

CALIFORNIA STATE UNIVERSITY, NORTHRIDGE

THE EFFECTS OF IMPULSIVITY AND DEPLETED SELF-CONTROL  
ON TEMPORAL DISCOUNTING

A thesis submitted in partial fulfillment of the requirements  
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By

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## ABSTRACT

# THE EFFECTS OF IMPULSIVITY AND DEPLETED SELF-CONTROL ON TEMPORAL DISCOUNTING

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Although the combination of impulsivity and depleted self-control could have unique effects on financial decision-making and temporal discounting, their combined influence has not been empirically tested. The present research addresses this gap by examining the effects of hunger-induced impulsivity and depleted self-control on intertemporal choice. The results suggest the combined influence of impulsivity and depleted self-control has no effect on temporal discounting specifically. However, depleted self-control did influence intertemporal choice in a way inconsistent with most previous studies: depleted participants displayed *less* myopic preferences.

## INTRODUCTION

Whether deciding between tasty but unhealthy food in the present and better future health, or between an immediate smaller monetary reward and a larger future reward, people are continuously making intertemporal choices (Chapman & Elstein, 1995; Xu, Liang, Wang, Li, & Jiang, 2009). Any decision or behavior comprised of consequences that occur at different points in time may be considered intertemporal in nature (Loewenstein & Prelec, 1992; Frederick, Loewenstein & O'Donoghue, 2002). One of the most commonly employed methods in studying intertemporal choice is to have people decide between small immediate monetary rewards and larger delayed monetary rewards. The smaller the reward they are willing to settle for, while foregoing the larger delayed reward, the more they are considered to devalue – or discount – the larger delayed reward (Frederick et al., 2002). This phenomenon is referred to as temporal discounting (Loewenstein & Prelec, 1992; Frederick et al., 2002).

In general, temporal discounting can be described as a negative relationship between the value of a good or an outcome and the amount of time before that good is received, or the outcome manifests. That is, time delay decreases the perceived value of future commodities, including effort and time, as well as outcomes (Trope & Liberman, 2000). For example, products that require effort to assemble, but are less expensive than fully assembled products, are more attractive when one considers buying them in the future, or when there is a long anticipated delivery time, than in the present (Soman, 2004). More specifically, the author found that a greater percentage of people expressed a preference for a product that required effort to assemble when there was a delay until it

could be received (Experiment 1). This was true for two products: a computer and a desk. Furthermore, participants attributed more weight to the effort required to assemble a product than to its price when delivery was immediate, whereas they attributed more weight to price than to effort required to assemble when delivery was delayed (Experiment 2). This finding suggests that some future attributes may be discounted differently than others.

Temporal discounting has also been examined in field studies, for example, where economic behavior was examined as a proxy for peoples' devaluation of future resources (Hausman, 1979). Specifically, using actual consumer data, the author found that people of various income levels preferred relatively cheap and low energy-efficient air conditioners than relatively expensive and high energy-efficient units (disregarding the future savings in electricity bills). Other field studies implicate temporal discounting in a wide range of behaviors such as saving for retirement, accumulating credit card debt, and even procrastinating (McClure, Ericson, Laibson, Loewenstein, & Cohen, 2007).

### **Temporal discounting across domains**

Some researchers have noted that even future health outcomes and future human lives are discounted. In a study by Horowitz and Carson (1990), participants demonstrated a preference for selecting risk reduction programs that would save fewer lives starting immediately instead of programs that would save a greater number of lives in three years. The pattern held across various domains, including highway safety measures, air travel regulations, and workplace safety measures. Cropper, Aydede, and Portney (1992) also observed that individuals preferred programs that saved few lives in the present as opposed to programs that save a more lives in the future. Similar

discounting patterns are found when people make decisions about their own health outcomes. For example, people prefer 2 years of good health now to 4 years of good health in the future, and prefer 3 years of bad health now to avoid 4 years of bad health in the future (Chapman & Elstein, 1995; Ganiats et al., 2000). Horowitz and Carson (1990) as well as Small, Loewenstein and Slovic (2007) have argued that individuals' proclivity to discount the value of future outcomes and commodities, may be one of the reasons for shortsighted public policies. These myopic tendencies may have negative consequences not only at the individual level, but for society at large, attesting to the importance of the study of intertemporal choices.

### **Temporal discounting of money**

When it comes to the temporal discounting of money, people show an overwhelming preference for smaller immediate rewards in choice tasks involving both real and hypothetical money (Frederick et al., 2002). More specifically, recent studies suggest that individuals discount in a quasi-hyperbolic way, characterized by greater temporal discounting when time delays between immediate and future rewards are shorter (e.g., \$1 today or \$2 tomorrow) and less temporal discounting when time delays between immediate and future rewards are longer (e.g., \$1 today or \$2 one year from now; Giordano et al., 2002; McClure et al., 2007).

Most temporal discounting tasks provide a behavioral measure; therefore, there are several purported "rational" reasons for why people appear to devalue the future. When people choose a smaller immediate reward instead of a larger delayed reward, several factors that are not necessarily mutually exclusive may interact to make it seem as though people are devaluing the future. For example, people may believe they will never

actually receive the delayed reward, they may be worried about high currency inflation, and/or believe they will be better off financially in the future, at which point the larger delayed reward may not be as valuable as the smaller one is now (Frederick et al., 2002). Indeed, some studies suggest there is a psychological disconnect between our present self and our future self, which leads to a preferential treatment of our present self (Hershfield et al., 2011). Illustrating this effect, participants who interacted with digitally aged versions of themselves exhibited less myopic preferences and chose larger delayed rewards.

In addition to the aforementioned cognitive factors, there are also incidental and affective factors involved in myopic intertemporal choices. For example, studies show that impulsivity may be triggered by visceral states such as sexual excitation, hunger, and opioid deprivation (Giordano et al., 2002), as well as exposure to tempting or provocative stimuli (Van den Bergh, Dewitte & Warlop 2008). In turn, this type of impulsivity leads to greater temporal discounting and the demonstration of more myopic preferences in decision-making. However, even with the adverse effect that impulsivity has on long term decisions, people still have the capacity to exert self-control, delay gratification, and opt for less myopic choices (Metcalfe & Mischel, 1999). Despite the potential personal and financial ramifications, there has been little research on whether self-control can curtail the influence of impulsivity, and if depleted self-control and impulsivity lead to even greater temporal discounting than impulsivity alone in the context of intertemporal choice. In order to address this gap in the literature, one purpose of the present study is to examine whether or not being in an impulsive state and having to exert self-control

influences intertemporal choice and temporal discounting differently than being in an impulsive state and not having to exert self-control.

