Under what circumstances does autobiographical memory enhance self-control?

By

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Abstract

Self-control is an important skill because it helps us regulate many of our behaviours, such as how much we eat and drink. Limiting our intake of food and drink is sometimes difficult to do, however. One explanation for why self-control can be difficult is because the value for good health is discounted because it's delayed, whereas the reward of food and drink are immediate. This is known as delay discounting: larger, future rewards (e.g. saving for a future holiday) decrease in value with the increase in delay and thus people sometimes pick a smaller, sooner reward instead (e.g. needless shopping now). Using a delay discounting paradigm, this study examined whether autobiographical memories can enhance self-control. Study 1 was a replication study and found that cuing participants to retrieve positive, episodic memories enhanced self-control. This effect was only evident in one out of two delay discounting measures used, however. Building on these findings, Study 2 and 3 investigated whether the amount of episodic detail in specific autobiographical memories and a positive self-concept contribute to the effect of autobiographical memory enhancing self-control. The amount of episodic detail recalled was not related to self-control and results about a positive self-concept were inconclusive. Unexpectedly Study 3 also yielded a non-significant result for positive, episodic memory enhancing self-control. Participants in Study 3 were, however, significantly more tired than participants in Study 1, raising the possibility that they were less engaged in the task. This pattern of findings suggests that the effect of autobiographical memory on self-control is fragile, and is possibly influenced by factors such as participant fatigue. Potential reasons for the fragile effect and inconclusive results, and a potential way forward are also discussed.

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Chapter 1: In what way can autobiographical memory help with self-control?

Self-control is an important skill to have - to regulate fast food and alcohol intake for example. Although limiting these goods seems logical due to their harmful effects when consumed excessively, it is often hard to do. One explanation for this is that the value for good health is discounted because it's delayed, whereas the reward of alcohol and fast food is immediate. This is known as delay discounting: larger, future rewards decrease in value with the increase in delay and thus people sometimes pick a smaller, sooner reward instead (James E. Mazur, 2015). That is, people often discount the future in favour of the present, despite knowing that waiting would yield better results.

The extent to which people discount the future in favour of the present can be measured in the laboratory. One common way is for participants to sit at a computer and select (using the computer's mouse) between hypothetical monetary options (i.e. a smaller sum of money now or a larger sum of money later) (Critchfield & Kollins, 2001). If a participant tends to choose the larger sums, it is regarded as self-control and the participant has a lower delay discounting rate; whereas a participant who tends to pick the smaller, sooner option is more impulsive and has a higher delay discounting rate (Critchfield & Kollins, 2001). This delay discounting paradigm has been used in many studies to demonstrate how people may discount the future for immediate rewards and how this, in turn, can impact health and wellbeing (Critchfield & Kollins, 2001), for instance, substance dependence (Dallery & Raiff, 2007; Reynolds, 2006).

To illustrate, people with a diagnosis of alcohol use disorder are less likely to choose larger, future rewards (i.e. money) than healthy controls, and that the severity of alcohol dependence is significantly correlated with higher rates of delay discounting (Reynolds, 2006). Dallery and Raiff (2007) found the same pattern of results with a sample of smokers: people who smoked during their four-hour experiment had higher rates of delay discounting (i.e. were more impulsive) than those smokers who did not smoke during the experiment. Furthermore, Castellanos-Ryan and colleagues (2016) conducted a large-scale study (N = 2,144) to investigate the correlates of psychopathology in an adolescent sample. They found that impulsivity and delay discounting were weak-to-moderate significant correlates of psychopathology, even after controlling for many personality and cognitive measures. Therefore, for psychologists and policy-makers, understanding and strengthening peoples' self-control so that they consider the future is important for changing problematic behaviours that impact future health and wellbeing.

How we discount the future

How does the delay of a reward influence a person's choice? For example, how does a student set a goal to attend every lecture and achieve an A at the start of the semester, however frequently chooses to sleep in and miss their morning class? Or how does a person set a goal to save money on a Monday, however continues to spend frivolously on the weekend? The Ainslie-Rachlin Theory (Ainslie, 1975; Rachlin, Green, Kagel, & Battalio, 1976) helps to answer this question how we sometimes discount the future. The Ainslie-Rachlin Theory makes two assumptions: it assumes that 1) the value of the reward decreases as the delay between making the choice and receiving the reward increases (i.e. delay discounting); and 2) a person will pick the reward that has the highest value when the choice is made. Thus, the reward's value is determined by how long the person must wait to receive it, as well as the proximity and size of the alternative, sooner reward. Often the immediate, smaller reward seems larger compared to the delayed, larger reward because it is received closer in time and thus appears more valuable and more appealing in comparison. The hyperbolic discounting model (Mazur, 1987) is one mathematical model that also helps to explain these types of preference reversals. The model describes a larger proportional decrease in the subjective value of a reward (e.g. receiving a good mark) at shorter delays (i.e. the morning of the lecture) than at longer delays (i.e. at the start of semester) (Myerson & Green, 1995).

Figure 1, from Mazur (2015), helps to depict the Ainslie-Rachlin theory using an analogy for a self-control situation. The buildings on the left (1 and 2) are rewards and the distance between point A and B is time. Building 2 is clearly larger, but for a person standing at point A, building 1 would appear larger. If the person was at point B however, both buildings would appear smaller, but building 2 would correctly appear as the largest of the two buildings. Similarly, making the goal to achieve an A and attend every morning class at the start of the semester, compared to early in the morning before class, is more palatable and logical because the student can see both choices from a wider perspective. Thus, when there is a delay in receiving both options, people can ‘step back’ from both buildings (i.e. both rewards) and gain perspective on their relative sizes and make a more informed, beneficial decision and pick the larger, later option. Therefore, the question naturally arises: if the immediate reward cannot be delayed, how can we encourage people to ‘step back’ and get a clearer perspective when making self-control choices? That is, how do we shift attention away from the present and broaden an individual’s time frame so that they consider the consequences of their behaviour?

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Figure 1. Analogy for delay discounting (Mazur, 2015, pg 312). For a person standing at point A, building 1 appears larger than building 2; however, a person standing at point B would see that building 2 is in fact the largest building. This is an analogy for a self-control situation, where the buildings are rewards and the distance between point A and B is time.

Episodic future thinking helps to strengthen self-control: decreasing delay discounting and problematic behaviour

Episodic future thinking (EFT) is one strategy to help decrease the rate of delay discounting (Rung & Madden, 2018). In a laboratory setting, when people think of possible future experiences, they are more likely to choose the larger sum of money. This effect of EFT decreasing delay discounting is evident in adults and children (Daniel, Said, Stanton, & Epstein, 2015) and is enhanced when the EFT is relevant to the delay discounting task (e.g. financially-orientated EFT like purchasing an item) (O'Donnell, Daniel, & Epstein, 2017). In addition to reducing delay discounting, EFT also helped to reduce cigarette consumption in a group of smokers (J. Stein et al., 2016), as well as food intake in people who were obese (Daniel, Stanton, & Epstein, 2013).

To illustrate, Stein and colleagues (2016) investigated whether EFT helps to reduce cigarette consumption, as well as delay discounting, in a group of smokers. Using a between participant design, one group thought of possible events at 1 day, 1 week, 1 month, 3 months and 1 year. The control group thought of positive, recent episodic events that occurred the previous day during five different time periods (i.e. 7am-9.59am, 10am-12.59pm, 1pm-3.59pm, 4pm-6.59pm, and 7pm-9.59pm). Stein and colleagues found that the EFT group had significantly lower rates of delay discounting compared to the control group. That is, the group that thought about possible future events picked the larger later option to a greater extent than the group that thought about an event the day before. Furthermore, the EFT group consumed significantly less nicotine than the control group. Thus, thinking about possible future events not only helped to decrease delay discounting, but also reduced smokers' nicotine consumption.

Similarly, Daniel and colleagues (2013) investigated the effect of EFT on delay discounting for overweight adults. Also using a between-participant design, the EFT group thought about possible future events at different time periods (i.e. 1 day, 2 days, 1 week, 2 weeks, 1 month, 6 months, and 2 years), whereas the control group completed an imagery task (i.e. participants thought about events described in a travel blog they read earlier). In addition to completing the delay discounting task, food was available for participants to consume, and participants' intake was also measured. Daniel and colleagues found similar results to Stein and colleagues' (2016) study: EFT, compared to the control imagery task, significantly reduced delay discounting and actual food intake. Evidently, EFT not only helps people ignore a smaller sum of money now and wait for a larger sum of money, but also helps to reduce cigarette and food consumption in adults that may already find it hard to moderate their intake.

Can autobiographical memories have a similar effect to EFT?

Since there is a well-established effect of EFT on delay discounting (Rung & Madden, 2018), it is reasonable to examine whether other forms of episodic thinking may also have an effect. The question arises whether autobiographical memory, specifically episodic memory, can also help to decrease delay discounting and strengthen self-control. Autobiographical memory is mental representations of the self in the past and is formed by specific personal events (i.e. episodic memory) and general knowledge about oneself (Conway & Pleydell-Pearce, 2000). According to Conway and Pleydell-Pearce's Self Memory System (SMS; to be discussed further below), autobiographical memory is hierarchically organised from conceptual self-knowledge down to episodic memory. That is, autobiographical memory is organised into, and retrieved from, themes (e.g. school life), lifetime periods (e.g. my time at university), general events (e.g. attending my weekly social psychology lecture), and specific events (i.e. episodic memory; e.g. the time I delivered my presentation to the class) (Conway & Pleydell-Pearce, 2000). Thus, considering the effect of EFT, perhaps episodic memory can also enhance self-control.

Some EFT studies have however used episodic memory as a control and have found significant differences (e.g. Dassen, Jansen, Nederkoorn, & Houben, 2016; O'Donnell et al., 2017; Stein et al., 2016) such that EFT was significantly better at decreasing delay discounting than episodic memory. Although this suggests that EFT has a stronger effect on delay discounting than episodic memory, it does not rule out episodic memory enhancing self-control entirely because it was not tested directly. Furthermore, the following sections examine how the neuropsychology research (e.g. the constructive episodic simulation hypothesis) (Addis, 2018; Schacter & Addis, 2007); the theory on the directive function of autobiographical memory (Bluck & Alea, 2002; David B Pillemer, 1992); and recent empirical evidence (Lempert, Speer, Delgado, & Phelps, 2017), suggest that episodic memories may also help to decrease delay discounting and thus strengthen self-control.

Neuropsychology evidence: episodic memory shares similarities to EFT.

Constructive episodic simulation hypothesis. Schacter and Addis' (2007) 'constructive episodic simulation hypothesis' suggests that episodic memories could help with self-control because future and past episodic thinking activate similar cognitive and neural processes in the brain. fMRI studies have demonstrated that both episodic memories and simulation of novel, future events activate the default mode network (DMN) (Addis, 2018). The DMN is the brain's 'event simulator' as it flexibly interacts with other brain networks to construct, encode and reconstruct a variety of event simulations (Addis, 2018). That is, the DMN underpins how we remember, imagine and perceive event representations in our mind via a common simulation process (Addis, 2018). Additionally, past and future episodic thinking have similar phenomenal characteristics (e.g. similar sensory and contextual features), and a common tendency to cluster around periods of self-development

(Schacter & Madore, 2016). Thus, if we are using the same cognitive and neural processes to recall the past and imagine the future, then episodic memory may also influence delay discounting.

Neuropsychology dissociation. Neuropsychology dissociations also suggests the link between EFT and episodic memory. For instance, people with amnesia who have severe difficulty remembering the past also show difficulties with imagining future events (Hassabis, Kumaran, Vann, & Maguire, 2007). To illustrate, Hassabis and colleagues tested a group of people with amnesia, who had primary damage to the hippocampus bilaterally, and asked them to construct novel, imagined events in response to short verbal cues (i.e. commonplace scenarios). Their results indicated that people with amnesia were markedly impaired at imagining new experiences compared to a matched control group. Hassabis and colleagues also found that people with amnesia gave fragmented images, rather than a holistic representation of the environmental setting. Furthermore, other clinical populations who also exhibit autobiographical memory impairment, such as temporary amnesia (Juskenaite et al., 2014), depression (Williams et al., 1996), schizophrenia (D'Argembeau, Raffard, & Van der Linden, 2008), post-traumatic stress disorder (Brown et al., 2014), and Alzheimer’s disease (Addis, Sacchetti, Ally, Budson, & Schacter, 2009), also show difficulty imagining their personal futures.

Considering that we use similar parts of the brain for prospection and retrospection and that impairment in autobiographical memory is associated with impairment in future thinking, this suggests that episodic memories, like EFT, could decrease delay discounting and enhance self-control.

Autobiographical memory theory: the directive function of memory.

At a theoretical level, we use our autobiographical memory to direct our behaviour. Pillemer (1992), and later Bluck and Alea (2002), identified the functions of autobiographical memory, and in turn suggested how we use our memory to make decisions and guide our behaviour. They proposed that autobiographical memory has a directive (i.e. guides future behaviour), self (i.e. promotes self-continuity and solidify one's identity), and social bonding function (i.e. develops, maintains and nurtures social bonds). Bluck, Alea, Habermas, and Rubin (2005) provided empirical evidence for the directive, self and social bonding functions of memory when they developed and validated their Thinking About Life Experiences (TALE) questionnaire, which asks people about how they use their autobiographical memories in their lives. That is, when Bluck and colleagues created their TALE scale, the factor analysis indicated three discrete factors.

Of the three memory functions (i.e. directive, self, and social) proposed by Pillemer (1992) and Bluck and Alea (2002), it is the directive function that would most likely play a role in self-control. This is because problem solving and making future goals (the TALE items falling under the 'directive function' factor of the TALE; Bluck & Alea, 2002), are critical skills that may help in a self-control decision making task. Essentially, autobiographical memory, particularly its directive function, directs our life path and thus guides future behaviour and decisions (Bluck & Alea, 2002, Pillemar, 1992). Although experimental research on the directive function is limited (Pillemer & Kuwabara, 2012; Selimbegovic, Regner, Huguet, & Chatard, 2016), preliminary findings are promising. For example, recall of a positive, episodic memory has led to an increase in donations (Kuwabara & Pillemer, 2010), exercise (Biondolillo & Pillemer, 2015) and helping behaviour (Ford et al., 2018). Thus, recall of a positive, episodic memory could be helpful in making delay discounting decisions.

Experimental evidence that positive memories may help to enhance self-control.

Lempert and colleagues (2017) provided empirical evidence for the idea that autobiographical memories can be used to decrease delay discounting and enhance self-control. In their study, Lempert and colleagues asked participants to recall and write down 30 positive, episodic memories, and rate the positivity and intensity of each memory. Participants then returned two days later and recalled the top 10 rated memories and completed a delay discounting task. That is, after recalling one of their memories, they made a series of choices between larger sums of money later and smaller sums of money now, and then repeated this for each of their 10 memories. For the control condition, which all participants completed, participants were asked to relax instead of recalling their memories. Results showed that participants had significantly lower delay discounting rates (i.e. were more self-controlled) after recalling positive, episodic memories compared to when they relaxed. In an additional three studies, Lempert and colleagues also demonstrated that negative memories and novel, positive ideas had no effect on delay discounting. Thus, Lempert and colleagues concluded that memories had to be positive and real experiences to decrease delay discounting and increase self-control. This study, as well as the neuroscience evidence and theory on the directive function of autobiographical memory, suggests that memories may play an important role in self-control.

