings* constitute rewards in themselves. But emotions are not just feelings: they are, rather, multidimensional constructs comprised of various components, including “subjective feelings, physiological response, motor expression, action tendency, and evaluation or appraisal” (Lempert et al., 2016: 648;

¹² One may also focus on imagining the event in the future rather than just on the emotion associated with the event, but nonetheless in these cases this will be an event that is emotionally arousing and which involves affect. Thanks to an anonymous reviewer for pointing to this possibility.

see also Scherer 2005). It is crucial to note that among these components is an “action readiness” element that motivates the subject to engage in certain actions (Frijda, 1986; see also Gross 1998). It is in virtue of this element that emotions are “causal determinants of action” (Frijda, 2010: 570).

Refining the suggestion made above, our proposal is that, while metacognitive control brackets the feeling component of the emotion that would otherwise result in decreased motivation, it does not bracket the action readiness component. In other words, this is the reason that bracketing the emotion does not nullify the effects of subject’s motivation: it is only the feeling component of the emotion that is bracketed, while the action readiness component, which is linked to motivation, is not bracketed. Engaging in mental time travel may thus increase motivation. Because the goal is not immediate, metacognition is further required to “tag” the goal as pertaining to the future. Our suggestion is that episodic future thought involves a form of metacognitive monitoring in which the object level provides the meta level with information: metacognitive monitoring links the *present* motivational component to a *future* goal. But there is also a form of metacognitive control, in which the meta level modifies the object level, ensuring that one’s behaviour is directed towards the fulfilment of a goal beyond the immediate present. In the case of overcoming procrastination, modification of the object level by the meta level results in the initiation of an unpleasant action in the present in order to achieve a desired outcome in the future.

It may also constitute a path to resisting temptation (as well as providing an additional way in which we may fail to overcome temptation); for metacognition, we are now in a position to see, arguably also has a role to play when one engages in episodic future thinking in tempting situations. We have argued that, in such cases, one imagines a future outcome that generates negative emotion in the present. Because the simulated event is located in the future rather than in the present or past, metacognitive monitoring will tag this negative outcome as pertaining to the future. The object-level informs the meta-level. Metacognitive monitoring links the motivational and appraisal components of the negative emotion in the *present* to a *future* outcome, and hence it also links that future outcome to an action that can be undertaken in the present. Because of this metacognitive connection between present actions and future outcomes, metacognitive control can impel one to refrain from a pleasant (tempting) action in the present in order to avoid a negative outcome in the future.

Negative emotions associated with future outcomes may also remain virtual. When they do, metacognition plays a role analogous to the role that it plays in cases of virtual positive emotion. It tags the outcome as belonging to the future, and it links the motivational aspects of the virtual emotion as pertaining to this future outcome.

5 Why Metacognition?

We have argued that mental time travel can aid self-control because it highlights the emotional salience of a future event for the temporally extended self and one remains motivated to achieve or avoid this future outcome through metacognition of one’s episodic future thoughts. In this section, we address a specific objection to this proposal.

It might be objected that we need not invoke metacognition in order to provide a full explanation of the effects of emotions on decision-making. Damasio and colleagues, for example, have outlined a position that could be construed as a rival to ours, or that could be articulated as an objection to our position. According to Damasio's *somatic marker hypothesis*, emotions guide and influence behaviour and are crucially involved in decision-making processes (Damasio, 1996). On this view, an emotion is defined "as a collection of changes in body and brain states triggered by a dedicated brain system that responds to specific contents of one's perceptions, actual or recalled, relative to a particular object or event" (Bechara & Damasio, 2005: 339). These somatosensory patterns lead to "feelings", which are perceptible to the individual. Emotional responses to stimuli lead therefore to "somatic markers", which can express themselves in emotions and feelings, and which influence decision-making. These somatic markers in effect provide implicit or explicit knowledge to aid decision-making. Somatic signals, tied to types of stimuli, will be reactivated in future encounters with those stimuli and will bias behaviour related to them (Gupta et al., 2011).

Somatic markers can be induced both by *primary inducers*, innate or learned stimuli that cause pleasurable or aversive states, and by *secondary inducers*, generated by the recall of a personal or hypothetical emotional event. Examples of secondary inducers are remembering an encounter with a snake or imagining winning the lottery. Importantly, secondary inducers can generate somatic markers and hence influence decision-making beyond the here and now. Thinking about a future event may count as a secondary inducer, which generates somatosensory patterns that can impact one's behaviour. This is a potential problem for our account because the induction of somatic markers in the form of emotions and feelings that influence behaviour is an immediate process that does not involve metacognition. In other words, the somatic marker account seems to explain what we want to explain but to do so without the additional complication of metacognition.¹³

In response to this objection, we note, first, that a somatic marker account is also compatible with a metacognitive account. For example, Proust (2013) takes somatic markers "to influence the processes of rational decision in general—including metacognition" (2013: 136). Both somatic markers and other types of feelings, such as epistemic feelings, which are involved in metacognitive processes, can influence decision making. In fact, the epistemic feelings involved in metacognition may have their own "dedicated somatic markers" (Proust, 2013: 136). We note, second, that the somatic marker hypothesis does not fully capture the motivational aspects of emotion. Emotions, on the somatic marker account, are alterations in somatic (brain and bodily) states, and a feeling is an awareness of these changes. But there is more to emotion than this. Once the appraisal and motivational components of emotion are factored in, an explanation is required of how one maintains motivation to achieve (or avoid) an outcome that is not in the immediate present. Our metacognitive account provides an elegant explanation of how one maintains motivation and refrains from engaging in (or is driven to initiate) an action in the *present* in order to achieve some

¹³ Other scholars argue for an even deeper integration between emotion and cognition. See, for example, Crippen 2018; Crippen & Schulkin, (2020).

future outcome. One needs to keep track of the fact that the outcome that one seeks to obtain or avoid, and to which one's present emotions and feelings are directed, is not immediate but is nonetheless connected to an action in the present. The metacognitive aspect of our account therefore actually supplements a somatic marker account.

6 Concluding remarks

Self-control is the capacity to refrain from acting in accordance with an occurrent dominant impulse by focusing on one's long-term interests. But a key puzzle of self-control is how we become motivated to act in our own long-term interests, when these interests precisely go beyond the here and now. How, in other words, do we navigate intertemporal choices, which have consequences that unfold over time? The capacity to imagine future scenarios is often thought to be crucial to overcoming the tendency to discount the future. But what exactly is the mechanism by which mental time travel facilitates more far-sighted choices? We suggest that our revised framework provides an answer to this question. This framework assigns central roles to emotion (properly understood as multidimensional constructs involving not just feelings but an action-readiness and other components), the temporally extended self, and metacognition. These three elements are key parts of the ways in which mental time travel enables us to resist temptation and overcome procrastination. Our framework hence provides a plausible explanation of the way in which mental time travel helps us navigate intertemporal choice and enables us to demonstrate self-control.¹⁴

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Declarations

Conflict of interest The authors declare that they have no competing interests.

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¹⁴ A further interesting line of research would be to focus on the role of anticipatory emotions in dilemmas of intertemporal choice, and outline the ways in which metacognition relates to this variety of future-oriented emotions.

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