### **Impulsivity and Temporal Discounting**

Several lines of research implicate impulsivity in myopic preferences during temporal discounting choice tasks. Much of this research has focused on the higher than average temporal discounting of particularly impulsive people, how the visceral states such as hunger and sexual excitation lead to greater temporal discounting, and the influence of tempting stimuli on temporal discounting. Evidence from the studies on these impulsive individuals suggest that their impulsive tendencies are responsible for how steeply they discount large future rewards, whether they be monetary or consumable (Bickel, Yi, Kowal, & Gatchalian 2008). Research on such groups suggests that a general impulsivity and a desire for instant gratification could influence intertemporal choices involving money, since impulsivity is thought to be implicated in the preference for decisions with short-term benefits as opposed to long-term benefits of impulsive groups. Researchers argue that acts involving trade-offs between immediate utility versus delayed utility, such as smoking cigarettes and eating healthy, are intertemporal choices (Critchfield & Kollins, 2001; Bickel et al., 2008). For example, by smoking cigarettes or opting for unhealthy snacks, people are demonstrating a preference for immediate hedonic pleasure versus the health of a future self (Chapman & Elstein, 1995). These studies suggest that the impulsivity and desire for instant gratification for certain individuals lead not only to myopic choices such as smoking cigarettes but also to myopic financial decisions such as gambling instead of putting money into a savings account, or choosing a smaller immediate reward instead of a larger delayed reward.

Additional research indicates that cigarette smokers, obese people, and opiate dependent individuals all discount larger delayed rewards more heavily than controls (Weller, Cook Iii, Avsar, & Cox, 2008; Bickel et al., 2008; Giordano et al., 2002). Although it might not be surprising to note that smokers value one cigarette in the present more than two cigarettes in the future (a reward in a domain relevant to their impulsive tendency) smokers also demonstrate a similar preference for immediate versus delayed monetary rewards. That is, they discount larger delayed monetary rewards to a greater extent than non-smokers (Bickel et al., 2008). Specifically, smokers and non-smokers made a series of choices between hypothetical monetary rewards and losses of different magnitude (e.g., \$10, \$100, \$1000). Overall, participants devalued larger delayed rewards when magnitude was relatively smaller (e.g., when choosing between \$10 now versus \$100 one year from now, as opposed to when choosing between \$100 now versus \$1000 one year from now). Importantly, smokers devalued both gains and losses more than non-smokers, regardless of the magnitude.

A similar preference for smaller immediate monetary rewards as opposed to larger delayed monetary rewards has also been found in opiate-dependent individuals during opiate deprivation (Giordano et al., 2002). Over eight sessions, participants made a series of choices between smaller immediate rewards and larger delayed rewards, of both heroin and money. During each session, they made intertemporal choices both before and after opiate deprivation. The authors found that participants discounted larger delayed rewards of money and heroin when participants were opiate deprived than when they were satiated. It is argued that a proclivity toward impulsivity and instant gratification skews the preference of these individuals toward immediate versus delayed

gratification (Kirby, Petry, & Bickel, 1999). Thus, there is reason to believe that it is impulsiveness that is driving their preference for immediate rewards, regardless of the domain in which they make choices.

While smokers and opiate dependent people may be particularly impulsive, everyone is susceptible to incidental states of impulsivity. Given that increases in discounting for delayed monetary rewards in smokers and in the opiate dependent is attributed to impulsivity and a reduced chance of using self-control, a similar pattern would be expected for individuals under the influence of impulsivity and depleted self-control. Studies show that myopic preferences in intertemporal choice can also be induced by impulsivity related to visceral states such as hunger and sexual excitation, as well as through exposure to tempting stimuli. Although people are generally myopic in their decision-making, circumstances and contextual factors can mediate the extent to which this is the case (Loewenstein & Prelec, 1992). For example, a pregnant woman might decide in advance to not be anesthetized. However, during labor she might change preferences and opt for the anesthesia when the influence of unforeseen or underestimated "visceral factors" is exerted (Chapman & Elstein, 1995).

Experimentally induced impulsivity could have similar consequences on intertemporal choice. Read and Van Leeuwen (1998) examined the effects of immediate and anticipated hunger on choice of snacks. Specifically, participants chose between a healthy and unhealthy snack to be received one week later. When the experimenters returned one week later to provide the snack, participants had an option to choose a different snack or stick to their original choice; again deciding between a healthy and unhealthy snack. One group of participants chose a snack when they were hungry and

when they anticipated being hungry upon receiving the snack one week later, while a second group knew they anticipated being satiated upon receiving the snack one week later. The third group of participants chose a snack when they were satiated that would be received when they were hungry, one week later. The final group chose a snack when they were satiated knowing they would be satiated upon receiving the snack. The greatest percentage of people choosing unhealthy snacks were in the group of participants who were hungry and who knew they would be hungry when they would receive the snack. This finding demonstrates that hunger has a greater effect on immediate consumption of unhealthy choices than on choices for future consumption, and that we are not adept at appreciating the influence the future visceral states.

Other visceral states also influence immediate behavior and intertemporal choices. For example, Ariely and Loewenstein (2006) found that a state of sexual arousal led to more myopic tendencies: participants were more willing to engage in morally questionable behavior and engage in unprotected sex in order to obtain instant gratification. Luo, Ainslie, and Monterosso (2012) using face priming, found that inducing certain affective states influenced intertemporal choices. Specifically, a positive affective state led to participants making more myopic intertemporal choices relative to people in a negative affective state and controls. In sum, these studies demonstrate that a variety of different visceral states could produce myopic preferences and shortsighted decisions.

Importantly, studies suggest that impulsivity induced in one domain could lead to more myopic intertemporal choices in a qualitatively different domain. For example, participants who were exposed to sexually exciting stimuli discounted future larger

monetary rewards more steeply than controls (Van den Bergh, Dewitte & Warlop, 2008). Specifically, one group of participants rated the attractiveness of landscape pictures and a second group rated the attractiveness of pictures of women in lingerie in swimsuits (both were ostensibly for a marketing campaign). Participants discounted larger delayed rewards more steeply in the latter condition than in the former. This effect was found for exposure to women in lingerie and swimsuits, as well as exposure to the lingerie and swimsuits alone, suggesting that it is the sexual cues themselves make people myopic. Solidifying the connection between induced impulsivity and myopic intertemporal choices, the authors found that men with a highly sensitive behavioral approach system (argued to be reflective of a reward circuitry highly sensitive to tempting stimuli) discounted larger delayed rewards more steeply after exposure to sexual stimuli than men who are less sensitive to rewards. Similarly, Wilson and Daly (2004) found that after viewing images of attractive people, participants discounted larger future monetary rewards more steeply relative to participants who did not view images of attractive people. Specifically, people of both sexes were exposed to images of either cars or men and women of varying attractiveness. Participants completed a temporal discounting task before and after exposure to either set of images, so that a baseline discounting rate could be established. Both men and women exposed to highly attractive faces discounted larger delayed rewards more steeply than participants exposed to less attractive faces. Another study suggests that the influence of tempting stimuli on intertemporal choice is quite robust, and that various tempting stimuli could induce impulsivity. In this study, the presence of a variety of tempting stimuli in a room led participants to more steeply discount larger delayed rewards (Soman et al. 2005).

Neurological research also supports the notion that induced impulsivity leads to more myopic intertemporal choices. When individuals are presented with a choice between an immediate and a delayed reward, the limbic system is activated, an area that is not activated when individuals are presented with two different delayed rewards (McClure, Laibson, Loewenstein, & Cohen, 2004; Laibson, Loewenstein, & Cohen, 2004). The activation of the limbic system is associated with impulsive behavior and a preference for immediate rewards. These regions are sensitive to cues such as the sight and smell of tempting stimuli, and not just the "temporal proximity" of a reward (McClure et al., 2004). Although it does not provide a causal link, this study does suggest that under certain circumstances, impulsivity and a desire for instant gratification lead to myopic financial intertemporal choices, as opposed to the more cognitive justifications mentioned previously (e.g. concern for not receiving a delayed reward, or optimism about future financial prospects).