The nature of the autobiographical memory: is self-control influenced by the amount of memory detail and a positive self-concept?

If autobiographical memory, particularly episodic memory, can help to decrease delay discounting, then what is it about the memory that helps? The amount of episodic detail recalled about a specific experience and a positive self-concept could be factors that help to decrease delay discounting and enhance self-control.

Greater memory detail may help with self-control.

Episodic memory allows people to mentally travel back and forward in time (i.e. autonoetic consciousness) and recall rich contextual details about events (Schacter & Addis, 2007; Tulving, 1985, 2002); such as, what happened during the event, when and where it happened, who was there, perceptual details (e.g. smells, sounds), and emotions and thoughts experienced at the time (Addis, Wong, & Schacter, 2008; Levine, Svoboda, Hay, Winocur, & Moscovitch, 2002). Memory specificity in autobiographical memory research can refer to the ability to retrieve episodic memories, as well as the amount of detail recalled about an episodic memory (Kyung, Yanes-Lukin, & Roberts, 2016). In this study, we are specifically interested in the amount of detail (i.e. episodic detail) that a person can recall about an experience and whether this is related to self-control. This is because experimental studies suggest that greater levels of episodic detail can enhance coping and psychological well-being (Jing, Madore, & Schacter, 2016) and creative thinking (Madore, Addis, & Schacter, 2015). Furthermore, greater episodic detail has also related to better problem-solving ability (Sheldon, McAndrews, & Moscovitch, 2011).

To illustrate, Madore and colleagues (2015) delivered an ‘episodic memory specificity induction’ to half their participants and a control induction to the other half. The ‘episodic memory specificity induction’ group learnt how to recall a specific memory in great detail. Participants were guided through a mental-imagery exercise, in which they were asked to close their eyes and generate a picture in their mind about the setting, people and actions from a video they had just watched. Conversely, the control group were asked to describe their opinions and impressions about a video they had just watched. Madore and colleagues found that participants in the ‘episodic memory specificity induction’ condition generated significantly more responses on an Alternate Uses Task (i.e. generate creative uses for common objects e.g. *try to think of different ways in which a newspaper could be used*) compared to those who did not receive the specificity induction. Schacter and Madore (2016) concluded that the ‘episodic memory specificity induction’ may help with event or scene construction in the mind, which is needed for not only episodic memory, but also for imagination, problem solving and creative thinking. Evidently memory specificity is related to positive benefits, which could extend to self-control.

Thinking about one's positive self-concept may enhance self-control.

Perhaps positive, episodic memories enhanced self-control in Lempert and colleagues' (2017) paper because a positive, episodic memory draws attention to one's positive self-concept (e.g. who I am). A person's self-concept is information about the self and is made up of attitudes, images, social roles (e.g. son/daughter), traits, thoughts and beliefs one holds about the self (Hards, Ellis, Fisk, & Reynolds, 2019; Kuhn & McPartland, 1954; Stopa, 2009). Considering that thinking about what makes one unique induces self-attention (Silvia & Eichstaedt, 2004), reflecting on a positive, episodic memory or positive aspects of oneself may heighten self-awareness and thus make people more self-controlled.

Memory and its connection to the self. Recall of an episodic memory may increase awareness about one's self-concept because autobiographical memory and the self are intimately linked. That is, how we encode and retrieve experiences influences how we construct and maintain our identity (Conway & Pleydell-Pearce, 2000). Conway and Pleydell-Pearce (2000) described this relationship between autobiographical memory and the self in their SMS model. The SMS describes the 'autobiographical knowledge base' and the 'working self' and how these two constructs interact to create autobiographical memory and our sense of self. The autobiographical knowledge base contains knowledge about the self (i.e. who I am, who I was and who I want to be) and this information is categorised and stored into lifetime periods, general events and episodic memory, which together make up the life story. The working self encompasses a person's self-concept and their goals, which are organised into goal hierarchies. The working self therefore influences behaviour and how autobiographical memory is encoded and retrieved, while the autobiographical knowledge base constrains the goals and one's self-concept of the working self (i.e. who I am and what I can do). Thus, the relationship between the autobiographical knowledge base and the working self is reciprocal. That is, autobiographical memory (i.e. our experiences) shapes the self (i.e. our self-concept and goals); and the self, in turn, influences the types of experiences that are encoded and retrieved. Considering autobiographical memory's relationship with the construction and maintenance of the self, then perhaps recall of an episodic memory heightens awareness about one's self-concept, which, in turn, raises self-awareness and helps participants to 'step back' and view all options and pick the most logical, beneficial one.

Heightened self-awareness can help to enhance self-control. Duval and Wicklund (1972) first suggested that heightened self-awareness can enhance self-control, and this idea was later developed into the cybernetic model of self-regulation by Carver and Scheier (2012). These researchers posited that when people focus inward, they become aware of the salient standard (i.e. either an internalised, social and/or situational standard) and any discrepancy between that particular standard and their own present state. This awareness of the discrepancy creates negative emotions which subsequently motivates people to try and reduce the discrepancy. Self-awareness therefore leads to a state of self-evaluation which motivates people to change and regulate their behaviour.

Many studies support their theory (Carver, 2003). For example, priming self-awareness by asking participants to face a mirror, unscramble sentences that start with 'I', hear their own tape-recorded voice or see their own profile picture, has been found to lead to a variety of outcomes: such as, students conform more closely to the instruction to work fast on a clerical task (Wicklund & Duval, 1971); students allocate group earnings more fairly when equity and equality norms were made salient (Kernis & Reis, 1984); people who opposed stereotyping, continued to restrain themselves from doing so, whereas those who condoned it stereotyped even more (Macrae, Bodenhausen, & Milne, 1998); and a significant improvement on a physical self-control task (Alberts, Martijn, & de Vries, 2011). Therefore, perhaps recalling an episodic memory heightens self-awareness which subsequently makes people aware of the salient standard and encourages them to pick the larger, later option.

The current study's aim

Our aim is to test whether episodic memory can help to increase self-control. Therefore, Study 1 will aim to replicate Lempert and colleagues' (2017) procedure and determine whether recalling positive, episodic memories can decrease delay discounting. If Study 1 finds an effect similar to Lempert and colleagues, Study 2 and 3 will aim to assess factors inherent to episodic memory that could be contributing to the effect, particularly the amount of episodic detail and a positive self-concept.

Chapter 2: Do positive, episodic memories enhance self-control? (Study 1)

The aim of Study 1 was to replicate Lempert and colleagues (2017) procedure, to determine whether recalling positive, episodic memories can decrease delay discounting. As outlined in Chapter 1, Lempert and colleagues asked participants to recall 30 positive, episodic memories, and rate each memory on valence, emotional intensity and feeling. Participants returned two days later and recalled the top 10 rated memories and completed a delay discounting task (i.e. choosing between a smaller sum of money now or a larger one later). They found that participants had significantly lower delay discounting rates (i.e. were more self-controlled) after thinking about their episodic memories compared to when they relaxed.

At the time Study 1 took place, Lempert and colleagues (2017) study was the only published paper that directly investigated whether episodic memory could enhance self-control. Thus, considering the limited research and the replication crisis, it was critical to replicate Lempert and colleagues study (Shrout & Rodgers, 2018). In light of Lempert and colleagues findings, as well as the evidence that suggests EFT and episodic memory activate similar cognitive and neural processes in the brain (i.e. the constructive episodic simulation hypothesis; Schacter & Addis, 2008; Addis, 2018) and that we use our autobiographical memory to guide our behaviour and decisions (Bluck & Alea, 2002; Pillemer, 1992), this study hypothesised that participants would be more self-controlled in the episodic memory condition compared to the control condition.

Method

Participants

Seventy-two psychology undergraduate students from Victoria University of Wellington participated in the study, in partial fulfilment of a course requirement. One person dropped out half way through the study, another completed the task incorrectly, and 17 had unsystematic data (see below); therefore, the final sample comprised of 53 participants. This research was approved by the School of Psychology Human Ethics Committee, under delegated authority of the Victoria University of Wellington's Human Ethics Committee.

Materials and Procedure

Study 1 aim was to replicate the Lempert and colleague's (2017) paradigm; therefore, following their design, this was a within-participant, two-part study. The experiment was created using Microsoft programme Visual Basic Express and was pre-registered on AsPredicted (https://aspredicted.org/bc2x2.pdf).

During both sessions, participants were seated at individual computer booths and the experimenter briefed participants on the task and requested they read through, and be comfortable with, the consent material before deciding whether to give consent and commence the experiment. In both sessions, participants were reminded they could leave anytime without penalty. Each session took approximately 45 minutes, taking 90 minutes in total to complete the study. At the end of the second session, participants were debriefed on the study's aim and were provided an information sheet with further study and contact details.

Session 1.

The first session asked participants to pick ten memory cues from a list of cues provided (e.g. a time I hosted a party / a time I went to the beach, see Appendix A; Lempert et al., 2017). After selecting a memory cue, participants recalled a positive, episodic memory that corresponded to that cue; wrote a description of the memory; and wrote their own memory cue, which helped them remember their memory in the second session. Participants were instructed that memories should be positive. If they could not recall a positive memory however, they were asked to pick a neutral memory, not a negative one. Additionally, for each memory, on a 4-point scale, participants rated valence (i.e. *how positive is this memory?*

1 = neutral, 4 = very positive), emotional intensity (i.e. *how intense is this memory?* 1 = not intense, 4 = very intense) and feeling (i.e. *how good does this memory make you feel?* 1 = neutral, 4 = very good).

Lempert and colleagues (2017) study's instructions were followed, which asked participants to write about events that they were personally involved in, had occurred at a specific place, and happened within a 24-hour period (see Appendix B). To ensure that this occurred, participants were also asked to type in the location and date of their experience in a specific field on the computer screen. If participants could not remember the specific date, they were asked to provide the approximate date (i.e. the month and year). Participants had two minutes to write about each memory and were encouraged to write as much as possible within that timeframe. At two minutes, a button ("next memory") appeared and the participant clicked it to move onto writing about the next memory. At the end of the session, participants created a unique identifier (i.e. username) that was linked to their memory cues, which was needed for the second session. A unique identifier also provided the participant anonymity.

Session 2.

Participants returned three days later (e.g. if the first session was on a Monday, the second session was on a Thursday) and participated in two experimental conditions (i.e. an episodic memory condition and a control condition). For the episodic memory condition, the task began with a fixation cross on the screen for three seconds, followed by 14 seconds exposure to a memory cue they had written in the first session (see Figure 2). Participants were asked to recall and think about their memory that corresponded to their memory cue. Memory cues were presented at random and did not correspond to the order that they were written in the first session. Next, participants filled in the same scales assessing valence, intensity and feeling as mentioned above in the first session. In the control condition, participants were asked to relax and rate how bored (1 = not bored, 4 = very bored), tired (1 = very awake, 4 = very tired), and good (1 = neither good nor bad, 4 = very good) they felt.

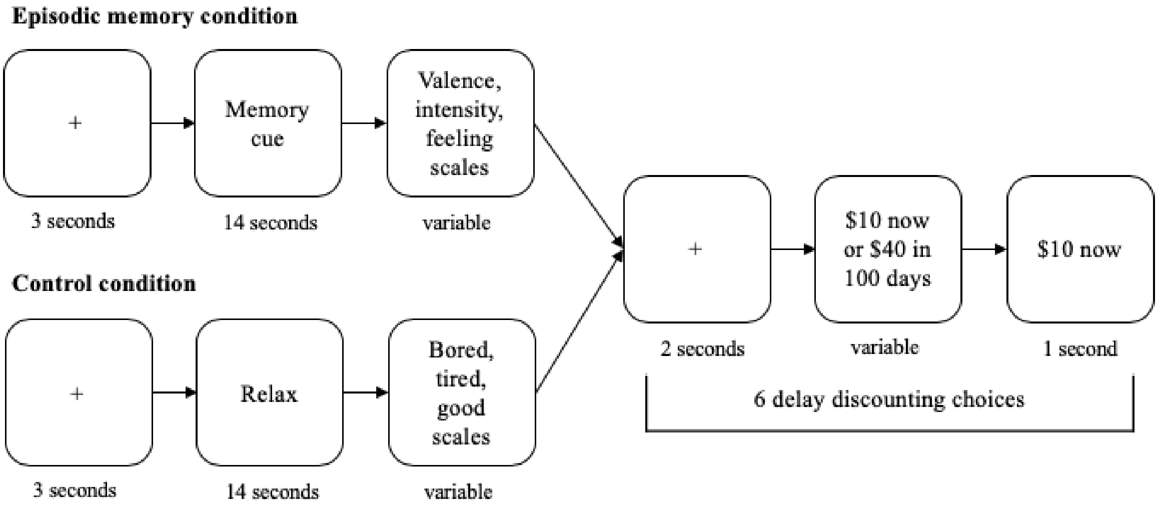

Figure 2. Session 2, Study 1: episodic memory and control conditions. For the episodic memory condition, a trial began with participants' recalling their memory using their memory cue; rating the memory's valence, intensity and feeling; and then completing six delay discounting choices. For the control condition, a trial began with the participants' relaxing; rating how bored, tired and good they felt; and then completing six delay discounting choices. The experiment included four blocks: two memory blocks and two control (i.e. relax) blocks, which were counterbalanced to start and then alternated (e.g. memory block, control block, memory block, control block). A memory block had five trials (i.e. five memories) and a control block had five trials (i.e. relax five times). Figure adapted from Lempert and colleagues (2017).

After completing the scales, participants completed six delay discounting choices, where they chose between a smaller sum of money now or a larger sum of money later. After a 2 second fixation cross, the delays and the amounts were displayed on the computer screen and the participant used their mouse and clicked on their preferred option. The delay options were 4, 7, 30, 60, 100 and 180 days, and amount options were $11, $15, $18, $20, $22, $25, $28, $30, $32, $35, $40; with "$10 now" always being the fixed, smaller sooner option. The options switched sides of the screen randomly and participants made decisions about every possible combination of delay and amount in random order. There was no time limit to make their monetary choice. Once their choice was made, their preferred option was displayed for 1 second and then followed by a 2 second fixation cross before the next options were displayed.

The second session had four blocks: two memory blocks and two control (i.e. relax) blocks. A memory block had five trials (i.e. five memories) and a control block had five trials (i.e. relax five times). Blocks were counterbalanced, such that half of the participants started with a memory block, and the other half started with the control block. Memory and control blocks then alternated.

