GLUCOSE AS AN ENERGY SOURCE TO INCREASE SELF-CONTROL IN RESTRAINED EATERS

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Research evidence is suggestive of a strength model of self-control, also known as ego depletion, in social psychological literature. Engaging in an initial task of self-control depletes a limited resource, resulting in less self-control on a subsequent, unrelated task. The strength model of self-control has been applied to many practical, everyday situations, such as eating behaviors among dieters. Newer studies suggest that blood glucose is the resource consumed during acts of self-control. Consuming glucose seems to “replete” individuals who have been depleted, improving performance and self-control. The current study aimed to examine the effects of ego-depletion on restrained eaters. The hypothesis was that restrained eaters who were depleted by a task of self-control would exhibit more disinhibition on a taste-test task than would restrained eaters who were not depleted. However, if the participants were given glucose following the depletion task, then their self-control would be “repleted” and they would exhibit similar control to that of the non-depleted participants. Contrary to expectations there were no differences between the groups in terms of total amount of cookies consumed. These results are inconsistent with a glucose model of self-control. Suggestions for future research and implications of the findings are discussed.
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CHAPTER 1
INTRODUCTION

Humans engage in activities that require self-control on a daily basis. For example, people refrain from yelling at or arguing with their partner following a stressful day at the office. People who are limiting their caloric intake are able to resist the temptation to eat dessert. People do not act on every sexual or aggressive impulse that comes to mind. These are just a few examples of everyday situations that require people to have good self-control. Baumeister, Vohs, and Tice (2007) define self-control as “the capacity for altering one’s own responses, especially to bring them into line with standards as ideals, values, morals, and social expectations, and to support the pursuit of long-term goals” (p. 351). Self-control is distinct from self-regulation, although they are often used interchangeably in the literature. Self-control is a deliberate, conscious, effortful subset of self-regulation; whereas self-regulation refers to homeostatic processes such as maintaining internal body temperature and pH levels of the blood (Baumeister et al., 2007). Self-control allows individuals to override one response, and make another response possible.

The lay media often describe self-control in terms of willpower, suggesting that self-control requires some sort of strength or energy. Often, people attempting to break a bad habit, such as quitting smoking, or making lifestyle changes such as changing eating habits or beginning an exercise plan state that the process will require a great deal of willpower and self-control. Psychology as a field had moved away from an energy-type conceptualization following the transition from Freud and other psychoanalytic theories to more behavioral and cognitive explanations for behavior. However, in the early 1990s, self-regulation research findings began to point toward an energy model of self-control (Baumeister et al., 2007).
Ego depletion was a term coined during this time. It refers to a popular theory which posits that self-regulatory operations consume a limited resource that is depleted afterward. When people override their impulses or responses, they are less successful at controlling themselves in a subsequent task requiring self-regulation, even if the new activity is unrelated to the first act of self-control. The implication is that some resource akin to energy or strength is expended in these processes, creating a state called “ego depletion.” A large body of research, including a meta-analysis (Hagger, Wood, Stiff, & Chatzisarantis, 2010), has been published examining this construct, how to manipulate it, whether or not it exists, how to counteract it, and how to apply this knowledge to clinical practice.

The idea that self-control depends on a limited resource was initially suggested in a literature review by Baumeister, Heatherton, and Tice (1994) and elaborated in several other review articles (Baumeister, 2002; Baumeister & Heatherton, 1996; Baumeister, Muraven, & Tice, 2000; Muraven & Baumeister, 2000). They observed that self-control appeared vulnerable to deterioration over time from repeated use, like a muscle becoming fatigued following repeated exertions. In order to test the depleted resource hypothesis, the authors had research participants perform an initial task requiring self-control, while other participants completed a comparable, but neutral task. Then all participants would perform a second, unrelated task requiring self-control. If self-control consumes a limited resource, then the participants who completed the initial task requiring self-control should be depleted, leaving fewer resources for the second task. Thus, they would have poorer performance on the second task than the participants who completed the neutral task. They suggested that different theories would predict different outcomes. For example, if self-control relies on activation of a cognitive schema, then the initial
act of self-control should prime that schema, therefore making performance on the second task improve rather than worsen.