Furthermore, visceral states and tempting stimuli may interact to produce greater myopic tendencies in intertemporal choice than either one alone. While individuals are more inclined to make myopic intertemporal choices in "drive states" such as hunger or sexual excitation (Loewenstein, 1996), they experience even greater impulsivity when they are both in a drive state and in the presence of tempting stimuli (Ainslie & Monterosso, 2004; Loewenstein, 1996). Thus, temporal discounting is expected to be more pronounced in individuals who are already in an impulsive state (e.g. hunger). For example, thirsty participants might discount the value of a larger amount of juice and water when it is delayed, even for a short period of time (McClure, Ericson, Laibson, Loewenstein, & Cohen, 2007). To examine this issue, thirsty participants made a series of

intertemporal choices between smaller immediate amounts and larger delayed amounts of juice and water. Both amounts (1 mL to 3 mL) and delays (1 min. to 25 min. later) were varied. In general, participants preferred smaller immediate amounts even when the larger delayed amount could be received minutes later – attesting to the potential influence of visceral states such as thirst and hunger. Furthermore, the limbic system was activated only when an immediate reward was available, and not when participants selected between two delayed rewards. This provides further evidence that induced impulsivity and a desire for instant gratification leads to myopic intertemporal choices.

### **The Relationship Between Impulsivity and Self-Control**

To date, most studies examining contextual factors have focused only on how impulsivity brought on by visceral states and/or the presence of tempting stimuli, impact myopic intertemporal choices. However, studies suggest that intertemporal choices are influenced by both self-control and impulsivity. More importantly, induced impulsivity and depleted self-control may have different consequences on temporal discounting (Loewenstein, 1996; Metcalfe and Mischel, 1999). The aforementioned studies on impulsivity all suggest that the mere presence of tempting stimuli would lead to steeper temporal discounting. However, they have not examined what happens if and when people exercise self-control to resist a tempting stimuli. Since self-control is at times required to delay gratification (i.e., to opt for the larger delayed reward) depleted self-control may, in fact, lead to steeper temporal discounting than impulsivity. Furthermore, even in the presence of a tempting stimulus, not exerting self-control (e.g., eating a chocolate chip cookie instead of resisting it) may actually lead to less myopic intertemporal choices, since self-control was not depleted.

Some studies have examined how people who anticipate future self-control failure sometimes employ precommitment devices to prevent or minimize future myopic behavior. Such precommitment devices have been observed in a variety of domains (Kivetz & Simonson, 2002). For example, some people take a drug called Antabuse to create aversive reactions to alcohol to prevent future drinking. Others join Christmas clubs in which they put money away that cannot be accessed until a certain date, to promote saving and minimize impulsive purchasing (Hoch & Loewenstein, 1991).

The influence on intertemporal choice of the type of self-control that has to be summoned in the moment to resist a tempting stimulus, however, has not been fully examined. The role of self-control in intertemporal choice was perhaps first observed and studied in experiments using marshmallows as a reward, wherein children had the option to wait 15 minutes to receive two marshmallows instead of one which could be provided immediately (Metcalfe & Mischel, 1999). While most children opted for having one marshmallow immediately, some were able to delay gratification by utilizing self-control. Indeed, self-control researchers have argued that self-control is necessary to override any impulsive tendency that is detrimental to goal-oriented behavior (Muraven, Collins & Nienhaus, 2002). In fact, specifically, the authors argue that people may be cognizant of the importance of self-control during goal-oriented behavior, and may be motivated to conserve this regulatory resource. For example, participants exerted less self-control during a task while they were instructed to submerge their hand in cold water for as long as possible when they were told they would have to exert self-control on subsequent tasks. Participants who were told they would have to exert self-control on later tasks kept their hand in the water for less time than participants who were not told they would be

using self-control on other tasks. Self-control conservation was even more pronounced when the demands on self-control of a future task are made particularly salient, suggesting that how much self-control is utilized or conserved depends on one's motivations (the importance of this aspect will be addressed in the discussion below).

Drug abuse and gambling are thought to be instances that exemplify the interplay between self-control and regulation of impulsive behavior (Estle, Green, Myerson, & Holt, 2007). It is not only the impulsivity of drug users and gamblers that skews their preference toward shortsighted decision-making, but also a lack of self-control that makes exercising restraint and opting for choices with long-term benefits difficult.

Metcalfe and Mischel (1999) have argued that the exercise of self-control and delay of gratification are difficult in the presence of tempting stimuli because tempting stimuli activate the "hot emotional system," which is more affect laden and heuristic driven. The activation of the hot system facilitates impulsive behavior by making the exercise of self-control more difficult, and thereby less likely to occur. However, they also argue that individuals who succeed in self-control employ certain strategies (e.g., distracting oneself from the immediately available tempting stimulus) in order to activate the "cool cognitive system," which is more rational and analytic. The authors argue that it is critical for keeping track of and maintaining long-term goals. The activation of the cool cognitive system may counteract the impulsivity induced by the activation of the hot emotional system. Utilizing self-control allows individuals to counteract impulsive tendencies and opt for larger or more beneficial delayed rewards.

Neurological studies suggest that impulsivity and self-control are different constructs. Moreover, depleted self-control and impulsivity may have different

behavioral consequences. Although the activation of the limbic system is implicated in impulsive behavior, it does not make such behavior inevitable. Individuals may employ self-control to opt for a larger delayed reward as opposed to a smaller immediate reward. This suggests that individuals in a state of impulsivity may still exercise self-control in order to opt for a larger delayed reward; making a less shortsighted intertemporal choice. When individuals choose delayed rewards, greater relative activation of the fronto-parietal brain regions (areas that are implicated in self-control and executive function) is observed (McClure et al., 2004). This is important because it suggests that depleted self-control may have different consequences on temporal discounting than impulsivity.

While self-control is important for counteracting impulsivity, it is not always available as a cognitive resource. Recent literature suggests that self-control may be thought of as a muscle in that it can be temporarily fatigued through exertion (Muraven, Tice, & Baumeister, 1998). In this seminal paper, the authors demonstrate this in a series of studies. In the first experiment, one group of participants were told to regulate their emotions while viewing an upsetting film while the second group did not regulate their emotions. The influence of the self-control depleting activity was assessed by having participants grip a handle for as long as they could. Importantly, this task was previously established to require self-control but not physical strength. Participants who regulated their emotions while viewing the film gripped the handle for a shorter interval than participants who did not. In the second study, one group of participants were instructed to not think about a white bear (a thought suppression task that requires self-control) while the other group was told to think about a white bear. A third group was given no instructions related to what to think about (control condition). Self-control depletion was

measured by the amount of time people persisted on anagram tasks in which they had to rearrange a word into a different word. Unbeknownst to the participants, the anagram was unsolvable. Thus, according to the authors, it provided a good measure of depleted self-control; a way of seeing how long people would persist. Participants with depleted self-control who were instructed to suppress the thought of a white bear persisted for a shorter amount of time on this task than participants in the other two groups. In the third study, one group of participants instructed to avoid thinking about a white bear while simultaneously writing down their thoughts, while the second group solved a series of math problems. The latter was judged to be as unpleasant and difficult as the thought suppression but did not involve self-regulation in the same way that thought suppression did. This allowed for further isolation of self-control depletion, measured by how well participants were able to suppress reactions to two humorous videos. Again, only participants who had to not think about a white bear were less able to suppress reactions to the videos (they smiled and laughed more than the control group). In summary, self-control may be depleted through various means and is necessary for persevering in a variety of domains.