Methodological discrepancies between Lempert and colleagues' (2017) experiment and the current experiment

Although Study 1 aim was to replicate Lempert and colleagues' (2017) experiment, there were some discrepancies that are worth noting. First, participants in their study wrote 30 memories and the experimenters picked the top 10 memories that had the highest combined valence, feeling and intensity ratings. In contrast, in this current study, due to time constraints and to reduce potential participant fatigue, we decided that participants would write only 10 memories. Therefore, we could not pick the highest positive rated memories. To check that participants in this study wrote positive memories, a manipulation check was conducted and found that 75% of participants rated their memories on average 3 or more on positivity in the second session, and 83% participants in the first session. Only one person rated their memories on average 1.5 on positivity in the second session (i.e. more neutral than positive); however, in the first session their average was 2.6 and removing them from the analysis did not yield different results (see Results section for median and interquartile range).

Second, Lempert and colleagues (2017) also wrote their participants' memory cues and the participants reviewed their memory cues at the beginning of the second session to ensure that they could identify the memory associated with each cue. Participants in this study however generated their own memory cues to ensure they would remember their memories, as well as to avoid making assumptions on what would help the participant remember. Third, Lempert and colleagues' (2017) memory cues were slightly adapted for a New Zealand and undergraduate audience and to ensure participants recalled specific and positive memories. That is, cues that referred to American holidays (e.g. 4th July, Thanksgiving) and neutral cues (e.g. drinking from the water fountain) were removed. "A time I.." was also placed in front of each cue to help participants think of a specific (i.e. episodic) memory.

Lastly, participants in Lempert and colleagues (2017) study were also told that one of their choices would be randomly selected and they would receive the amount of money that they chose at the specified delay. This study's participants did not participate for money, but instead participated in partial fulfilment of a course requirement. Research suggests there is no significant discrepancy between real and hypothetical money scenarios in delay discounting tasks, however (for reviews, see Johnson & Bickel, 2002; Madden, Begotka, Raiff, & Kastern, 2003)

Analytical Plan

Calculating the indifference point.

The purpose of the delay discounting task was to determine the rate at which rewards lose value as a function of delay for each participant. To calculate the delay discounting rate, the first step was to calculate each participant's indifference point at each delay. The indifference point is interpreted as the subjective value of the smaller, sooner reward (Mazur, 2015). That is, when the participant saw both sums of money (i.e. the smaller, sooner and the larger, later amounts) as equally preferable at a delay (Mazur, 2015). To illustrate, if a participant selected $10 now instead of $25 in 30 days, and then picked $28 in 30 days instead of $10 now, it is estimated that $10 now is equal to receiving $26.50 in 30 days, because $26.50 is halfway between $25 and $28 (Mazur, 2015). Thus, a low indifference point (i.e. subjective value) is regarded as greater self-control.

Following Lempert and colleagues' (2017) study, we also used a logistic function to calculate the indifference points at each delay. Hence, the following Equation 1 was used:

$$f(x) = \frac{L}{1+e^{-k(x-x_0)}} \quad (1)$$

L is the curve's maximum value (here, set to 1); *e* is natural logarithm base (i.e. 2.71828); *k* is the logistic growth rate (i.e. steepness of the curve) and is a free parameter; and x_0 is the sigmoid point, a free parameter, and is the point where the probability of the participant picking the smaller, sooner amount is equal (0.5) to the probability of them picking the larger, later option at a particular delay (i.e. the indifference point; see Figure 3).

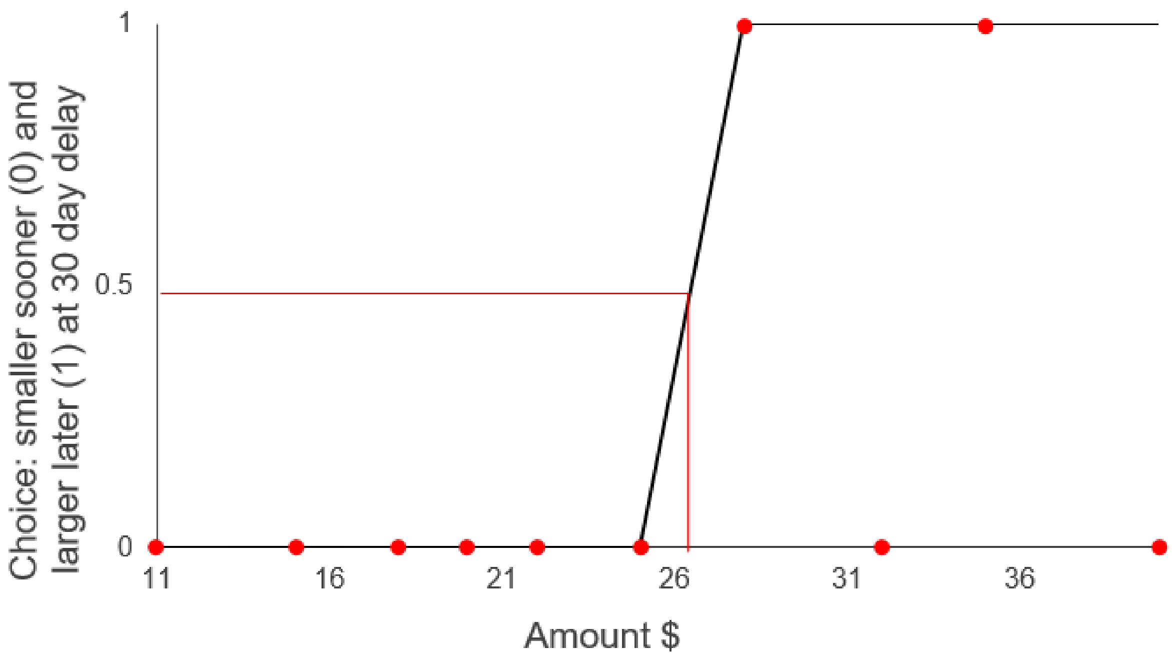

Figure 3. Calculating the indifference point example (30 day delay). The graph depicts a participant's choices (represented by the red dots) at a delay of 30 days. The amounts of the larger, later reward are along the x axis, and the choice the participant made along the *y* axis. The larger, later option is represented as one, and the smaller, sooner (i.e. $10 now) as zero. The logistic function model predicts (represented by the black line) that the sigmoid point (i.e. indifference point; represented by the red line) is $26.50. That is, the

participant is equally likely to choose either $10 now or $26.50 in 30 days. In other words, the subjective value of $10 now is $26.50 in 30 days.

As illustrated by Figure 3, for each delay, the larger later amounts were plotted on the x axis and whether participants selected the larger, later (represented as one) or smaller, sooner (represented as zero) option was plotted on the y axis. The logistic function model (represented by the black line) therefore calculated the indifference point using the sigmoid point (represented by the red line). To fit the logistic function and thus the sigmoid point, this study used the solver function within Microsoft Excel. The solver algorithm minimised the model's sums of squared estimates (SSE; i.e. the squared residuals) by changing the slope (i.e. k) and the sigmoid point (i.e. x_0) (Reed, Kaplan, & Brewer, 2012). This is because SSE indicates how close the model is to the data: the closer SSE is to zero, the better the model fits the data and thus predicts the most accurate sigmoid point (i.e. indifference point; Reed et al., 2013). Before using the solver, participants' sigmoid point was placed at $23 and the slope at 10. The slope was also constrained to be equal to or greater than .1. This was to ensure that the solver estimated from the same place each time; that the starting point was closer to the best fit value to reduce the likelihood of a false minimum; and to calculate a realistic slope. The sample's median R^2 value for the indifference points for both conditions, .79 (interquartile range (IQR) = .38 – 1.0), indicated good model fit.

Next, for each delay, $10 (the smaller, sooner amount) was divided into the indifference point (i.e. the sigmoid point) to obtain the fraction of the objective value that the larger, later option retained at that delay. For example, using the example from Figure 2, if the indifference point is $26.50 at a 30-day delay, this fraction is therefore 0.38 (i.e. $10/$26.50 = 0.38). This means that when $26.50 is delayed by 30 days in retains 38% of its value. These indifference points were used to calculate the delay discounting rate for each participant in both conditions.

Unsystematic indifference points.

Participants whose indifference points were unsystematic were removed from the analysis. Unsystematic indifference points were defined as not declining monotonically as a function of delay (Johnson & Bickel, 2008). Johnson and Bickel (2008) set out two criteria for identifying non-systematic discounting data: 1) if any indifference point (starting with the second delay) was greater than the preceding indifference point by greater than 20% of the undiscounted value; and 2) if the last indifference point was not less than the first indifference point by at least 10% of the undiscounted value. The first criterion excludes participants who become more self-controlled as the delay increased. For example, consider a participant's indifference point at the 7-day delay was 0.43, but it then increased to 0.77 at the 30-day delay. This would mean that the amount needed for that participant to wait (instead of taking the $10 now) was smaller at 30 days ($13) compared to at 7 days ($23.50). The second criterion suggests removing participants who do not discount the future (e.g. would prefer to wait 180 days to receive $11 rather than receiving $10 now). Seventeen participants (24%) were either unsystematic according to one or both criteria, and in either one or both conditions, and were therefore removed from the analysis (see Table 1). These non-systematic response patterns are consistent with the general trend in other research findings of 18%, with university students having significantly higher rates than participants recruited from non-university settings (K. R. Smith, Lawyer, & Swift, 2018).

Table 1. *Number of participants who met exclusion criteria by condition for Study 1.*

	Control condition		Episodic memory condition	
	Criterion 1	Criterion 2	Criterion 1	Criterion 2
Number of participants who met criteria	10	6	8	6
Percentage of participants who met criteria	14.1%	8.5%	11.3%	8.5%

Calculating the delay discounting rate.

The indifference points for each delay were then plotted on a graph, with the delay along the x axis and the indifference points along the *y* axis. From here, the area under the curve (AUC) and the *k* parameter (the slope) were calculated to identify the delay discounting rate. Note that Lempert and colleagues (2017) only calculated *k*; however, this study also calculated AUC because results can differ depending on whether *k* or AUC is adopted (Olsen, Macaskill, & Hunt, 2018; C. Smith & Hantula, 2008).

K parameter. *k* is a free parameter of a hyperbolic model that measures the slope of the relationship between delay and indifference points. *k* is estimated using Equation 2 (Mazur, 1987; Lempert et al., 2017):

$$\mathrm{V} = \frac{\mathrm{A}}{(1+k\mathrm{D})} \qquad (2)$$

V is the subjective value of the delayed reward, *A* is the undiscounted value of the delay reward (i.e. 1), *D* is the delay, and *k* is the slope and the delay discounting rate. *k* is a free parameter and was identified once the model had been fitted to the indifference points. To fit the model and to calculate *k*, the solver within Microsoft Excel was used (Reed et al., 2012). The algorithm required the model's SSE to be at a minimum by changing *k*. The sample's median R^2 value for *k*, for the control condition (.78; IQR = .42 - .89) and episodic memory condition (.67; IQR = .22 - .85), indicated relatively good model fit. A higher *k* indicates relatively impulsive decision making (i.e. a higher delay discounting rate) whereas a lower *k* indicates relatively self-controlled decision making (i.e. a lower delay discounting rate).

AUC. As mentioned above, the delays and indifference points were first graphed. Next, lines connected each data point and vertical lines were placed from the data point to the x axis. These lines create trapezoids, the area of which is calculated and summed to provide the total AUC. Hence, the following Equation 3 (Myerson, Green, & Warusawitharana, 2001) was used to calculate the AUC:

$$\text{AUC} = \sum (x_2 - x_1)\left[\frac{(y_1 + y_2)}{2}\right] \qquad (3)$$

x_1 and x_2 are successive delay values and y_1 and y_2 are the indifference points associated with those delays. A total proportion of AUC was then calculated: the summed AUC (i.e. the result from the equation above) was divided by the total possible AUC, which is equal to the maximum delay (180 days) multiplied by the maximum amount (1). Thus, the AUC values range from 0 (maximum delay discounting) to 1 (no delay discounting), with lower scores indicating a higher delay discounting rate and higher scores indicating a lower delay discounting rate.

Results

Descriptive Statistics

The median and IQR were calculated for each scale and the AUC and *k* scores for each session (see Table 2).

Table 2. *Median and IQR for AUC, k and rating scores across both sessions and conditions for Study 1.*

	First session		Second session			
			Episodic memory condition		Control condition	
Measure	Median	IQR	Median	IQR	Median	IQR
AUC	-	-	.38	.33 - .47	.35	.31 - .47
k	-	-	.03	.02 - .05	.04	.01 - .05
Valence (i.e. positivity)	3.4	3.1 – 3.6	3.4	3.0 – 3.6	-	-
Intensity	2.5	2.0 – 3.0	2.5	2.1 – 3.1	-	-
Feeling	3.4	3.2 – 3.7	3.5	3.2 – 3.8	-	-
Bored	-	-	-	-	3.1	2.3 – 3.4
Tired	-	-	-	-	3.1	2.6 – 3.6

Good	-	-	-	-	2.0	1.5 – 2.4

Note. N = 53. A higher *k* and a lower AUC indicate relatively impulsive decision making (i.e. a higher delay discounting rate) whereas a lower *k* and higher AUC indicate relatively self-controlled decision making (i.e. a lower delay discounting rate). Scales ranged from 1 to 4, with higher scores indicating higher levels of that factor.

The descriptive statistics indicate that the sample on average rated their memories positively and that they produced good feelings, and that these scores were relatively stable across the two sessions. The positivity scale's IQR for both sessions was narrow, which means that participants followed instructions and wrote positive memories. Intensity was rated as moderate. The IQR for all three scales (i.e. valence, intensity and feeling) across both sessions were narrow, which indicated that much of the sample clustered around the median and did not vary greatly on these scales.

Normality Testing

Using the Kolmogorov-Smirnov test, AUC and *k* scores for the memory and control conditions were tested for normality. AUC episodic memory condition, $D(53) = .20$, $p < .001$, AUC control condition, $D(53) = .20$, $p < .001$, *k* episodic memory condition, $D(53) = .24$, $p < .001$, *k* control condition, $D(53) = .24$, $p < .001$, scores had non-normal distributions.

Hypothesis – positive, episodic memories decrease delay discounting

To test the hypothesis that positive, episodic memories decrease delay discounting (i.e. enhance self-control), we analysed whether there was a significant difference between the episodic memory condition and the control condition in delay discounting scores. Since the data were non-normally distributed, a Wilcoxon matched-pair signed rank test was used to determine whether there was a significant difference between the episodic memory and control conditions in delay discounting scores (i.e. AUC and *k* scores). There was a significant difference in AUC scores between the episodic memory (M*dn* = 0.38) and control (M*dn* = 0.35) conditions, $z = -2.20$, $p = .028$. In contrast, there was no significant difference in *k* scores between the episodic memory (M*dn* = 0.03) and control (M*dn* = 0.04) conditions,

z = 1.38, p = .169. See Brinley plots (Figure 4) below which depict individual data points for AUC and k for both episodic memory condition (y axis) and control condition (x axis). Data points on the line show that both conditions yielded same scores, whereas data points above or below the line indicate a change in delay discounting rates between conditions.