Early laboratory studies of ego-depletion followed this basic design. Muraven, Tice, and Baumeister (1998) conducted three studies testing the strength model of self-control. In all three studies participants completed an initial task of self-regulation and then performed a subsequent, seemingly unrelated task that also required self-regulation. In the first study, participants were asked to regulate their emotional responses to an evocative film. They were instructed to either decrease or increase their emotional response while watching an upsetting movie. Control participants were not asked to change their emotional responses at all. The subsequent task of self-control was a task of physical stamina. Participants were timed to see how long they could squeeze a handgrip. To control for differences in hand strength, participants were measured on this task both before and after the affect manipulation. The second and third studies asked participants to suppress a forbidden thought (i.e. a white bear). Participants wrote down all of their thoughts and were instructed to either think about a white bear as much as they could, try not to think about a white bear, or were given no specific thought control instructions. The dependent variable in Study 2 was persistence on an unsolvable anagram task; whereas the dependent variable in Study 3 was participants’ ability to stifle their laugher in response to an amusing video. In all three studies self-control on the dependent measure was impaired by prior exertion of self-control.

Baumeister, Bratslavsky, Muraven, and Tice (1998) also conducted a series of early studies of the strength model of self-control. As in the Muraven (1998) studies, all of the experiments asked participants to engage in an initial task requiring good self-control followed by a second, unrelated task of self-control. In the first study, participants were led to believe that
they were participating in a study about taste perception. They were assigned to taste either chocolate chip cookies, radishes, or to the no food control group. Participants were exposed to both types of foods and were asked to eat at least two or three cookies or radishes, depending on their condition. The idea was that participants in the radish condition had to resist the temptation to eat the cookies and they had to force themselves to eat two to three bitter radishes. Participants who forced themselves to eat radishes in the presence of tempting cookies quit faster on unsolvable anagrams than did people who did not have to exert self-control over eating.

In a second study, (Baumeister et al.) participants were assigned either to the suppress-emotion condition or the no-regulation condition. Participants in the suppress emotion condition were instructed to try not to show or feel any emotions during either a humorous video or a sad video. The participants in the no-regulation condition were not given any specific instructions about their emotional responses. Suppressing emotion led to a drop in performance on a puzzle-solving task. In the fourth study, participants in the control condition were given a sheet of paper of meaningless text and told to cross off every instance of the letter e. The participants in the ego-depletion condition had a more difficult task, requiring them to consult multiple rules and monitor their decisions carefully. They were told to cross off an e only if it was not adjacent to another vowel or one extra letter away from another vowel. Participants then watched a boring video. Half were told to press a button when they wanted to stop (“active quit”) and half were told to hold the button down as long as they wanted to watch more of the movie; releasing the button would stop the video (“passive quit”). Participants who were depleted were more likely to take the passive route compared with participants who were not depleted, suggesting that ego-depletion made the participants more passive. Overall, the authors concluded that their results
suggest that “the self’s capacity for active volition is limited and that a range of seemingly different, unrelated acts share a common resource” (p. 1252).

In their review article, Baumeister, Vohs, and Tice (2007) summarize the different responses and interpersonal processes that have been shown to consume limited self-regulatory resources. Responses that require self-control include controlling thoughts, managing emotions, overcoming unwanted impulses, fixing attention, guiding behavior, and making many decisions. Therefore laboratory tasks such as asking participants not to think about a white bear, to control their emotional responses to a film, or to eat radishes instead of cookies can all be expected to deplete self-control. Interpersonal processes that have been shown to require self-regulation include self-presentation or impression management, kindness in response to a partner’s bad behavior, dealing with demanding partners, and interracial interactions. All of these processes have been included as “depleters” in studies of the strength model of self-control.

All of these studies point toward the conclusion that the first self-control task consumed and depleted some limited resource that was less available for performance on the second self-control task. These effects are not due to a diminished perception of self-efficacy or the inference that the participant is poor at self-control (Wallace & Baumeister, 2002). The authors hypothesized that the effects of ego-depletion are explained either by an energy model of self-control or by self-attribution of failure from the first task. Indeed, failure and poor self-evaluations could be expected to result in decreased motivation and persistence. The authors hypothesized that if impairments of self-control arise because people believe they have failed on the initial self-control task, then people who receive success feedback on the initial task should not show impairments on the second task. In the Wallace and Baumesiter study, participants in the depletion condition completed the Stroop task (a color-naming task in which participants
stated the color of the ink a word is printed in, rather than reading the word itself), a task of inhibition. In the no depletion condition participants completed a variation of the Stroop task in which the ink color and the word matched. Participants then either received no feedback, positive feedback, or negative feedback about their performance on the task. The dependent variable in this study was the participants’ performance on an unsolvable, figure-tracing puzzle. The manipulation of success and failure feedback regarding performance on the first task had no effect on self-control on the second task, which contradicts the self-attribution explanation of ego-depletion and supports the energy depletion model.