Domain spillover effects of depletion are also observed with emotional regulation and thought suppression, in paradigms that only deplete self-control (Wegner, Schneider, Carter, & White, 1987). Similar to the aforementioned research, participants specifically who attempted to suppress the thought of a white bear had a greater difficulty exercising self-control on subsequent tasks. These studies were among the first to suggest that self-control is a limited cognitive resource crucial for persevering and adhering to goal oriented behavior in a variety of domains. In summary, when individuals exercise self-

control to refrain from engaging in an activity contrary to their goal (e.g., resisting chocolate cake while dieting, resisting a cigarette while attempting to quit) their ability to exercise it again is temporarily stymied (Shmueli & Prochaska, 2009).

Several other studies suggest that self-control is crucial for suppressing impulses detrimental to goal-oriented behavior. Vohs and Heatherton (2000) found that for dieters, self-control is necessary to prevent overeating and to resist temptation from unhealthy food items. Specifically, dieters and non-dieters watched a 10 min. film while there was a bowl of ice cream placed either next to them or far away. Some participants were told to help themselves to as much ice cream as they would like while others were told not to touch the ice cream. The dieters ate less ice cream as opposed to non-dieters when they had the option to eat as much as possible, utilizing self-control of their own volition in order to refrain from eating. In contrast, there was no difference in consumption amount between dieters and non-dieters when both groups were instructed not to eat.

Gailliot and Baumeister (2007) found that depleted participants were less able to regulate inappropriate responses than non-depleted participants. Specifically half of the participants completed a Stroop task (depleted self-control group), whereas the other half read a list of words. Relative to the control group, participants in the depleted self-control group were more likely to provide an inappropriate sexual word on a subsequent anagram and word filler task. In the second experiment, the effects of depleted self-control on willingness to commit hypothetical acts of infidelity were examined. Self-control depletion was manipulated by having one group of participants change their editing rule halfway through a journal editing task (i.e., crossing out the letter E). The non-depleted group continued with the same editing rule. Depleted participants reported a greater

perceived likelihood of committing acts of infidelity. The negative impact of depleted self-control on suppression of inappropriate behavior was also found with behavioral measures. In the third experiment, couples involved romantically had to either avert their attention during specific parts while watching a video (depletion condition) or watch without averting their attention. Depleted participants engaged in more kissing and touching. The results of these experiments suggest self-control is necessary for curtailing impulsive and inappropriate behavior that is potentially detrimental to present goals and long-term interests.

Importantly, a series of studies by Vohs and Faber (2007) demonstrate that depleted self-control could lead to impulsive purchases and overspending. In the first experiment, one group of participants was instructed to avert gazing at words that would appear on the screen during a video (depletion condition) while the control group was given no instruction. Depleted participants expressed a greater willingness to pay for products, suggesting that they had either a greater difficulty in assessing their actual economic cost, or that they had a greater difficulty monitoring their own willingness/ability to pay. In the second experiment, participants were either told to suppress the thought of a white bear while writing down their thoughts (depletion condition) while the control group were told they were free to think of anything – including a white bear – while writing down their thoughts. Following the writing task, all participants were given \$10 and were presented with an unexpected shopping scenario, which provided them with the option to either hold on to their payment for participation or spend it on any of 22 various items (with prices ranging from \$.33 to \$4.50). Depleted participants spent more money during this impulse shopping scenario.

Similarly, in a third experiment, the impact of self-control depletion on impulsive purchasing was examined with a behavioral regulation manipulation. One group of participants had to continuously smile and make specific hand gestures while reading a script (depletion condition) while the control group simply read the script without special instructions. Again, depleted participants spent more money during the impulsive purchasing shopping scenario as in Experiment 2. These studies suggest that self-control is important even during economic transactions, and depleted self-control may therefore influence whether people opt for smaller immediate rewards for larger delayed rewards during a temporal discounting task.

The aforementioned studies show that depleted self-control also reduces the ability to self-regulate during an intertemporal choice tasks involving money (e.g. not overspending/engaging in impulsive buying). This suggests that self-control depletion resulting from resisting a tempting stimulus could lead to the failure to curb impulsivity and more myopic preferences during a temporal discounting task (in a qualitatively different domain). Importantly, depleted self-control, or lack thereof, and impulsivity may have different consequences on intertemporal choice than either one alone. Exercising self-control may subsequently lead to impulsive preferences and behavior, similar to induced impulsivity. However, resisting the consumption of a tempting stimulus may lead to steeper temporal discounting than merely being exposed to a tempting stimulus. Furthermore, having the option to consume the tempting stimulus may, in fact, lead to less myopic preferences, thereby, *reducing* temporal discounting, because one did not exert self-control even though one was still exposed to the tempting stimulus.

## PRESENT STUDY

While most previous studies have focused only on how impulsivity leads to more myopic intertemporal choices, examining the interaction between impulsivity and self-control is equally important. For example, Vohs et al. (2008) find that even making a series of choices in a variety of contexts depletes self-control. In addition to making choices, a person may be in an impulsive state such as hunger. Since both impulsivity and depleted self-control may lead to myopic intertemporal choices (e.g., opting for a cheaper but less energy-efficient appliance) understanding how these two psychological states interact would shed light on behavior with real personal and economic consequences.

The present study was designed to examine the effects of these two states on intertemporal choice. Specifically, the present study examined the effect of hunger-induced impulsivity and depleted self-control on temporal discounting of monetary rewards. It was hypothesized that these effects would be demonstrated despite the domain differences between the impulsivity as well as depleted self-control induction, and the intertemporal choice task. Specifically, participants exposed to tempting stimuli (induced impulsivity) who were able to resist consumption of tempting stimuli (depleted self-control) were expected to discount more steeply than those exposed to tempting stimuli who were not able to resist consumption (no depleted self-control) and more steeply than controls.

## **General Method**

### **Overview**

In the current experiment, the influence of depleted self-control and impulsivity on intertemporal choice was examined using a paradigm adapted from Baumeister, Bratslavsky, Muraven, and Tice (1998). Hungry participants were presented with cookies and radishes, and were randomly assigned to eat one or the other. Impulsivity was induced in both of these groups, while depleted self-control was manipulated by having participants exposed to the cookies only eat radishes. The consequences of these manipulations on intertemporal choice were examined using a temporal discounting task adapted from Green, Myerson and Ostaszewski (1999). Impulsivity may be induced in a variety of ways. However, its behavioral consequences appear to be similar and consistent regardless of the induction process, providing support for the use of hypothetical monetary rewards to gauge the effects of impulsivity on intertemporal choice. Importantly, Frederick et al. (2002) found no evidence to suggest there is a difference between how people discount real and hypothetical monetary rewards, supporting the use of the latter in the present study.