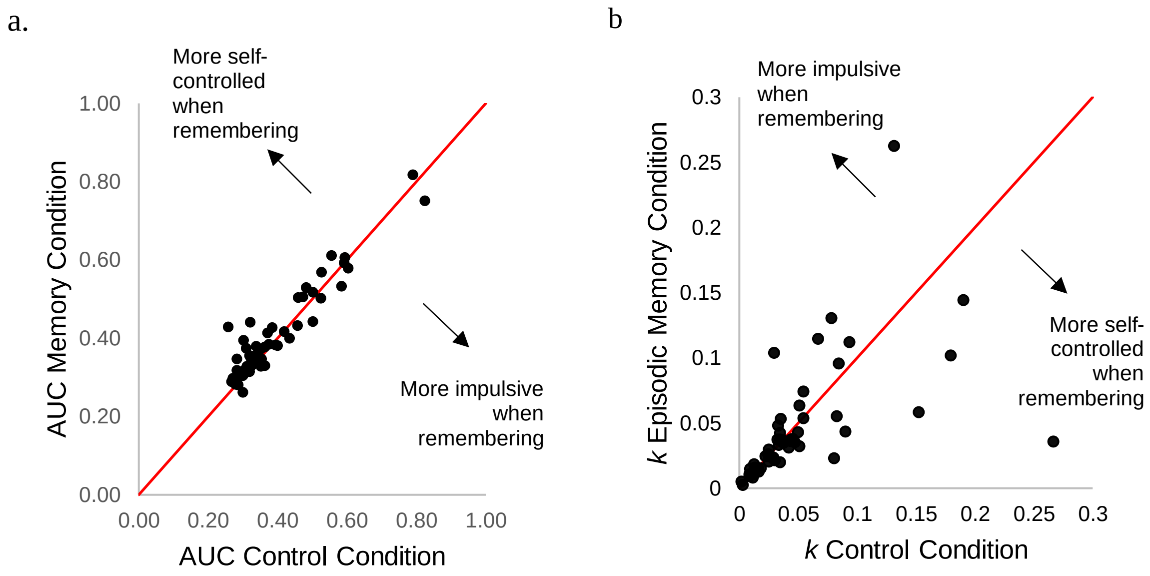

Figure 4. Brinley plots that show the relationship between episodic memory condition and control condition for Study 1. Data points indicate participants' AUC (a) and k (b) scores. Data points on the line show that both conditions yielded the same scores, whereas data points above or below the line indicate a change in delay discounting rates between conditions.

The following Equation 4 (Rosenthal, Cooper, & Hedges, 1994) was used to calculate the effect size:

$$r = \frac{z}{\sqrt{N}} \qquad (4)$$

Where r is the effect size, z is the z-score or the standardised test statistic, and N is the sample size. Thus, the effect size (using AUC) was r = .21.

In partial support of the hypothesis, results indicated that there was a small but significant effect of memories decreasing the rate at which participants discounted the future. This effect was only evident with the AUC measure, not k, however.

Post hoc exploratory analysis

Since indifference points from longer delays contribute disproportionately more to the total AUC compared to shorter delays (Borges, Kuang, Milhorn, & Yi, 2016), and the effect of episodic autobiographical memory may have a larger effect at longer delays (Snider, Laconte, & Bickel, 2016; J. Stein et al., 2016), post hoc exploratory analysis were conducted to test whether this contributed to the discrepancy between AUC and *k*. Therefore, a related samples Friedman's two-way ANOVA was used to see if there was a significant difference between the sample's memory effect score for each indifference point at each delay. 'Memory effect score' is the predicted effect; that is, how much the episodic memory condition had an effect on delay discounting compared to the control condition. (See Equation 5 in Chapter 3 for more information, but substitute AUC in the equation for indifference point. All were non-normally distributed, $p < .001$). Results indicated a significant difference, $x^2(5) = 13.15$, $p = .022$. Follow up Wilcoxon matched pair signed rank tests with a Bonferroni correction indicated that memories at a 30-day delay had a significantly higher memory effect score ($M = .04$) compared to the 4-day delay ($M = .004$, $p = .043$). Thus, the middle delay, not the longer delays, had a significant effect on delay discounting compared to the shortest delay (4 days). Further interpretation of these results is discussed in the discussion section below.

Discussion

The aim of Study 1 was to replicate Lempert and colleagues' (2017) study, which found that positive, episodic autobiographical memories decreased the rate at which participants discounted the future and thus enhanced self-control. Results indicated that Study 1 partially replicated Lempert and colleagues' study. Although results indicated a significant difference between the episodic memory and control conditions, such that participants were more self-controlled after recalling a positive, episodic autobiographical memory compared to relaxing, the effect was only evident with the AUC measure, not *k* (i.e. the measure Lempert and colleagues used).

The discrepancy between the findings produced by AUC and *k* could be explained by the inherent differences between the two measures. *k* is a hyperbolic, mathematical model and is therefore theory driven. It assumes that people discount the future monotonically and that their indifference points steadily decrease as a function of delay. However, some participant's indifference points may not be accurately captured by *k*, particularly if a person's indifference points vary across delays or if their indifference points do not decrease steadily. Although we removed participants who were unsystematic (see Method section; Johnson & Bickel, 2008), the criteria do not exclude everyone who has a slight variation to the hyperbolic model. To illustrate, although the sample's median R^2 value for *k* indicated good model fit, the 25% quartile value for both the episodic memory and control conditions were low (.22 and .42 respectively). In contrast, AUC is atheoretical and makes no assumptions about the participants' discounting curve. Whereas AUC incorporates all indifference points into the equation and takes into account when indifference points slightly increase, *k* assumes that this variation is error. Consequently, AUC accurately describes a wider range of choice patterns and is perhaps better at capturing the effect compared to *k*.

Another reason why AUC may have produced significant findings instead of *k* is because indifference points from longer delays contribute disproportionately more to the total AUC compared to shorter delays (Borges et al., 2016). This occurs because researchers tend to include more shorter delays and fewer longer delays, as we have done in Study 1. Therefore, when the delays and indifference points are graphed (see Method section), longer delays are spaced further apart on the x axis and consequently create larger trapezoids that contribute more to the overall AUC score compared to the shorter delays that are spaced closer together. Thus, if there was an independent variable that had a larger effect on delay discounting at longer delays, then AUC would be more sensitive to this effect than *k*. Indeed, the effect of EFT on delay discounting may be larger at longer delays (Snider et al., 2016; J. Stein et al., 2016). For example, Snider and colleagues (2016) found that indifference points were significantly higher in an EFT condition compared to control, but only for the longer delays (at 1 month, 3 months and 1 year), not for the shorter delays (at 1 day or 1 week). Therefore, we tested whether longer delays in this study had a larger effect on delay discounting and thus contributed to a larger effect in AUC. Post hoc results indicated that the 30-day delay had a significantly larger effect than the shortest delay (4 days), however the longest delays (100 and 180 days) did not have a significantly larger effect on delay discounting compared to the shorter delays. Therefore, the significant effect of AUC did not reflect a bigger effect of memories at longer delays. It is unclear why 30 days (the middle delay) would have had a larger effect than the shortest delay as this effect is not evident in literature. Possibly EFT performs a different function than episodic memories at longer delays, and participants may feel more influenced by their memories at the middle delay because it is not too close or too far in time to consider.

In summary, Study 1 partially replicated Lempert and colleagues (2017) study, such that participants in Study 1 were significantly more self-controlled after recalling their positive, episodic memories compared to when they relaxed. This effect was only evident in AUC and not *k*, however. A post hoc analysis indicated that this was not because longer delays were contributing more to the effect, like how longer delays were in Snider (2016), Stein (2016) and colleagues' studies with EFT. Therefore, perhaps we found a significant result in AUC and not *k* because simply of AUC's ability to consider a wider range of responses. Nonetheless, Study 1 did find that episodic memory significantly enhanced self-control; therefore, what is about episodic memory that helps with this effect?

Chapter 3: Do higher levels of episodic memory detail correlate with higher levels of self-control? (Study 2)

Study 1 found that positive, episodic memories increased self-control. Therefore, what is it about the memories that influences this effect? One possibility is the amount of detail recalled about the memory; such as, what happened during the event, when and where it happened, who was there, perceptual details (e.g. smells, sounds), and emotions and thoughts experienced at the time (Addis et al., 2008; Levine et al., 2002). The amount of memory detail could be an important variable to measure because studies have demonstrated that greater levels of episodic detail can enhance coping and psychological well-being (Jing et al., 2016) and creative thinking (Madore et al., 2015). Episodic detail is also positively related to better problem-solving ability (Sheldon et al., 2011). Thus, for Study 2, participant memories from Study 1 were coded for episodic detail. We hypothesised that higher levels of episodic detail would be related to higher levels of self-control. More specifically, episodic detail would be negatively correlated with the memory effect score. The 'memory effect score' refers to how much the manipulation (i.e. positive, episodic memory) had an effect on delay discounting in comparison to the control (see Equation 5 and 6 under the Results section for more details).

Method

Participants

This analysis used the data from the same 53 participants from Study 1 (see Chapter 2). This research was approved by the School of Psychology Human Ethics Committee, under delegated authority of the Victoria University of Wellington's Human Ethics Committee.

Materials and Coding Procedure

To measure episodic memory detail, we used the Adapted Autobiographical Interview scoring manual (Addis et al., 2008) and the procedure outlined below has been guided by Addis and colleagues' (2008) coding manual unless specified.

The coding scheme had two steps: 1) isolate the main event (i.e. their specific memory); and 2) segment and categorise the detail pertaining to the main event, as well as the detail unrelated to the main event (see below for more information). Using Syed and Nelson (2015) guidelines to establish reliability, one primary researcher coded all memories and one secondary coder coded 25% of the total memories for reliability (see Interrater Reliability section below for more information). Participant memories were entered into the computer programme SciTos (Version 2.2.0; Wickner, 2017) and coders coded the memories within this program.

Isolate and define the main event.

Although the episodic memory condition's instructions requested specific and positive memories, often participants wrote about more than one event or gave a non-specific event (e.g. an extended event that lasted longer than a day). Additionally, as described above, details related to the main event are coded differently to unrelated details. Thus, importantly, the main event was identified first (i.e. a specific, single event, lasting no more than 24 hours and that the participant was personally involved in) (Addis et al., 2008). If the main event extended over days or weeks (e.g. a holiday), the coder chose a specific event which was described in the most episodic detail.

Text segmentation and categorisation.

Once the main event was identified, the memory was segmented and categorised into 'internal' detail (i.e. episodic detail: information related to the main event) and 'external' detail (i.e. details or semantic information that are not related to the main event). A segment is a piece of information or detail: a unique occurrence, observation, fact, statement or thought. Typically, a segment is a grammatical clause, although a single clause can contain more than one detail. For example, the statement "*he had an old brown fedora*" would be segmented into three details: "*old*" and "*brown*" significantly alters the meaning of "*he had a fedora*", which on its own would be counted as one internal detail (or one external detail if it was not related to the main event). Therefore, for each clause, the coder considered whether its constituent parts conveyed additional information that could be further separated and scored.

Internal detail. Internal details are characteristics that pertain directly to the main event and can be further broken down into event (i.e. describes the event unfolding), place (i.e. where the event took place), time (i.e. when the event took place), perceptual (i.e. auditory, olfactory, tactile/pain, taste, visual details), and emotion/thought (i.e. the mental state of the participant at the time of the event) details (Addis et al., 2008).

External detail. External details are not part of the main event and include semantic details (i.e. general knowledge or facts about the world and the participant), repetitions (i.e. details that are repeated and do not add any new information to the narrative), generic events (e.g. routine behaviour, like going to the supermarket each day), and any other details, such as meta-cognitive statements (e.g. "*let me see if I can remember*") or inferences (e.g. "*I must have been wearing a coat because it was winter*") (Addis et al., 2008). External details also include specific events that are secondary to the main event (i.e. external episodic detail). For example, if the participant's main event was winning their hockey game, but they also wrote in detail about their afternoon training a week prior, then the training becomes a secondary event and is coded as external detail. Although this study only hypothesised about episodic detail (i.e. internal detail), external detail was also coded because it was integral to the coding scheme and assisted coders in determining internal detail.

Internal and External Detail Scores

To get an overall internal and external detail score for each participant, internal and external details were collapsed across categories and summed separately across participants' memories (see Table 3; Addis et al., 2008). Higher overall internal and external detail scores indicate higher levels of episodic and semantic detail respectively.

Interrater Reliability

Each participant wrote 10 memories, and 530 memories were coded. The secondary coder therefore coded 130 random selected memories for reliability testing. An additional 20 memories were selected at random and were used by the two coders to practice and discuss the coding scheme (Syed & Nelson, 2015). To elaborate, the primary and secondary coders first coded 10 of the same memories and then worked through all discrepancies slowly and methodically, while consistently referring to the coding scheme and to another experienced coder. This process was then repeated with another 10 memories and ensured that both coders had a mutual understanding of the coding scheme. Coders also periodically checked in with each other and the experienced coder to prevent coder drift (Syed & Nelson, 2015).

Intraclass correlation coefficient (ICC) estimates and their 95% confident intervals were calculated, based on a single rating, consistency, two-way mixed effects model. This approach was taken because memory detail scores are continuous, coders were not picked at random, and only the primary coder scores were used in the final analysis (for more information see Koo & Li, 2016; Syed & Nelson, 2015). Reliability analysis indicated there was good, significant reliability for internal details, ICC = .86, $F(129,129) = 13.70$, $p < .001$, 95% CI (.81, .90), and external details, ICC = .80, $F(129,129) = 9.08$, $p < .001$, 95% CI (.73, .86).

Results

Hypothesis – higher levels of episodic memory detail will relate to higher levels of self-control

To test the hypothesis that higher levels of episodic memory detail (i.e. internal detail) positively correlated with self-control, the log ratio of the predicted effect was first calculated to generate a ‘memory effect score’. For AUC memory effect score, Equation 5 was used:

$$\log\left(\frac{\text{AUC episodic memory condition}}{\text{AUC control condition}}\right) \tag{5}$$

For *k* memory effect score, Equation 6 was used:

$$\log\left(\frac{k \text{ episodic memory condition}}{k \text{ control condition}}\right) \tag{6}$$

Where the episodic memory condition’s AUC/*k* was first divided by the control condition’s AUC/*k*, and this answer was then logged to obtain the memory effect score (see Table 3). Larger AUC scores indicate higher levels of self-control; therefore, positive AUC memory effect scores indicate more self-control in the episodic memory condition, whereas negative scores indicate more self-control in the control condition. Lower *k* scores indicate higher levels of self-control; thus, the *k* memory effect score is interpreted differently than the AUC memory effect score. That is, negative *k* memory effect scores indicate more self-control in the episodic memory condition, whereas positive *k* memory effect scores indicate more self-control in the control condition. More extreme AUC/*k* memory effect scores indicate bigger differences between conditions.

Table 3. *Medium and IQR for internal and external detail scores and memory effect scores.*

	Memory detail		Memory effect score	
Measure	Mdn	IQR	Mdn	IQR
Internal detail	10.10	6.95 – 12.45		
External detail	2.40	1.6 – 3.05		
AUC			.01	-.01 – .04
k			-.03	-.14 – .06

Using Kolmogorov-Smirnov test, internal and external detail scores and AUC/*k* memory effect scores were tested for normality. Internal detail scores, $D(53) = .10$, $p = .200$, and external detail scores, *D*(53) = .10, p = .200, indicated normal distributions. However, k memory effect score, *D*(53) = .14, p = .016, and AUC memory effect score, *D*(53) = .17, p = .001, were significantly non-normal. Therefore, a Spearman rank correlation coefficient was used. Results yielded no significant correlation between episodic detail (i.e. the amount of internal detail) and memory effect score for either AUC, r_s = -.06, p = .667, or k, r_s = -.09, p = .502 (see Figure 5).

Post hoc exploratory analysis

As there was no significant correlation between episodic detail and memory effect scores, we investigated whether external detail may influence delay discounting. Therefore, as an exploratory analysis, external details were also analysed. Results also yielded non-significant results for AUC, r_s = .05, p = .747, and k, r_s = -.03, p = .84 (see Figure 4).

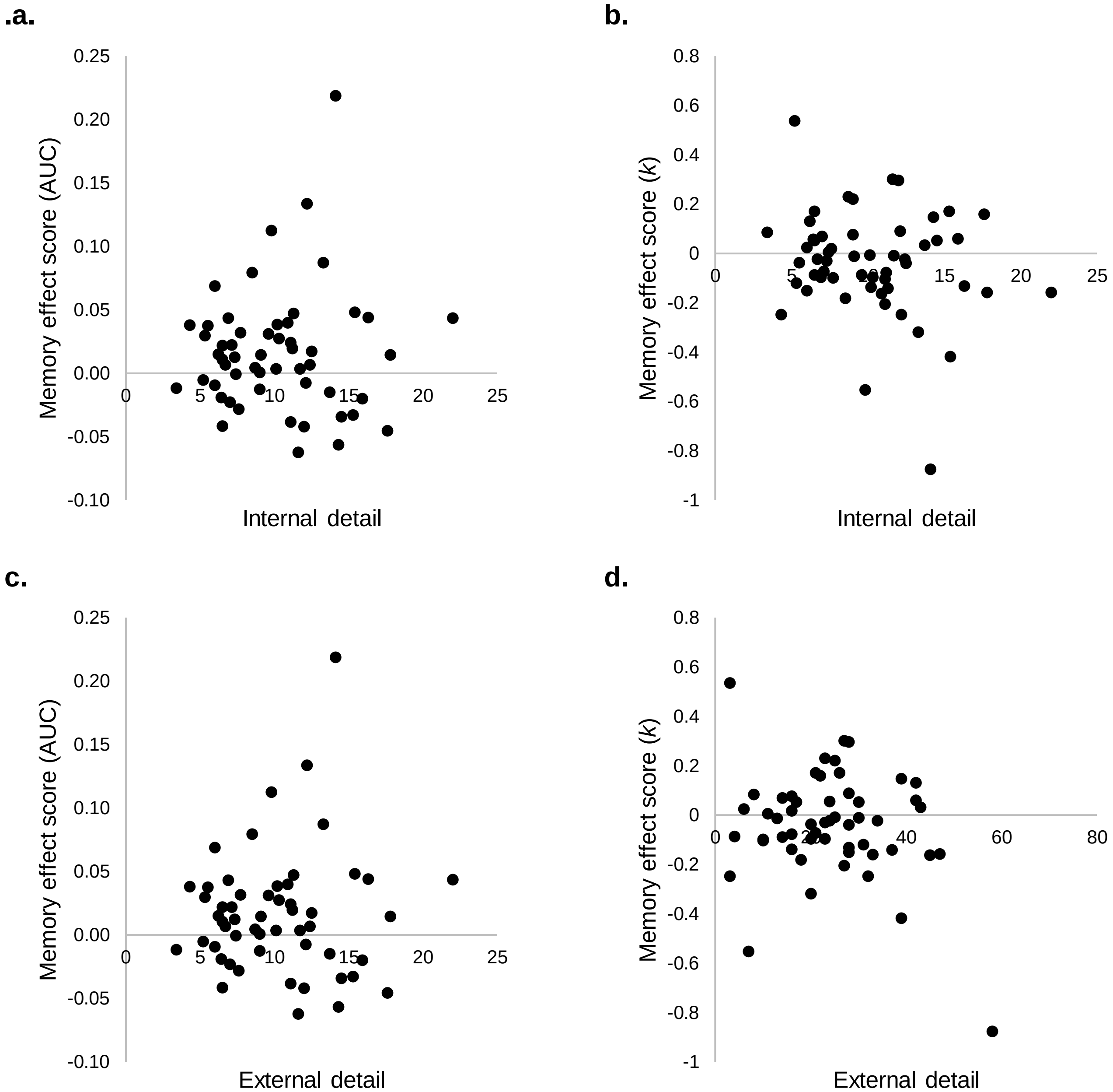

Figure 5. Scatterplots of memory effect scores and internal/external detail score. Scatterplots show the relationship between the AUC memory effect score and internal (a) and external (c) detail, as well as *k* memory effect score and internal (b) and external (d) detail. All relationships were tested using Spearman rank correlation coefficient and yielded non-significant results.

Discussion

Study 1 found that positive, episodic memories enhanced self-control; therefore, the aim of Study 2 was to investigate whether the amount of episodic detail contributes to this effect. Thus, we tested whether higher levels of episodic memory detail (i.e. internal detail) positively correlated with higher levels of self-control (i.e. memory effect score). Scatterplots and correlations indicated a non-significant relationship between episodic detail and memory effect scores. That is, the amount of detail participants recalled had no relationship with how they performed on the delay discounting task. As an exploratory analysis, external detail was also analysed, yet had no significant relationship with memory effect scores.

This result suggests that remembering many episodic details about a specific memory is not essential to decreasing delay discounting and enhancing self-control. This finding is interesting because, as highlighted in Chapter 1, experimental studies have demonstrated that episodic detail can enhance coping and psychological well-being (Jing et al., 2016) and creative thinking (Madore et al., 2015). For instance, Madore and colleagues' (2015) 'episodic memory specificity induction', helped participants to recall greater episodic detail and generate significantly more responses on an Alternative Uses Task compared to participants who did not receive the induction. Schacter and Madore (2016) concluded that the 'episodic memory specificity induction' may help with event or scene construction in the mind, which is needed for not only episodic memory, but also for imagination, problem solving and creative thinking. Making a choice between a smaller sum of money now and larger one later may not require as much scene construction in the mind compared to creative thinking and problem solving, however.

Although this study only investigated episodic detail, it is important to note that many studies highlight the association between overgeneral memory (i.e. the difficulty to recall specific memories) (Williams & Broadbent, 1986) and psychopathology, such as major depression, trauma and suicidality, and to other important aspects of psychological functioning, such as problem solving and goal setting (for review, see Williams et al., 2007). Thus, the importance of memory specificity has been emphasised in the autobiographical memory research, without much reference to general memory. Consequently, research has positioned specific memories as the ultimate form of remembering (Wang, Hou, Koh, Song, & Yang, 2018).

Furthermore, much of the research in the overgeneral memory area use participants with current mental health difficulties (e.g. Williams et al., 2007), which is not overly representative of the general population. To illustrate, Gutenbrunner, Salmon, and Jose (2018) conducted a three-year longitudinal study to test whether overgeneral memory predicted the development of depression and anxiety in an adolescent community sample ($N = 269$). Gutenbrunner and colleagues found that an overgeneral memory style in adolescence did not predict depression or anxiety across time; however, some overgeneral memories from those who reported elevated and increasing levels of rumination over time did predict anxiety across two time points. Thus, general memories are a normal function of autobiographical memory and may only be a risk factor in people who already have elevated levels of psychopathology.

In addition, in some cultural contexts, specific memories are not as adaptive as the research suggests. For instance, Wang and colleagues (2018) conducted four studies to assess the relationship between memory specificity and psychological wellbeing in healthy adults and children from European American and East Asian cultural backgrounds. Wang and colleagues found that memory specificity in East Asian samples was associated with elevated depressive symptoms, decreased adaptive skills, and increased negative affect; however, this effect was not seen in the European American samples. Asian cultures are more collective than they are individualistic, so specific memories about the self may bring about anxiety and negative affect in people who do not necessarily think about themselves in an idiosyncratic way (Wang et al., 2018). Indeed, memories are created within a cultural context which shapes the way the past is remembered and used (Wang et al., 2018). That is, the societal norms that shape how we remember and think about the self, influence how we encode and retrieve our memories and our subsequent behaviour.

Gutenbrunner and colleagues (2018) and Wang and colleagues (2018) studies suggest that recalling general memories is a normal function of autobiographical memory and in some circumstances can be more beneficial than specific memories. Although these studies specifically investigated overgeneral memory and not episodic detail, it does raise the question whether recalling a specific memory is essential to decreasing delay discounting. This study did not test for general memories though, so future research could investigate whether general memories could also enhance self-control.

Chapter 4: Is a positive self-concept an important factor to enhancing self-control? (Study 3)

Study 2 results suggest that the amount of detail a participant recalled about their memories had no relationship to their level of self-control. Thus, it appears that episodic detail is not an important factor of episodic memory that helps to reduce delay discounting and enhance self-control. Another possible reason for why episodic memory enhanced self-control in Study 1 and Lempert and colleagues' (2017) paper is because episodic memory draws attention to one's self-concept (e.g. who I am). A person's self-concept refers to information about the self and consists of attitudes, images, social roles (e.g. son/daughter), traits, thoughts and beliefs one holds about the self (Hards et al., 2019; Kuhn & McPartland, 1954; Stopa, 2009). Considering that thinking about what makes one unique induces self-attention (Silvia & Eichstaedt, 2004), reflecting on an episodic memory or one's self-concept may heighten self-awareness and thus make people more self-controlled.

Recall of an episodic memory may increase awareness about one's self-concept because autobiographical memory and the self are intimately linked. Conway and Pleydell-Pearce (2000) SMS model (as described in Chapter 1) posits that the relationship between autobiographical memory and the self is reciprocal. That is, autobiographical memory (i.e. our experiences) shapes the self (i.e. our self-concept and goals); and the self, in turn, influences the types of experiences that are encoded and retrieved. Therefore, thinking about a positive, episodic memory may raise awareness about one's own positive self-concept.

This heightened attention to the self may highlight the salient standard and motivate participants to choose the larger, later option. That is, when people focus inward, they become aware of the salient standard (i.e. either an internalised, social and/or situational standard) and any discrepancy between that particular standard and their own present state (Carver & Scheier, 2012; Duval & Wicklund, 1972). Self-awareness therefore leads to a state of self-evaluation which motivates people to change and regulate their behaviour. Therefore, thinking about one's positive self-concept may heighten self-awareness which makes the participant aware of the salient standard and subsequently selects the larger, later option. Thus, to test this idea more directly, Study 3 added a self-concept condition, whereby participants were asked to fill in five "I am…" statements with positive descriptions about themselves (i.e. Twenty Statements Test; Kuhn & McPartland, 1954), in addition to them recalling five positive, episodic memories.

The delay discounting paradigm does however assume that the salient standard is to choose the larger sum. Perhaps choosing the larger sum is not the participant's salient standard or preferred choice, and their internal standard outweighs the situational standard (Carver & Scheier, 2012; Duval & Wicklund; 1972). Therefore, this study will also see whether participants' attitudes about the future (using the Consideration of Future Consequences Scale; Joireman, Shaffer, Balliet, & Strathman, 2012) is related to memory/self-concept effect scores. 'Memory/self-concept effect scores' refers to how much the manipulation (i.e. positive, episodic memory and positive self-descriptions) had an effect on delay discounting in comparison to the control (see Equation 5 and 6 in Chapter 3 for more details on effect scores).

Thus, Study 3 hypothesised that positive, episodic memories and positive descriptions about the self would significantly decrease delay discounting relative to a control (i.e. relaxing). We also predicted that participants' attitudes towards future consequences would correlate with episodic memory/self-concept effect scores.

Method

Participants

Sixty-three psychology undergraduate students from Victoria University of Wellington participated in the study, in partial fulfilment of a course requirement. Six participants dropped out and 17 had unsystematic data (see below for detail); therefore, the final sample comprised of 40 participants. This study was approved by the School of Psychology Human Ethics Committee, under delegated authority of the Victoria University of Wellington's Human Ethics Committee.

Materials and Procedure

Study 3 was a within-participant, two-part study and was pre-registered on AsPredicted (https://aspredicted.org/ut5ks.pdf). For both sessions, participants were seated at individual computer booths and the experimenter briefed participants on the task and requested they read through, and be comfortable with, the consent material before consenting and commencing the experiment. In both sessions, participants were reminded they could leave anytime without penalty. Each session took approximately 45 minutes to complete, taking 90 minutes in total to complete the study. At the end of the second session, participants were debriefed on the study's aim and were provided an information sheet with further study and contact details.

Session 1.

Memory writing task. All participants started with the memory writing task. This task was the same as Study 1 memory writing task, such that participants were asked to write about their positive, episodic memories using the cues provided. However, to allow time for the self-concept task, participants were asked for five memories instead of ten. As in Study 1, participants also rated the valence, emotional intensity and feeling for each memory.

Self-concept task. Next, participants completed a self-concept task, which asked them to generate five positive descriptions about themselves (Kuhn & McPartland, 1954). Participants were instructed to fill in “I am…” statements as though they are describing themselves to themselves, not anybody else (see Appendix C). Participants had unlimited time to fill in the “I am” statement and once they had finished the task, they clicked a button (“continue”) to move onto the last task. This task was used to heighten participants’ self-awareness, as thinking about what makes one unique induces self-awareness (Silvia & Eichstaedt, 2004). For each self-concept, participants rated the valence (i.e. *how positive is this statement?* 1 = neutral, 4 = very positive), emotional intensity (i.e. *how intense is this statement?* 1 = not intense, 4 = very intense) and feeling (i.e. *how good does this statement make you feel?* 1 = neutral, 4 = very good).

Consideration of future consequences scale (CFCS). In the last task, participants completed the CFCS, which measures the extent to which they consider potential distant consequences of their current behaviour and whether they are influenced by those potential outcomes (Joireman et al., 2012). CFCS has 14 items (e.g. *I consider how things might be in the future, and try to influence those things with my day to day behaviour)*; including 7 reversed items (e.g. *I only act to satisfy immediate concerns, figuring the future will take care of itself*) (see Appendix D). Participants were asked to rate how much the statement was characteristic of them using a 5-point scale (1 = extremely uncharacteristic to 5 = extremely characteristic). Higher numbers indicate a greater consideration of future consequences.

Unique identifier. At the end of the session, participants created a unique identifier (i.e. username) that was linked to their memory cues, which were needed in the second session. A unique identifier also allowed for anonymity.

Session 2.

In the second session, three-days later, all participants completed three conditions: an episodic memory condition (i.e. recall a positive, episodic memory from the first session and complete a delay discounting task); a self-concept condition (i.e. generate a positive description about the self and complete a delay discounting task); and a control condition (i.e. relax and complete a delay discounting task; see Figure 6). The order of the episodic memory and self-concept conditions was counterbalanced, such that half the participants started with the episodic memory condition and the other half began with the self-concept condition, with the control condition (i.e. relax) always as the middle condition. Before commencing the experiment, participants used a drop-down list and clicked on their unique identifier, allowing the program to present the participants' memory cues that they had generated during session one.