### **Participants**

Participants at California State University, Northridge were recruited using an electronic participant recruitment and scheduling platform. There were 43 men and 74 women. The ages ranged from 18 to 47, with an average age of 20 ( $SD = 3.85$ ). Participants with allergies to nuts, wheat, or dairy were excluded from the study. All other participants were included. Participants received credit that went toward their

course completion in psychology in exchange for participation. All participants were asked not to eat anything for four hours prior to participating in the experiment.

## **Design**

A between-subjects design was employed, and participants were randomly assigned to conditions prior to each experiment session. The self-control depletion manipulation had three levels. Participants either tasted only radishes and resisted cookies (depletion condition) or tasted only cookies (no depletion condition). Participants in the control group were not exposed to either food item and proceeded straight to providing their overall attitude toward cookies and radishes. Temporal discounting rates and appliance preference constituted the dependent measures.

## **Materials and apparatus**

There were two sets of stimuli for the two different phases of the study. The food items were always in two white bowls adjacent to each other, located next to the computer station. To the left of where the participants sat was a toaster oven in which the cookies were baked. Overall impression of the food items, or participants' general attitude toward these food items if they were in the control group, was assessed using a scale. The temporal discounting task was programmed with and administered using DirectRT.

Participants provided responses during the temporal discounting task by pressing keyboard keys marked with stickers stating SIR or LDR to represent smaller immediate rewards for larger delayed rewards, respectively. The appliance preference task, and all other questions, scales, and surveys were designed and administered with Qualtrics. Participants provided all responses on Dell desktop computers.

## **Procedure**

The procedure, with the exception of the temporal discounting task, closely followed that of Baumeister et al. (1998). Prior to the arrival of participants, chocolate chip cookies were baked in a small toaster oven in a room where the tasting phase took place, with the intention that both the scent and the presence of the chocolate chip cookies would increase desire to eat the cookies as opposed to the radishes. All participants who signed up for the study were asked not to eat 4 hours prior to their experiment timeslot. The experiment was always conducted starting at 12 PM, allowing participants enough time to not eat after waking up. All participants were tested individually.

Upon arrival, an experimenter provided an overview of the study, an informed consent form (Bill of Rights) for participants to sign, and elaborated the cover story. Participants were told that their time would be divided between two studies conducted by two different experimenters. Additionally, they were told that the first study was an examination of food preferences and that the second study examined decision-making. In reality, the first study constituted the tasting phase of the same study.

Based on random assignment, participants were asked to taste and rate either chocolate chip cookies or radishes. For participants assigned to one of the eating conditions, food items were displayed on the same table in separate bowls during the tasting phase. Tasting of either cookies or radishes took place in the room where cookies were baked. A third subset of participants, who were not exposed or asked to taste any food items, constituted the control group.

Participants were asked to taste the assigned food for five minutes while the experimenter was out of the room. In the radish condition, participants were asked to eat

no more than two radishes, and in the chocolate chip cookie condition, participants were asked to eat no more than two cookies. Both groups were asked to eat only the assigned food.

To assess participants' impression of the food items after the tasting phase, participants were asked to rate their overall impressions of the food (cookies or radishes) on a 7-point scale (1 = "*not appetizing*" to 7 = "*very appetizing*"). Participants in the control condition were not exposed to food items and were simply asked to rate their general impression of cookies and radishes. Participants in the control group could still see the oven in which cookies were baked as well as smell them.

After completing the questionnaires, participants were told to proceed to a different room where the decision-making part of the study will take place (ostensibly, a second and different experiment). Participants proceeded to one of three randomly assigned rooms where they were met by a different experimenter who provided them with the instructions for the temporal discounting task (adapted from Green, Myerson & Ostaszewski, 1999). Participants were seated at a computer station and were given instructions for the intertemporal choice task (Appendix A1).

Participants were presented with a series of 144 choices of smaller immediate rewards and larger delayed rewards. Stickers were placed on keyboards to help participants identify which keys correspond to a reward. Participants chose between 24 smaller immediate rewards (amounts between \$1 - \$499 were randomly selected once prior to testing and used in all sessions), and one larger delayed reward of \$500, at each of six different time delays. The 144 choices were evenly split by different time delays, such that every participant made choices between the same set of smaller immediate

rewards and the same larger delayed reward at each of six different time delays: 1 month, 6 months, 1 year, 3 years, 5 years, and 10 years. The choices were presented in a fixed order.

As an additional dependent variable to assess potential changes in time preference, participants were asked to make a choice between two appliances. This is a novel task that gauged monetary time preference more analogous to a real world choice. Participants were given the following prompt:

“Imagine you are shopping for an appliance and are presented with two options. Appliance Y costs \$400 but is energy-efficient. Appliance X costs \$300 but is less energy-efficient. By choosing appliance Y, you will gain approximately \$200 over the next five years on electricity bills. By choosing appliance X, you will gain \$100 NOW by purchasing the less expensive appliance. Choose ONLY ONE of these appliances.”

As a manipulation check, participants were asked whether they had to exercise self-control to eat only the assigned food, and whether they had difficulty resisting the non-assigned food (7-point scale ranging from: 1 = “*not true at all*” to 7 = “*very true*”).

Participants were then asked to complete two questionnaires: the Restraint Scale (Herman & Polivy, 1975; Appendix A2) and the PANAS scale (Watson, Clark, & Tellegen, 1988; Appendix A3). These were used to isolate individual differences in dieting behavior and diet-related goals as well as differences in affect. It was important to isolate dieting goal differences because an individual who has had experience exercising self-restraint while dieting might find it less difficult to utilize self-control in the present study.

Participants were also asked how long it had been since they last ate a snack or a meal before the experiment (open-ended question), and how hungry they were before the experiment (7-point scale ranging from: 1 = “*Not at all*” to 7 = “*Extremely hungry*”). Furthermore, because lack of sleep has been shown to result in a proclivity toward impulsivity and greater difficulty of self-control utilization (Baumeister, 2002), participants were asked at what time they woke up on the day of the experiment (open-ended), as well as the number of hours they slept the night before him the experiment (open-ended). Finally, participants were asked to write about what they believed the true purpose of the study was. All participants were offered a debriefing sheet and were thanked for their time.

## Results

### Missing data

A missing value analysis was conducted on the three dependent measures – short delay discounting rates, long delay discounting, and appliance preference – in order to examine the amount of missing data, and to determine if it was missing at random (Tabachnick & Fidell, 2008). All participants indicated their preference for an appliance (0% missing).

The results show that 7% of participants did not complete the temporal discounting task. Little's MCAR test shows that the data for this variable is missing at random (Chi-Square = .932, df = 1,  $p = .334$ ). Since the temporal discounting data was missing at random, an EM imputation method, recommended as the more powerful and accurate of the imputation methods, was used (Tabachnick & Fidell, 2008). Imputed data for this variable was used in subsequent analysis.