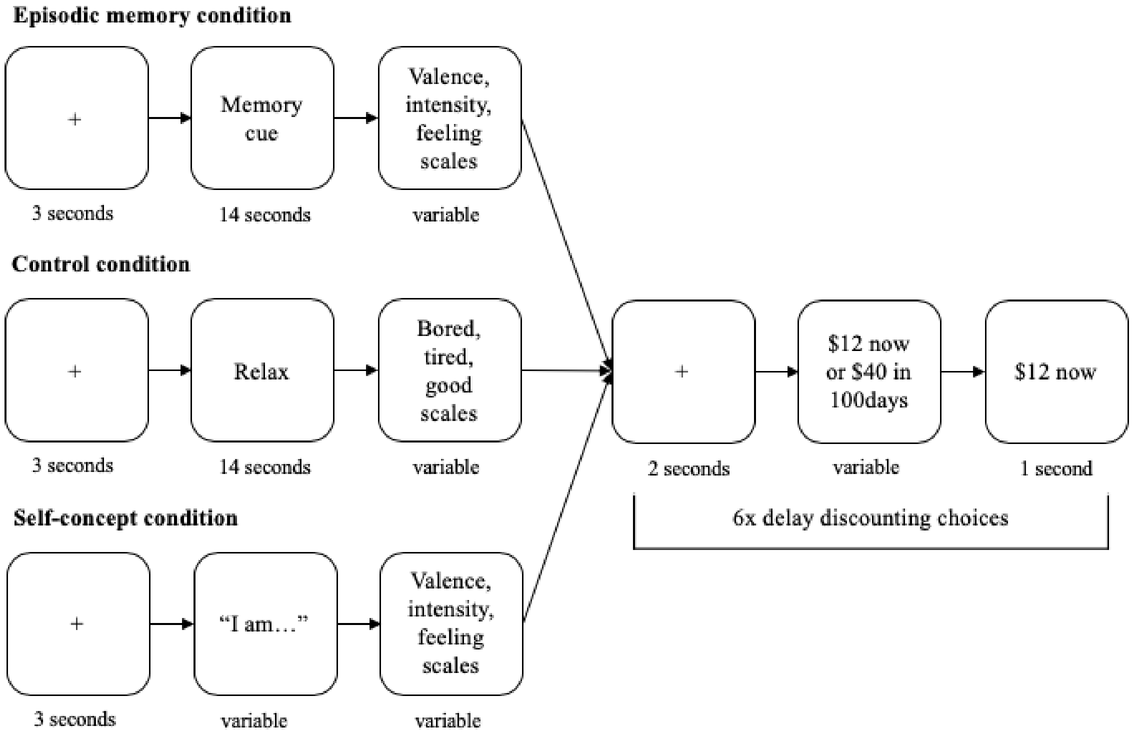

Figure 6. Second session, Study 3: episodic memory, self-concept and control conditions. For the episodic memory condition, a trial began with participants' recalling their memory using their memory cue; rating the memory's valence, intensity and feeling; and then completing six delay discounting choices. The episodic memory condition had five trials, one trial per memory. For the control condition, a trial began with the participants' relaxing; rating how bored, tired and good they felt; and then completing six delay discounting choices. The control condition had five trials. For the self-concept condition, a trial began with participants' filling in an "I am..." statement with a positive description about themselves; rating the description's valence, intensity and feeling; and then completing six delay discounting choices. The self-concept condition had five trials, one trial per "I am" statement. Memory and self-concept conditions were counterbalanced, with the control always as the middle condition.

Episodic memory condition. The episodic memory condition had five trials (i.e. one trial per memory) and ran the same as Study 1 episodic memory condition. However, at the end of the condition, as a manipulation check, participants were asked "*How aware of your* *thoughts and emotions were you while remembering and making monetary choices?*" and answered on a 4-point scale (1 = not self-aware at all, 4 = very self-aware).

Self-concept condition. The self-concept condition had five trials and ran the same as Study 1 episodic memory condition, however instead of asking participants to recall positive, episodic memories, participants wrote positive descriptions of themselves (i.e. filling in "I am" statements; Kuhn & McPartland, 1954). At the end of the self-concept condition, participants were also asked to report their level of self-awareness during the task. (i.e. *How aware of your thoughts and emotions were you while filling in the I am statements and making monetary choices?* 1 = not self-aware, 4 = very self-aware).

Control condition. There were five trials in the control condition (i.e. relax five times) and ran the same as the Study 1 control condition. The control condition also asked participants how aware they were during the task (i.e. *how aware of your thoughts and emotions were you while relaxing and making monetary choices?* 1 = not self-aware to 4 = very self-aware).

Delay discounting task. The delay discounting task was slightly different than Study 1, such that the delayed amount was fixed to $40 (instead of the immediate amount fixed at $10). A titrating-amount delay discounting procedure was also used (see rationale below). That is, the immediate amounts were modified based on the participants' previous choice at the same delay, instead of presenting a fixed set of amounts (i.e. fixed amounts procedure) like in Study 1. The immediate reward increased if the participant picked the delayed reward, however the immediate reward decreased if they picked the immediate reward. Immediate choices began at $20 for each delay and increased or decreased (depending on the previous choices) by 10% of the larger later amount (i.e. $4). For example, if a participant chose $40 in 100 days instead of $12 now (i.e. the larger, later reward), then the next choice for that delay would be $40 in 100 days or $16 now. Although if they picked $12 (i.e. the immediate reward), the next immediate choice would be $8.

The immediate amount adjustments took place over 5 choices for each delay. The indifference point was therefore calculated using the last immediate amount and participant's last, fifth choice. To illustrate, if the last option was either $40 in 60 days or $20 now and the participant picked the immediate reward of $20 now, the indifference point (i.e. how much $40 is worth in 60 days) would be $18 as it is in between $16 (what the next choice would have been) and $20 (what they picked). If, however, they picked the $40 in 60 days, their indifference point would be $22 (i.e. between $24 and $20). Thus, contrary to Study 1, larger indifference points in Study 3 were indicative of self-control.

A titrating procedure allowed for another condition and mitigated potential participant fatigue, because a fixed amount procedure would have doubled the number of choices (i.e. 180 choices compared to 90). Additionally, although the median R^2 values for the indifference points and *k* in Study 1 indicated good model fit, the IQR was widely spread and had low 25% values, which indicated that some participants' indifference points and *k* did not accurately reflect their choice pattern. Conversely, a titrating procedure calculates indifference points without using a logistic function. Furthermore, evidence suggests that titrating and fixed amounts procedures calculate similar discounting rates (Rodzon, Berry, & Odum, 2011). Delays (i.e. 4, 7, 30, 60, 100, 180 days) and the number of delay discounting choices per trial (i.e. 6) were the same as Study 1.

Results

Unsystematic data

As in Study 1, participants whose indifference points were unsystematic were removed from the analysis (see exclusion criteria in Chapter 2). A total of 17 participants

(30%) had unsystematic data in either one or both criteria, and in either one or more conditions (see Table 4).

Table 4. *Number of participants who met exclusion criteria by condition for Study 3.*

	Control condition		Episodic memory condition		Self-concept condition	
	Criterion 1	Criterion 2	Criterion 1	Criterion 2	Criterion 1	Criterion 2
Number of participants who met criteria	2	4	4	7	2	10
Percentage of participants who met criteria	3.5%	7%	7%	12.5%	3.5%	17%

Descriptive Statistics

The median and IQR were calculated for each scale in each session, as well as for the manipulation check (i.e. self-awareness) question (see Table 5). The mean and standard deviation was calculated for the CFCS.

Table 5. *Descriptive statistics for scales and self-awareness question for Study 3.*

	First session						Second session					
	Memory task		Self-concept task		Questionnaire		Episodic memory condition		Self-concept condition		Control condition	
Measure	Median	IQR	Median	IQR	Mean (*SD*)	Range	Median	IQR	Median	IQR	Median	IQR
Valence (i.e. positivity)	3.6	3.4 – 3.8	3.4	3.0 – 3.8	-	-	3.6	3.4 – 3.8	3.3	3.0 – 3.6	-	-
Intensity	2.9	2.6 – 3.4	3.0	2.6 – 3.4	-	-	2.9	2.4 – 3.4	2.8	2.4 – 3.2	-	-
Feeling	3.6	3.2 – 3.6	3.4	3.0 – 3.6	-	-	3.6	3.0 – 3.8	3.2	2.8 – 3.6	-	-
Bored	-	-	-	-	-	-	-	-	-	-	3.0	2.6 – 3.4
Tired	-	-	-	-	-	-	-	-	-	-	3.6	3.0 – 4.0
Good	-	-	-	-	-	-	-	-	-	-	2.0	1.4 – 2.2
Self-awareness question	-	-	-	-	-	-	3.0	2.0 – 3.0	3.0	2.0 – 3.8	3.0	2.0 – 3.0
CFCS	-	-	-	-	46.32 (*7.93*)	31 – 63	-	-	-	-	-	-

Note. N = 40. Scales ranged from 1 to 4, with higher scores indicating higher levels of that factor. The CFCS has a maximum score of 70 and a minimum score of 14, with higher scores indicating greater consideration of future consequences.

The descriptive statistics were similar to those found in Study 1. That is, they indicated that the sample in general rated their memories positively and indicated that they produced good feelings, and that these scores were relatively stable across the two sessions. Intensity was also somewhat lower compared to positivity and feeling, however across both sessions, intensity was moderate. IQR for all three scales across both sessions were closely spread, which indicated that much of the sample clustered around the median and did not vary greatly on these scales. The CFCS results indicated that the sample are moderate to high on thinking about future consequences.

Manipulation check

To check that participants had written positive memories and descriptions about themselves, a manipulation check was conducted and found that 96% of participants rated their memories, and 76% rated their descriptions, on average 3 or more on positivity in the second session. In the first session, 95% of participants rated their memories, and 84% rated their descriptions, on average 3 or more on positivity. No participants rated their descriptions or memories less than two (i.e. more neutral than positive) in the first or second session. Additionally, the median scores for the positivity scale across both sessions and conditions were consistent, moderate-to-high and the IQRs were small. Thus, participants followed instructions and wrote positive memories and descriptions about the self.

Participants self-awareness was moderate across the conditions in the second session. These scores were non-normally distributed (using Kolmogorov-Smirnov test) in the episodic memory, $D(40) = .30$, $p < .001$, self-concept, $D(40) = .24$, $p < .001$, and control $D(40) = .28$, $p < .001$, conditions. Using a Friedman's ANOVA, we tested whether self-awareness scores were different across conditions. Results indicated that participants were not significantly different on self-awareness between conditions, $x^2(2) = 2.18$, $p = .321$, and suggests that the self-concept manipulation did not work. This will be discussed further in the discussion section below.

Delay discounting rate

AUC and *k* were used to calculate the delay discounting rate (see Table 6; see Study 1, Chapter 2, for further detail about how AUC and *k* are calculated). The sample's median R^2 value for the control condition *k* (.87; IQR = .75 - .93), self-concept condition *k* (.87; IQR = .70 - .92), and episodic memory condition *k* (.87; IQR = .59 - .95) indicated good model fit. This indicates that the *k* model (i.e. the slope) fit the data well.

Table 6. *Median and IQR for AUC and k for session 2, Study 3.*

	Delay discounting rate	
	AUC	*k*
Condition	Median (IQR)	Median (IQR)
Episodic memory	.40 (.27 - .57)	.03 (.01 - .05)
Self-concept	.42 (.25 - .57)	.02 (.01 - .05)
Control	.39 (.30 - .58)	.02 (.001 - .05)

Note. N = 37. A higher *k* and a lower AUC indicate relatively impulsive decision making (i.e. a higher delay discounting rate) whereas a lower *k* and higher AUC indicate relatively self-controlled decision making (i.e. a lower delay discounting rate).

Normality testing

Using Kolmogorov-Smirnov test, AUC and *k* scores for the episodic memory, self-concept and control conditions were tested for normality. AUC self-concept, $D(40) = .09$, $p = .200$, and control scores, $D(40) = .13$, $p = .077$, indicated normal distributions. AUC memory, $D(40) = .14$, $p = .045$, *k* memory, $D(40) = .22$, $p < .001$, self-concept, $D(40) = .28$, $p < .001$, and control scores, $D(40) = .24$, $p < .001$, were all significantly non-normal.

Hypothesis 1 – Positive, episodic memories and positive descriptions about the self will enhance self-control

To test whether positive, episodic memories and positive descriptions about the self could enhance self-control, the first analysis investigated whether the episodic memory condition and the self-concept condition was significantly different from the control condition. Since the AUC self-concept and control conditions' delay discounting scores were normally distributed, and the boxplots for AUC memory scores indicated a relatively normal distribution, a one-way repeated-measures ANOVA was used to test whether there were any significant differences between the three conditions. Mauchly's test indicated that the assumption of sphericity had not been meet, $x^2(2) = .817$, $p = .022$, therefore the Greenhouse-Geisser correction was applied. ANOVA results indicated that AUC was not significantly affected by condition, $F(1.69, 65.94) = 0.192$, $p = .789$. Since *k* values were non-normally distributed, a Friedman's ANOVA was used. Results also suggested that values did not significantly change across the conditions, $x^2(2) = .994$, p = .608. Brinley plots (see Figure 7) also show that the majority of participants are clustered around the diagonal reference line, which suggests that neither episodic memory or self-concept conditions had an impact on delay discounting rates. Thus, thinking about a positive and episodic memory, or a positive description about oneself, did not have a significant impact on delay discounting rates.