## Calculating temporal discounting rates

Temporal discounting rates were calculated using an area under the curve method advanced by Myerson, Green, and Warusawitharana (2001). According to the authors, previous mathematical approaches are rife with disagreement over which formulas best capture temporal discounting and which are best for calculating subjective perception of monetary value and the impact of time delay. The area under curve method is argued to require the least assumptions in order to calculate temporal discounting rates and does not presuppose how people *should* be valuing smaller immediate rewards and discounting larger delayed rewards.

Using data from the temporal discounting task, there were several steps to this process. Participants made a series of choices between smaller immediate rewards and a larger delayed reward of \$500. They made these choices across six sets, with only the delay increasing.

Table 1

*Sample stimuli from monetary choice task and visual illustration of switching/indifference point*

Delay	Choice	Option	Subjective Value
1 month	delayed	\$12 now or \$500 in 1 month	0.024
1 month	delayed	\$20 now or \$500 in 1 month	0.04
1 month	delayed	\$72 now or \$500 in 1 month	0.144
1 month	<i>immediate</i>	\$79 now or \$500 in 1 month	<b>0.158</b>

The following formula was used to convert the switching points into points on the area under curve graph:  $(X_2 - X_1) [(Y_1 + Y_2)/2]$ . The Xs correspond to successive delays on the x-axis and the Ys correspond to the subjective values of the immediate rewards which are calculated by dividing the smaller immediate reward by the larger delayed reward – at the switching point at which participants switch from a larger delayed reward to a smaller immediate reward (see Table 1).

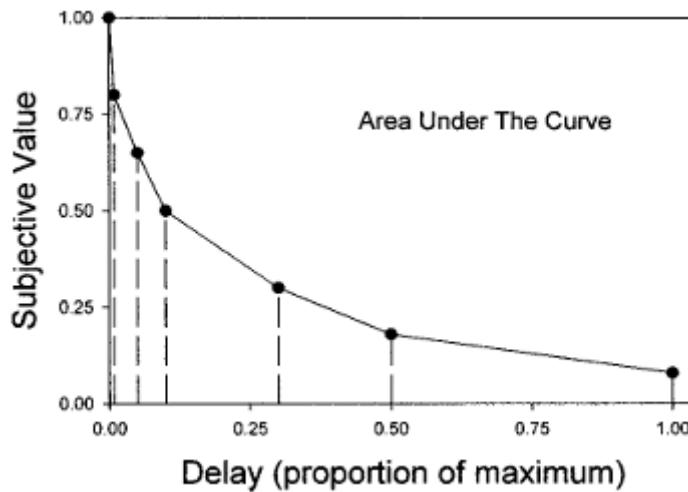


Figure 1

The values on the x-axis remain the same since the delays are constant across participants. Delay values are represented as a percentage that the value at each set is of the largest delay (10 years). For example, the first delay set of one-month is equivalent to .01 (rounded to two decimal places) of the longest delay in the temporal discounting task, which is 10 years (120 months). The values on the y-axis are unique to each participant, as they represent the smaller immediate amount each participant is willing to settle for to forgo the larger delayed reward. Thus, at each increasing delay interval, the subjective value of the immediate reward at a switching point, or indifference point (see Table 1), is calculated for each participant and is plotted on a graph using the aforementioned

formula. The attained area under the curve represents how steeply each participant discounts larger delayed rewards (Figure 1). The smaller the area, the more steeply the participant was considered to temporally discount the larger delayed rewards.

*Analysis of different time delays.* Myerson, Green, and Warusawitharana (2001) point out that even within the same sample, the area under the curve analysis of temporal discounting can yield different results dependent on whether the data used is from short delays (large delayed reward to be received in a week or a month) compared to data from long delays (large delayed reward to be received in 10 years). Although in the present experiment, short delay discounting rates and long delay discount rates were strongly correlated,  $r(111) = .914$ ,  $p < .001$ , short delay discounting rates and long-delayed discount rates were analyzed as separate dependent measures to account for this possibility.

### **Testing theoretical predictions**

Initially, a multivariate analysis of variance was conducted with discount rates, analyzing separately short and long delay rates, and appliance preference, with condition as the independent variable. Temporal discounting rates were analyzed with and without data from 19 participants who violated temporal discounting patterns (discussed further below). There was no significant difference on the temporal discounting task between conditions when these participants were included,  $F(1, 114) = .720$ ,  $p = .674$ , and when they were excluded,  $F(1, 95) = .631$ ,  $p = .751$ .

There was a marginally significant difference in appliance preference between groups,  $F(1, 114) = 2.951$ ,  $p = .056$ ,  $\eta^2_p = .049$ . On the appliance task, the less myopic appliance was anchored at zero and the more myopic appliance was anchored at 100.

Tukey post-hoc comparisons of the three groups revealed that participants who tasted radishes and resisted cookies (depletion condition;  $M = 26.17$ ) preferred the more expensive more energy-efficient appliance (the less myopic option) than participants who tasted cookies (no depletion condition;  $M = 44.15$ ),  $p = .024$ . There was also a marginally significant difference between depleted participants ( $M = 26.17$ ) and control participants ( $M = 39.92$ ); the former preferred the less myopic appliance,  $p = .058$ . There was no significant difference between control and non-depleted participants,  $p = .563$ . Contrary to the hypothesized role of self-control, these results suggest that exposure to and interaction with tempting stimuli (cookies) leads to more myopic intertemporal choices, which is consistent with previously cited studies.

Furthermore, comparing only the experimental conditions, regression analyses showed that results do not support the theoretical predictions. It was necessary to only use the experimental conditions (depletion or no depletion conditions) because the control group was not asked how difficult it was to resist the non-assigned food item and how difficult it was to only eat the assigned food item – as they were not presented with any of the food items.

### **Manipulation check**

There was a significant difference between the depleted group (group who tasted radishes) and the non-depleted group (group who tasted cookies) in the difficulty they had of only eating their assigned food and how difficult it was resisting the non-assigned food,  $F(1, 72) = 17.58$ ,  $p = .02$ . As expected, those asked to taste radishes reported greater difficulty exercising self-restraint to the cookies ( $M = 2.45$ ) as opposed to those asked to eat only the cookies and resist consuming radishes ( $M = 1.47$ ). However, the

difficulty did not mediate their intertemporal preference for a particular appliance,  $F(1, 79) = 1.86, p = .143$ ; the difficulty of restraint to only eat the assigned food item and to resist a non-assigned food item did not significantly predict appliance preference,  $F(2, 67) = .568, p = .569$ .

It was predicted that subjective level of hunger, the number of hours since a person last ate, and the number of hours of sleep on the night before the experiment would significantly predict how difficult it would be to resist eating a non-assigned food item. Specifically, it was predicted that the hungrier participants who were made to eat only radishes were, the more difficult it would be for them to resist the cookies. Contrary to the hypothesis, neither level of hunger nor the number of hours since a person last ate significantly predicted how difficult it was to only consume the assigned food item,  $F(2, 67) = .051, p = .950$ , or the difficulty of resisting a non-assigned food item,  $F(2, 67) = .045, p = .956$ . Furthermore, conducting an ANCOVA with level of hunger, number of hours since a person's last meal, and impression of food items as covariates, revealed that they did not significantly predict appliance preference,  $F(2, 95) = 2.056, p = .134$ .