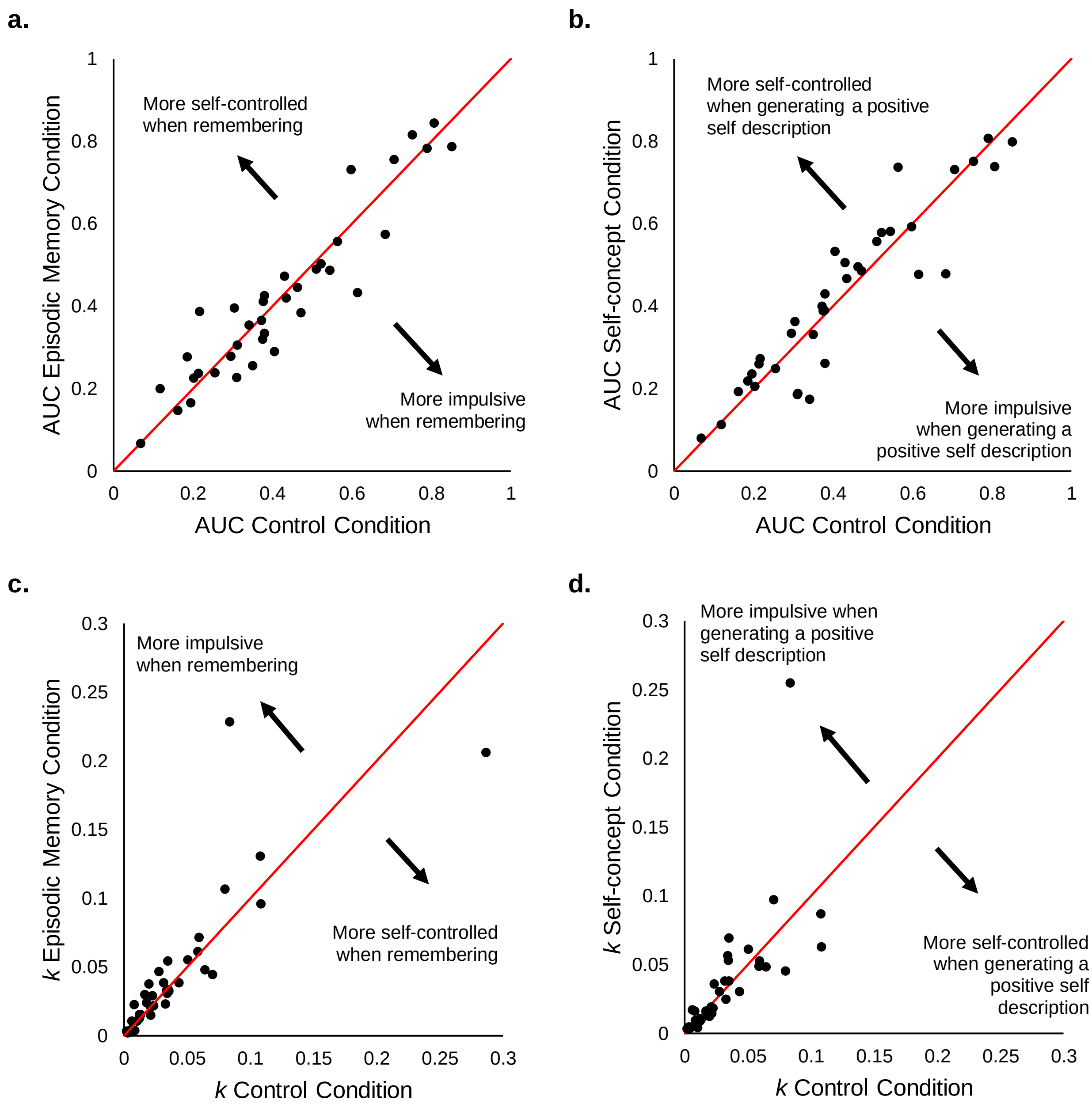

Figure 7. Brinley plots that show the relationship between the episodic memory (a, c) and self-concept (b, d) conditions and the control condition for Study 3. Data points indicate participants' AUC (a, b) and *k* (c, d) scores. Data points on the line show that both conditions yielded the same scores, whereas data points above or below the line indicate a change in delay discounting rates between conditions.

Hypothesis 2 – CFCS scores will correlate with the predicted effect of memory and self-concept conditions

Although the ANOVA results and the Brinley plots yielded no significant difference between the groups, Hypothesis 2 was still tested. That is, we tested whether attitudes towards future consequences (as measured by CFCS) would be related to the predicted effect of memory and self-concepts on self-control. First, AUC and *k* memory/self-concept effect scores were calculated using Equation 5 and 6 respectively (see Table 5 for descriptive statistics).

Table 7. *Descriptive statistics for AUC and k memory and self-concept effect score for Study 3.*

	Effect score			
	AUC		*k*	
Condition	Mean (*SD*)	Range	Mean (*SD*)	Range
Memory	.00 (.09)	-.16 - .27	.03 (*.18*)	-.38 - .44
Self-concept	-.01 (.11)	-.29 - .12	.05 (*.24*)	-.37 - .92

Note. N = 37. For AUC, positive scores indicate more self-control in the episodic memory and self-concept conditions and negative scores indicate more self-control in the control condition. For *k*, negative scores indicate more self-control in the episodic memory and self-concept conditions and positive scores indicate more self-control in the control condition. Extreme scores indicate bigger differences between conditions.

Using the Kolmogorov-Smirnov test, AUC and *k* memory and self-concept effect scores were then tested for normality. AUC self-concept effect score, $D(40) = .21$, $p < .001$, showed a non-normal distribution. AUC memory effect score, $D(40) = .12$, $p = .126$, and *k* memory effect score, $D(40) = .09$, $p = .200$, and *k* self-concept effect score, $D(40) = .13$, $p = .116$, indicated normal distributions. The CFCS also had a normal distribution, $D(40) = .11$, $p = .200$.

A Spearman rank correlation coefficient was used to test whether AUC self-concept effect scores correlated with the CFCS scores. Results yielded no significant correlation between CFCS and AUC self-concept effect score, $r_s = -.09$, $p = .567$ (see Figure 8). A Pearson correlation coefficient was used to test whether *k* memory and self-concept effect scores and AUC memory effect scores correlated with the CFCS scores. Results yielded no significant correlation between CFCS scores and *k* memory effect scores, $r = .12$, $p = .479$, *k* self-concept effect scores, $r = .08$, $p = .613$, and AUC memory effect scores, $r = -.07$, $p =$ .661.

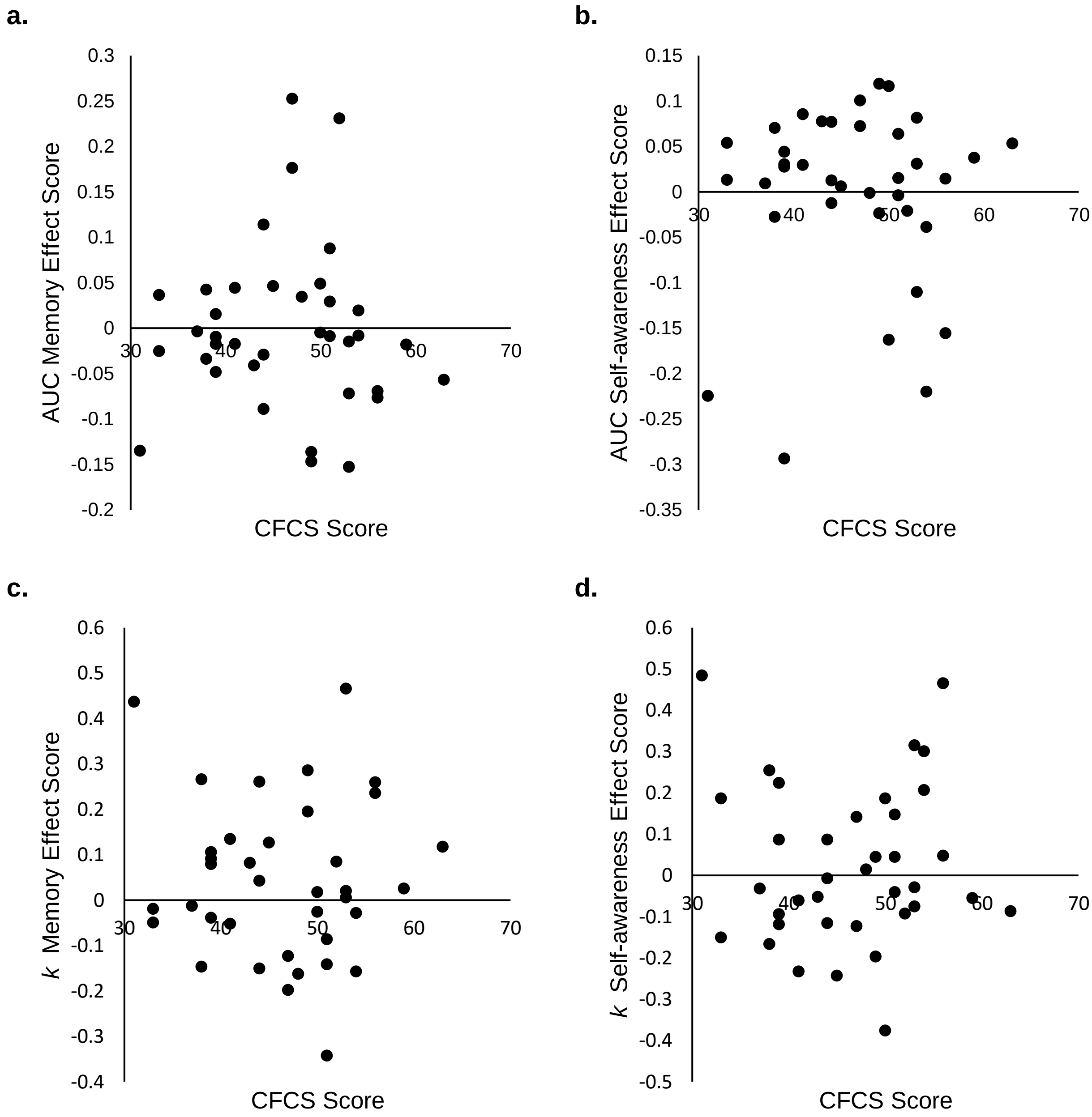

Figure 8. Scatter plots of CFCS scores and predicted effect scores for memory and self-concept conditions. Note variation in y-axis range across graphs.

Post hoc exploratory analysis

Results indicated no significant difference between conditions on delay discounting scores. Perhaps the additional condition meant that participants got tired by the third condition and therefore did not engage fully on the task. This raises the possibility that the episodic memory and/or self-concept conditions that participants completed earlier in the session increased self-control (as in Study 1) but this effect was masked by the absence of an effect in conditions completed at the end of the session when participants had become tired.

To test for this, we looked at whether there was a significant difference between the first condition and control. For participants who started with the episodic memory condition, there was no significant difference in delay discounting scores between the episodic memory condition (AUC *Mdn* = .39; *k Mdn* = .03) and the control condition (AUC *Mdn* = .38; *k Mdn* = .03) in delay discounting scores for AUC, $z = 0.89$, $p = .375$, and *k*, $z = -0.64$, $p = .520$. For those who started with the self-concept condition, there was also no significant difference in delay discounting scores between the self-concept condition (AUC *M* = .40; *k Mdn* = .02) and the control condition (AUC *M* = .43; *k Mdn* = .02) for AUC, $t(18) = 1.04$, $p = .314$, and *k*, $z = 1.05$, $p = .295$. Thus, it does not appear that participants got more fatigued as the experiment progressed.

Perhaps, therefore, participants turned up to the experiment already tired and thus felt unmotivated to engage with the task entirely. To test for this possibility, tiredness levels were compared from Study 1 and 3. Using an independent samples Mann-Whitney U test, results yielded a significant difference in tiredness scores between Study 1 and 3 participants, $U = 1360$, $z = 2.35$, $p = .019$. That is, participants in Study 3 were significantly more tired than those who participated in Study 1. Study 3 participants could have been less engaged with the entire experiment and hence the non-significant result. This idea, along with other potential reasons for the non-significant result, will be discussed further in the discussion section below and in Chapter 5, General Discussion.

Discussion

The aim of Study 3 was to test whether a positive self-concept was an important factor in why episodic memory enhanced self-control. The rationale for this question was that autobiographical memory and the self are closely linked (i.e. SMS; Conway & Pleydell-Pearce, 2000), so thinking about your positive, episodic memories may draw attention to one's positive self-concept and thus heighten self-awareness. Consequently, heightened self-awareness could have enhanced self-control (Alberts et al., 2011; Kernis & Reis, 1984; Macrae et al., 1998; Wicklund & Duval, 1971). Thus, Study 3 included an additional self-concept condition and predicted that cuing both positive, episodic memories and positive descriptions about the self would reduce delay discounting compared to when the participants relaxed. In contrast to the hypothesis however, there was no significant difference between any of the conditions on delay discounting scores, such that both the episodic memory condition and self-concept condition were not significantly different from the control condition or from each other.

Study 3 also investigated whether participants' attitudes about the future (using the CFCS; Joireman et al., 2012) were correlated with the predicted effect (i.e. memory/self-concept effect scores). This was because thinking about positive, episodic memories and positive descriptions about oneself may make participants more aware of their internalised standard (i.e. their attitude towards the future), rather than the situational standard of choosing the larger, later option. However, CFSC scores did not correlate with the effect of positive, episodic memory and positive self-descriptions. One possibility for the non-significant result could be because the CFSC range was restricted. That is, CFSC scores were moderate-to-high, with a high range and relatively small standard deviation, so therefore there was not much room to detect a correlation.

Although delay discounting scores were not statistically different between conditions, we cannot conclude that a positive self-concept is not an important factor of episodic memory which helps to enhance self-control. This is because participants' responses to the self-awareness manipulation check were also not statistically different between conditions. The manipulation check asked participants how self-aware they were during the task (i.e. *How aware of your thoughts and emotions were you while* [*remembering/filling in the I am statements/relaxing*] *and making monetary choices?*). Therefore, according to the manipulation check, it appears that the episodic memory and self-concept conditions did not raise self-awareness and thus we cannot draw conclusions from the findings.

The non-significant results for the manipulation check was unexpected, considering Conway and Pleydell-Pearce's (2000) SMS theory (i.e. that the self and autobiographical memory are closely linked) and the evidence that suggests that heightened self-awareness increases self-control. However, the studies that do propose that heightened self-awareness motivates people to eliminate the discrepancy between the salient standard and their own present state (i.e. Alberts et al., 2011; Kernis & Reis, 1984; Macrae et al., 1998; Wicklund & Duval, 1971) ask participants to face a mirror, listen to their own voice recordings, and unscramble sentences that start with 'I' to prime for self-awareness. Thinking about one's positive self-concept or a positive, episodic memory is different to looking in the mirror or hearing your own voice, and are perhaps therefore tapping into different aspects of the self. That is, it is possible that self-concepts and episodic memory tap more into the content of the self (e.g. this is what happened to me, and this is who I am), whereas looking at oneself in the mirror, for example, triggers one to monitor, evaluate and judge information about the self (Luke & Stopa, 2009; Stopa, 2009). To explain further, Luke and Stopa (2009) conducted a comprehensive review of theories about the self and their implications for psychopathology, and developed a model that groups the self into three broad categories: content, structure and process. According to Luke and Stopa's model, content is knowledge and information about the self (e.g. self-concepts/images, autobiographical memory), structure is the way that information is organised (e.g. is the self clear or complex), and process is how attention is allocated to self-relevant information, as well as the strategies that are used to attend and regulate the self (e.g. self-awareness, self-evaluation, social comparison). Therefore, recall of episodic memories and descriptions about oneself are perhaps tapping into the content of the self (e.g. who I am) not the process (e.g. self-awareness). If so, then Study 3 episodic memory and self-concept conditions may have inadvertently asked people to think about the content of the self (e.g. this is who I am), rather than directly heightening self-awareness through tapping into the process of the self. Consequently, this may have led to the non-significant results of the manipulation check and potentially the non-significant results. Although we cannot draw conclusions whether heightened self-awareness can decrease delay discounting, it is still an important question to ask. If self-concepts and episodic memory do not heighten self-awareness, future research could use a mirror or recordings of the participant's voice to prime for self-awareness and investigate whether heightened self-awareness can indeed enhance self-control on a delay discounting task.