Although marginally significant, the regression analysis shows that an increase in amount of sleep leads to a greater difficulty of exercising self-control to resist a non-assigned food item,  $\beta = .017, t(68) = 2.358, p = .052$ , which is contrary to what prior research shows. Prior research suggests lack of sleep makes the exercise of self-control more difficult (Baumeister, 2002). Furthermore, the number of hours of sleep on the night before the experiment, did not significantly predict appliance preference,  $F(3, 99) = .142, p = .935$ .

Reuben, Sapienza, and Zingales (2010) found in their study that participants heavily discounted chocolates only if they found the chocolates appealing, and if they generally liked to consume chocolates. This suggests that in the present study, only those who actually found the cookies appealing may have exercised self-control to resist consuming them if they were told not to. In the present study, a regression analysis shows that impression of the food items did significantly predict the difficulty of only eating the assigned food item,  $\beta = -.299$ ,  $t(67) = -3.556$ ,  $p = .001$  and resisting the non-assigned food item,  $\beta = -.298$ ,  $t(67) = -3.986$ ,  $p < .001$ . That is, the more unappealing participants found their assigned food item, the more difficult it was to eat only it and resist a non-assigned food item. However, using impression, difficulty of self-restraint, and difficulty of resisting the non-assigned food item does not yield a regression model that significantly predicts intertemporal choice on the appliance preference,  $F(3, 65) = .783$ ,  $p = .508$ .

Further analysis reveals that the results are more consistent with previous studies which show that mere exposure to tempting stimuli leads to more myopic preferences and greater temporal discounting of larger delayed monetary rewards. A regression analysis reveals a marginally significant trend: The more appealing participants found the stimuli, the more myopic they were in their temporal discounting,  $\beta = -.023$ ,  $t(67) = 3.796$ ,  $p = .056$ .

## **Discussion**

Overall, the present findings do not suggest self-control depletion influences temporal discounting. There was no difference between how depleted and non-depleted participants discounted larger delayed rewards. Although the results show the

experimental manipulation influenced intertemporal preference for an appliance, they do not support the influence of self-control depletion in this context. There was a significant difference between the appliance preference of depleted and non-depleted participants. However, the pattern was inconsistent with the hypothesis; depleted participants preferred the *less* myopic appliance. Furthermore, although participants who tasted radishes and resisted cookies reported greater self-control exertion than participants assigned to taste cookies, the severity of self-control depletion did not significantly predict appliance preference. Both regression analyses and an analysis of covariance revealed that neither level of hunger nor lack of sleep significantly predicted difficulty of exercising self-control or intertemporal choices. Finally, higher evaluation the food items did predict the difficulty of resisting a non-assigned food item, but did not predict intertemporal choices.

*Limitations.* Although the missing value analysis revealed that data on this measure was missing at random across conditions, the results from 19 participants suggests they either did not understand the temporal discounting task, or that it did not accurately capture their intertemporal preferences. During the temporal discounting task, smaller immediate reward continues to increase until it is large enough for the participants to accept it instead of the larger delayed reward. If the task had adequately captured their time preference, they would have waited for the immediate reward to increase to an amount they deemed satisfactory. For these 19 participants, they accepted smaller immediate rewards for the first several trials, but subsequently rejected larger immediate rewards. Regardless of whether smaller immediate rewards are objectively better than larger delayed rewards, the choices of these participants suggest deliberately

settling for the worst of the possible immediate rewards – which gives no indication of time preference. There is no clear consensus regarding what should be done with such data. The area under the curve analysis is better than mathematical formulas at dealing with such anomalies; normally such data is excluded (Myerson, Green, and Warusawitharana, 2001). An analysis of the data without these participants did not influence the effect of the manipulation; there was no significant difference on the temporal discounting task across conditions. Despite the superiority of the method, including data from these participants undoubtedly lowered the power of detecting an effect, since they violate temporal discounting patterns. In the present study, the exclusion of such participants did not influence the interpretation of the findings. Furthermore, according to Frederick, Loewenstein and O'Donoghue (2002), most studies find a weak correlation between temporal discounting patterns in the lab and real-world behavior, suggesting that current laboratory methods of measuring time preference are imperfect at best and that the psychological construct of time preference needs to be developed further.

*Alternative explanations.* The results raise serious doubts about whether participants assigned to taste radishes actually had depleted self-control from resisting consuming the cookies. Those asked to taste radishes reported greater difficulty exercising self-restraint to the cookies ( $M = 2.45$ ) as opposed to those asked to eat only the cookies and resist consuming radishes ( $M = 1.47$ ). Although significant, this is only a one-point difference on a seven point scale. If self-control was in fact exerted, the present results do not suggest this influenced intertemporal choice or led to more myopic preferences. Neither difficulty of exercising self-restraint to eat only the assigned food item nor the difficulty

of resisting a non-assigned food item predicted intertemporal preferences on either the appliance task or the temporal discounting task. Furthermore, participants in the depletion condition actually displayed less myopic preferences on the appliance task than participants in the non-depletion condition – a trend opposite to the one predicted.

At first glance, and consistent with prior research, the present analysis reveals that mere exposure to tempting stimuli leads to more myopic intertemporal choices (Van den Bergh, Dewitte & Warlop 2008; Wilson and Daly, 2004). Participants who were exposed to and consumed cookies exhibited more myopic preferences during the appliance choice task (preferring the less expensive less energy-efficient appliance). Furthermore, the more appealing participants found the tempting stimuli, the more they discounted larger delayed rewards (because it cannot be attributed to an experimental manipulation, it does not provide a causal link but merely support). However, this account does not explain why participants who were exposed to and consumed cookies exhibited similar intertemporal preferences to participants in the control condition, who were not exposed to any food items. Furthermore, participants in the depletion condition were also exposed to the cookies. If mere exposure to tempting stimuli explained the present findings, then participants in the depletion and no depletion conditions who were exposed to both food items would have discounted similarly and more heavily than the control group.

Two alternative explanations for the present findings are derived from several studies which challenge the self-control as a limited resource model, as well as other studies which suggest that internally and externally imposed self-control have different perceptual and behavioral outcomes. Self-control may be depleted only when it is internally imposed; when people find its utilization necessary to pursue goal-oriented

behavior. For example, Vohs and Heatherton (2000) find that for dieters, self-control is necessary to prevent overeating and to resist tempting and unhealthy food items. In this study, dieters and non-dieters watched a 10-min. film while there was a bowl of ice cream place either next to them or far away. Some participants were told to consume as much ice cream as they wanted, while others were told not to consume any. The dieters ate less ice cream when they had the option to eat as much as possible; when they have to use their own volition and self-control to refrain from eating, and not when self-control was externally imposed (when experimenters instructed them not to touch the ice cream). In the aforementioned study, the authors found that dieters only utilized self-control when it was of their own accord, and not when they were following experimenters' instructions. Since in the present research, participants exercised self-control only following the experimenter's instruction, self-control may not have been depleted.