Episodic memories in Study 3 did not enhance self-control, therefore the effect of episodic memory on delay discounting appears fragile. The effect size for Study 1 and Lempert and colleagues' (2017) study were r = .21 and d = .48 respectively, and it is possible that any variation to the original paradigm removes this small-to-medium effect. However, it is hard to determine how the two key differences between Study 1 and 3 (i.e. the use of a titrating method and adding a condition) could have had a significant impact. The first difference was that Study 1 used a fixed amount procedure to calculate indifference points, whereas Study 3 used a titrating method. A titrating method in Study 3 meant participants had fewer choices in comparison to Study 1 and indifference points were calculated differently. As previously noted, research findings suggest that titrating and fixed amount procedures calculate similar discounting rates (Rodzon et al., 2011) and the sample's median k R^2 values for the episodic memory, self-concept and control conditions indicated good model fit. Therefore, this difference should not have had a significant impact on the results. The other key difference between Study 1 and 3 was adding the self-concept condition, which may have made participants fatigued by the third condition and consequently removed the effect. Yet, there was no order effect, such that whether participants started with the episodic memory condition or the self-concept condition did not influence the results. Perhaps the non-significant results for episodic memory in Study 3 are better explained by the participants' overall level of tiredness and possible disengagement with the task. Tiredness was significantly higher in Study 3 compared to Study 1 which may have made it difficult for participants in Study 3 to engage with the task (to be discussed further in Chapter 5, General Discussion).

To conclude, Study 3 found no significant difference between conditions on delay discounting rates, such that neither positive, episodic memories or positive descriptions about the self (i.e. a positive self-concept) enhanced self-control. However, this study cannot conclude that a positive self-concept, and thus self-awareness, is not an important factor in why episodic memory enhanced self-control in Study 1 and Lempert and colleagues (2017) study. This is because the manipulation check suggests that neither the episodic memory or self-concept conditions raised self-awareness. One explanation is because episodic memory and self-concepts tap more into content about the self, rather than specifically self-awareness. Furthermore, positive, episodic memories did not increase self-control, which was unexpected considering Study 1 and Lempert and colleagues (2017) findings. High levels of tiredness could explain this result and will be discussed in the following chapter.

Chapter 5: General Discussion

Under what circumstances does autobiographical memory enhance self-control?

Our aim was to test whether autobiographical memory can enhance self-control. More specifically, whether positive, episodic memories could decrease delay discounting. Although only evident in the AUC delay discounting measure (not *k*), Study 1 produced significant results: participants had significantly lower delay discounting rates (i.e. were more self-controlled) after recalling a positive, episodic memory compared to when they relaxed. It was posited that the discrepancy between AUC and *k* could be because AUC makes no assumptions about the participants' discounting curve. Therefore, the AUC calculation captures a wider range of participant choice patterns and is perhaps better at finding the effect compared to *k*.

Study 2 and 3 were conducted to test whether certain characteristics of episodic memory (i.e. episodic detail and attention to one's positive self-concept) were contributing to this effect. That is, we tested whether the amount of episodic detail correlated with the predicted effect and whether generating positive descriptions about oneself would also increase self-control. There was no significant relationship between the amount of episodic detail and the predicted effect in Study 2. There was also no significant difference between episodic memory, self-concept and control conditions in Study 3. Study 3 manipulation check meant that we could not determine whether a positive self-concept, and thus heightened self-awareness, was an important factor in why positive, episodic memory enhanced self-control. It was suggested that episodic memory and positive self-descriptions tap more into the content of the self, rather than self-awareness.

Although Study 1 successfully replicated Lempert and colleagues (2017) study, Study 3 yielded a non-significant result for episodic memory enhancing self-control. Therefore, the effect of episodic memory on self-control appears fragile and any variation to Lempert and colleagues' original paradigm seemed to dampen the effect. It is difficult to determine exactly what change to Lempert and colleagues' methodology led to the non-significant result for episodic memory in Study 3, however. Since there was no order effect, adding a condition in Study 3 is an unlikely explanation. In addition, using a titrating method to calculate delay discounting rates instead of fixed amount procedure in Study 1 should not have had a substantial impact on results (Rodzon et al., 2011). One possible reason for the differences in results between Study 1 and Study 3 is that participants were significantly more tired in Study 3 compared to Study 1.

High levels of tiredness: a reason why episodic memory did not enhance self-control in Study 3?

Perhaps the non-significant results for episodic memory in Study 3 are better explained by the participants' level of tiredness and thus potential lack of engagement with the task. This is because the level of tiredness was rated as significantly higher in Study 3 compared to Study 1. The mean level of tiredness in Study 3 (M = 3.32) also appears higher than that reported by Lempert and colleagues' (2017) participants, whose mean tiredness scores ranged between 2.35 - 2.75 across four studies. Additionally, participants in Study 3 were also slower to sign up to the study compared to Study 1 participants; 15 participants who initially signed up to participate did not turn up to the first session; and 6 participants dropped out after the first session. A reason for the high level of tiredness and slow sign up could be because Study 3 was scheduled at the end of the semester and year. First year undergraduate students may have been too busy and tired to fully engage with the task. Furthermore, Lempert and colleagues (2017) paid $10-25 (US dollar) per hour to their participants for partaking in their experiments. This was in addition to participants receiving one of their choices at random. Lempert and colleagues' participants could possibly be more motivated to fully engage in the task because they were getting paid for their time.

The significant difference in the level of tiredness between studies is noteworthy because studies suggest that fatigue diminishes motivation, increases distractibility and influences information processing (Boksem, Meijman, & Lorist, 2006; Lorist, Boksem, & Ridderinkhof, 2005). People who are tired are also less likely to detect errors and more willing to take chances in everyday decision making (Hockey, John Maule, Clough, & Bdzola, 2000). Furthermore, Mullette-Gillman, Leong, and Kurnianingsih (2015) found that cognitive fatigue destabilised economic decision making in their participants, such that participants gave inconsistent preferences to a range of economic measures. In essence, fatigue could influence a participant's motivation and engagement on the task, as well as their delay discounting choices.

Fatigue would also make it difficult to retrieve episodic memories as it requires the participant to search their autobiographical memory (Conway & Pleydell-Pearce, 2000; Williams et al., 2007) which takes effortful control (Dalgleish et al., 2007). That is, according to Conway and Pleydell-Pearce's (2000) SMS model, autobiographical memory is structured hierarchically, from life chapters through to general events and then to episodic memory, so it takes effort to search down through the SMS to reach an episodic memory. Therefore, if Study 3 participants were more tired than people in Study 1 and engaged with the task less fully, then it may have been difficult for them to retrieve an episodic memory, recall it for 14 seconds in their mind and then make a series of monetary choices.

Future research could untangle what 'tiredness' means for participants. Are they indicating a high level of tiredness because they are stressed by end-of-year assignments and exams and do not see the incentive to engage in the task, or are they sleep deprived, or are they burnt-out? All are possible explanations of tiredness and could impact participants' level of engagement. Unpacking tiredness would be beneficial because it would help us understand the impact of tiredness on experimental research and thus design better experiments so that participants can engage fully.

Autobiographical memory influence on self-control: a worthwhile research topic?

Participant tiredness aside, the effect does appear fragile and low in these studies, which raises questions about whether autobiographical memories influence self-control, particularly when self-control is conceptualised as delay discounting. When conducting this research, Lemepert and colleagues' (2017) study was the only published paper directly investigating whether positive, episodic memory could increase self-control (i.e. decrease delay discounting). Not only does this show the importance of replicating their findings, it also raises questions around why other researchers have not pursued this research topic and whether non-significant findings are yet to be published (Shrout & Rodgers, 2018). However, before leaving this research topic behind, it could be worthwhile considering the type of memories people recall and what they do with those memories once they are recalled, and how this, in turn, can impact decision making and behaviour.

To elaborate, if we use our memory to guide and direct our behaviour (i.e. the directive function; Bluck & Alea, 2002; Pillemer, 1992), then perhaps memories need to be more directly related to the target behaviour and more directive in guiding participant behaviour. For instance, in the current studies and Lempert and colleagues' (2017) procedure, participants are asked to think of a specific and positive memory that corresponds to a cue without guidance on what to do with that memory once it is generated. The memory cues provided to participants are also not related directly to self-control or saving money and therefore could elicit memories that are helpful or unhelpful. In the debrief sessions held after Study 1 and 3, some participants did mention that some of their memories made them more impulsive, while others said they made them more self-controlled. For example, one participant thought about how much money they spent during that event which subsequently made them want to save more, whereas another said they thought about how much fun they had and picked the immediate rewards. Autobiographical memory is reflected upon, and is integrated into one's life story, identity and understanding of the world (Bluck & Alea, 2002; Conway & Pleydell-Pearce, 2000; Pillemer, 1992). Therefore, perhaps the type of memory and the participant's reflection of their experience impacts self-control.

To illustrate further, the studies discussed in Chapter 1 (i.e. recall of a positive, episodic memory led to an increase in donations (Kuwabara & Pillemer, 2010), exercise (Biondolillo & Pillemer, 2015) and helping behaviour (Ford et al., 2018)), used memories that were related to the target behaviour or the context. For example, participants who thought about a positive, episodic memory about their university were more likely to donate money to the university and indicate intentions to donate in the future, attend a class reunion and recommend the university to others, even after controlling for pre-existing feelings towards the university (Kuwabara & Pillemer, 2010). Biondolillo and Pillemer (2015) also found that positive, motivational memories (i.e. an experience that would increase their motivation to exercise) had a significant effect on students' self-reported exercise activity, even after they controlled for prior attitudes, motivation and exercise activity.

Therefore, in the next study, participants could be asked to recall a memory where they were self-controlled and it paid off (e.g. a time they chose to study instead of going to a party and got a good mark on their test), and to reflect on what they learnt from their experience. Furthermore, Study 1 and 3 experimental designs limited our ability to investigate the impact of individual memories on delay discounting. Therefore, using multi-level modelling (see Field, 2013), it would be beneficial to measure the impact of individual memories on delay discounting so that a more nuanced evaluation of the memories could be undertaken.

Conclusion

In conclusion, autobiographical memory (i.e. positive, episodic memories) can enhance self-control, albeit a fragile and small effect. This effect is not related to the amount of episodic detail recalled, but could depend on motivated and alert participants, and the delay discounting measure and the original Lempert and colleagues' (2017) paradigm being used. Future research could test whether memories need to be related to the task and/or whether participants need to draw lessons from to have an effect on self-control.

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Appendix A: Episodic memory condition cues

Lempert and colleagues' (2017) memory cues were slightly adapted for a New Zealand and undergraduate audience and to ensure participants recalled specific and positive memories. That is, cues that referred to American holidays (e.g. 4th July, Thanksgiving) and neutral cues (e.g. drinking from the water fountain) were removed. "A time I.." was also placed in front of each cue to help participants think of a specific (i.e. episodic) memory. Refer to the table below for a list of Lempert and colleagues' and study's memory cues.

Lempert et al. (2017) memory cues	This study's memory cues
Getting an ID card	A time I bought something I really wanted
Going to the theater	A time I got a new pet
Drinking from a water fountain	A time I hosted a party
Visiting a museum	A time I played a game of my favourite sport
Going to a first session of a class	A time when I played in the snow or went skiing/snowboarding
Vacuuming	A time I received a present
Going to a movie the day it opens	A time I went to a gig or a show
Washing dishes	A time I visited a museum
Participating in sports	A time I went to a movie the day it opened
Being in a wedding	A time I went to the beach
Thanksgiving	A time I went to the first session of a class
Looking for an apartment	A time I went to the theatre
Folding laundry	A time my favourite team won a competition
Graduating	A time I went to a wedding
Getting a haircut	My favourite Christmas day
Hosting a party	The day my friend/relative arrived to visit
Having a friend/relative visit from out of town	A time when I attended a friend's birthday party
Fourth of July	A time I went on a date
Playing in the snow	A time when I drove my car
Seeing a band in concert	My first day on the job
Attending a friend's birthday party	A time I had a good conversation with a friend
Getting a pet	
Shopping for a winter coat	
Receiving college/graduate school/job acceptance letter	
Brushing your teeth	
Getting engaged or married	
Going to the beach	
Watching the news	
Getting a good grade in a class	
Favorite team winning a championship	

Appendix B: Memory task instructions

Once you click 'start task', a list of event cues will appear in a drop-down menu. Pick an event cue and then think and write about one specific memory that is associated with the event cue. Please provide responses for TEN event cues.

The memory must follow these guidelines:

- It must be positive. If you cannot think of a positive memory, then choose a neutral one, but not a negative one.
- It must have occurred at a specific place and time and last for no more than 24 hours.
- It cannot be something you only heard about from others.
- You must write about a different memory for each event cue.

HELPFUL HINTS

- If multiple memories come to mind and you have trouble deciding which to choose, perhaps pick the one that comes to mind with ease or sticks out the most.
- If the event is something you do quite frequently, perhaps pick the most recent experience. Also, be sure you're selecting a specific event and not thinking of this experience in general.

You will also be asked to write a short cue that will help you remember this memory in the next session, as well as when and where this event happened.

Click ‘start task’ when you are ready.

Appendix C: Self-concept "I am" instructions

The self-concept condition's "I am" task was taken from the Twenty Statements Test by Kuhn and McPartland (1954). The instructions for the task were:

Complete the "I am.." statements as if you were describing yourself to yourself, not to somebody else. It needs to be positive, but don't worry about logic or 'importance.' Just fill them in however you see fit.

Appendix D: Consideration of Future Consequences (CFCS; Joireman, Shaffer, Balliet, & Strathman, 2012) instructions and items

For each of the statements below, please indicate whether or not the statement is characteristic of you. If the statement is extremely uncharacteristic of you (not at all like you) please select the circle on the left; if the statement is extremely characteristic of you (very much like you) please select the circle on the right. And, of course, use the circles in the middle if you fall between the extremes. Please keep the following scale in mind as you rate each of the statements below.

1. I consider how things might be in the future, and try to influence those things with my day to day behavior.
2. Often I engage in a particular behavior in order to achieve outcomes that may not result for many years.
3. I only act to satisfy immediate concerns, figuring the future will take care of itself.
4. My behavior is only influenced by the immediate (i.e., a matter of days or weeks) outcomes of my actions.
5. My convenience is a big factor in the decisions I make or the actions I take.
6. I am willing to sacrifice my immediate happiness or wellbeing in order to achieve future outcomes.
7. I think it is important to take warnings about negative outcomes seriously even if the negative outcome will not occur for many years.
8. I think it is more important to perform a behavior with important distant consequences than a behavior with less important immediate consequences.
9. I generally ignore warnings about possible future problems because I think the problems will be resolved before they reach crisis level.

10. I think that sacrificing now is usually unnecessary since future outcomes can be dealt with at a later time.
11. I only act to satisfy immediate concerns, figuring that I will take care of future problems that may occur at a later date.
12. Since my day-to-day work has specific outcomes, it is more important to me than behavior that has distant outcomes.
13. When I make a decision, I think about how it might affect me in the future.
14. My behavior is generally influenced by future consequences.