It is also possible that if it had been depleted, depletion of externally imposed self-control mechanisms has different consequences than depletion of internally motivated self-control. That is, externally imposed and internally motivated self-control may be different constructs. Evidence for this possibility comes from a study by Trope and Fishbach (2000). Specifically, participants had the option to take either a boring test that yielded more accurate results of their reading abilities or an interesting test that yielded less accurate results. It was hypothesized that only participants not influenced by external self-control factors would employ internal self-control strategies such as penalizing themselves to pursue the goal when there are short-term costs (taking a test at an inconvenient time). Short-term cost was manipulated by administering the test at

either a convenient or an inconvenient time. Some participants were told they would receive a payment for completing the test (externally imposed self-control) while others were not. Participants also had the option to pay a self-imposed fine if they failed to take the test (internally motivated self-control). The authors found that participants who were not offered payment for completing the test imposed higher fines on themselves to ensure they would complete the test than participants who were offered payment. Furthermore, participants in the former condition had a higher evaluation of the test. These studies suggest that there may be distinct internal and external self-control processes that have different effects on perception and behavioral outcomes, providing further support that the external self-control imposed in the present study does not lead to subsequent inability to curtail myopic preferences during an intertemporal choice. Although in the present study, self-control was depleted according to the manipulation check, self-control may not have affected intertemporal choice because it may not have been the goal of participants to delay gratification in order to opt for larger delayed rewards and/or because self-control was externally imposed.

Complicating matters further is a study by Laran and Janiszewski (2011). The authors found that when experimenters construed a task as work – imposing an externally motivated need for self-control – participants became more depleted during a task than when a task was construed as fun, which prompted an internally motivated need for self-control. It appears there is a lack of consensus over whether internal and external self-control mechanisms, indeed, have different consequences. If they do have different consequences, it is not clear which of the two tasks leads to greater self-control depletion and, therefore, whether the differences between them can explain the present findings.

Potential differences between internal and external self-control notwithstanding, some studies suggest that the self-control as a limited resource model does not apply in the present research. This model was recently challenged by Dewitte, Bruyneel, and Geyskens (2009). The authors found that exercising self-control enhances the ability to exercise it again if the subsequent task is similar in nature (e.g. resisting the consumption of one unhealthy snack and then another). However, this does not explain why participants in the depletion condition in the present study were less myopic after tasting radishes and resisting cookies, as the latter is qualitatively different from resisting a larger delayed reward during a monetary choice task. If this effect is more robust than the authors initially observed, then it would explain why participants were less myopic after tasting radishes and resisting cookies than participants in the control condition, who were not exposed to any food items. In other words, it is possible that under certain circumstances, self-control becomes activated rather than depleted, facilitating its use in subsequent tasks.

Some indirect support for this possibility comes from the study by Tabibnia, Satpute, and Lieberman (2008). The authors found that regulating emotion after receiving an unfair offer requires self-control utilization, which may persist temporarily. In this study, participants played an ultimatum game in which they were offered a monetary amount that was either small or large (\$.50 or \$7.00) and either fair or unfair (e.g. by manipulating whether the \$.50 was a percentage of one dollar or \$10). In this game, accepting an offer leaves both players with money while rejecting an offer leaves players with no money. The fairness of an offer – whether it was a small or large percentage of the total possible amount – more than the objective monetary value, predicted subsequent

positive affect. Furthermore, the authors found that disregarding the unfairness of an offer during an exchange required self-control in order to accept. It is possible that, in the present study, participants assigned to eat radishes in the presence of cookies found it unfair, requiring the utilization of self-control, which persisted rather than faded, leading to subsequent less myopic intertemporal choices. However, this is speculative as no feelings of fairness ratings were collected.

Findings by Laran and Janiszewski (2009) provide some explanation of the present findings by demonstrating the possibility that the exercise of self-control may be followed by further restraint rather than self-regulatory failure, when people are not carefully monitoring their goal progress. When this is the case, a passive guidance system influences whether an indulgence is followed by an indulgence or restraint. Specifically, they argue that a goal may either be activated or perceived as achieved. If the goal is activated – for example, by exposure to radishes that is not followed by the consumption of a sufficient number radishes (healthy eating) – healthy consumption may be followed by further consumption rather than indulgence. In other words, in this scenario, restraint would be followed by further restraint. On the other hand, if a person believes the goal (restraint or healthy eating) has been successfully achieved, restraint may be followed by indulgence. Such a passive guidance system thus ensures a balancing of different goals. It suggests that in the present study, the goal of restraint was activated in participants consuming radishes. However, because they may have felt it has not been successfully achieved, it may have led to further restraint on the temporal discounting task in which they resisted smaller immediate rewards and opted for larger delayed rewards.

## CONCLUSION

In summary, further research is required to understand precisely under which circumstances self-control is depleted, whether internal and external self-control are different constructs, when restraint is followed by restraint (self-regulatory failure), and how these factors influence financial intertemporal decision-making.

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## APPENDIX A

“During this task, you will make a series of choices between smaller immediate monetary rewards and larger delayed monetary rewards. Amounts and delay times will differ between each choice set. You should treat each individual choice set independently from the others, and not let your preference in one influence your preference in others. The immediate reward will always be on your left, and a delayed reward will always be on your right. The smaller immediate reward can be received RIGHT NOW while the larger delayed reward can only be received LATER. The amount of time you have to wait to receive the delayed reward will always be shown, but will sometimes change. Pay close attention to the exact time delay before making each choice. There are no right answers, and you should express your true preference for one of the rewards that will appear on the screen one at a time. Please make your choices as if the immediate and delayed rewards were real.”

## APPENDIX B

### Restraint questionnaire

#### *Diet and Weight History*

1. How many pounds over your desired weight were you at your maximum weight?
2. How often are you dieting?
3. Which best describes your behavior after you have eaten a "not allowed" food while on your diet?—return to diet, stop eating for an extended period of time in order to compensate, continue on a splurge, eating other "not allowed" foods.
4. What is the maximum amount of weight that you have ever lost within 1 month?
5. What is your maximum weight gain within a week?
6. In a typical week, how much does your weight fluctuate (maximum-minimum)?

#### Concern with Food and Eating

7. Would a weight fluctuation of 5 pounds affect the way you live your life?
8. Do you eat sensibly before others and make up for it alone?
9. Do you give too much time and thought to food?
10. Do you have feelings of guilt after overeating?
11. How conscious are you of what you're eating?

## APPENDIX C

"The scale below consists of a number of words that describe different feelings and emotions. Read each item and then indicate to what extent you feel this way right now; how you feel at this moment."

	1 = does not capture how I feel (1)	2 = weakly captures how I feel (2)	3 = moderately captures how I feel (3)	4 = strongly captures how I feel (4)	5 = captures exactly how I feel (5)
interested (1)					
distressed (2)					
excited (3)					
upset (4)					
strong (5)					
guilty (6)					
scared (7)					
hostile (8)					
enthusiastic (9)					
proud (10)					
irritated (11)					
alert (12)					
ashamed (13)					
inspired (14)					
nervous (15)					
determined (16)					
attentive (17)					
jittery (18)					
active (19)					
afraid (20)					