In a review of the literature, Baumeister, Gailliot, DeWall, and Oaten (2006) summarized previous literature in order to validate the construct of ego depletion. They argued against several commonly cited alternative explanations for the effect. First, the results do not appear to be a consequence of just completing a difficult task. Performing a difficult task does not require self-control (e.g. completing math problems, memorizing words). Ratings of task difficulty are not related to performance and performing a difficult task does not impair performance on later attempts at self-control (e.g. Muraven & Slessareva, 2003). After exerting self-control, participants perform worse only on tasks of depletion (Muraven & Slessareva) or executive functioning (Schmeichel, Vohs, & Baumeister, 2003).

Additionally, fatigue does not appear to be a viable explanation. Fatigue causes people to apply less effort toward unimportant goals and tasks, but more effort toward important goals and tasks. Self-regulatory goals are believed to be the most important (Baumeister et al., 1994) and therefore should be the last capacity to become impaired during a state of fatigue. Fatigue also tends to be domain specific such that performing one task impairs performance on the same task but not on other unrelated tasks. Researchers have also failed to find any evidence that the
depletion effect is attributable to mood or arousal (Schmeichel et al., 2003). The pattern also
does not appear to be due to participants refusing to exert themselves on the second task because
they think they have done enough on the first task and have fulfilled their obligation to the
experimenter. Several studies have presented the two tasks of self-control as separate
experiments and have still found that participants perform worse on the second task (e.g.
Baumeister et al., 1998). All of the research summarized above suggests that the ego-depletion
effect does exist as a strength model of self-control. Many alternative explanations have been
ruled out through previous literature.

Recently researchers have begun exploring the possible mechanisms underlying the
strength model of control. Miller, Pattison, DeWall, Rayburn-Reeves, and Zentall (2010)
proposed that the depletion of self-control resources is biological in nature. The authors suggest
that perhaps self-control does not require a sense of self; rather it results from executive-control
processes. This sort of processing relies on a limited energy resource that becomes depleted
through a biological mechanism, namely availability of glucose in the bloodstream. Therefore,
the authors conducted two experiments using domesticated dogs as participants rather than
humans. The first experiment showed that dogs required to exert self-control on an initial task
(dog told to sit and stay for 10 minutes) persisted for a shorter time on a subsequent unsolvable
task (toy with treat that cannot be removed) than did dogs that had not previously exerted self-
control. This study suggests that non-human animals are also vulnerable to ego-depletion,
implying that there may be a biological mechanism involved rather than a “sense of self.” The
second experiment found that providing depleted dogs with a boost of glucose eliminated the
negative effects of prior exertion on persistence. This study is important because the results
suggest that a sense of self is not necessary for self-regulatory behaviors and that a simpler, biological mechanism is involved.

Gailliot and Baumeister (2007) review evidence suggesting that blood glucose plays an important role in self-control in humans. They also explain some of the physiological explanations and anecdotal findings in support of these effects. They argue that blood glucose is an important, integral part of the body’s energy processes. They state that all brain processes involve and are dependent upon the consumption of energy from blood glucose; however self-control may be unusual in its relatively high demand for energy due to its central importance in daily life. Additionally, self-control utilizes the executive functions, which primarily occur in the prefrontal cortex. This region of the brain requires a particularly extensive amount of glucose. The authors summarize research evidence suggesting that self-control failures are more likely when glucose is low or cannot be metabolized effectively to the brain (for example, when insulin is low or ineffective). They point to the fact that alcohol reduces glucose throughout the body, particularly to the brain, and likewise impairs many different forms of self-control. Self-control failure is also more likely during periods of the day when glucose is lowest and is metabolized least effectively (e.g. in the evening and later at night). Thus, self-control appears highly susceptible to glucose.

Gailliot, Baumeister, DeWall, Maner, Plant, Tice, et al. (2007) demonstrated the effects of the Miller (2010) study using human participants instead of dogs. In a series of nine studies, the authors found that laboratory tests of self-control (i.e. the Stroop task, thought suppression, emotion regulation) and of social behaviors (i.e. stifling prejudice, engaging in helping behavior) depleted blood glucose levels. As blood glucose levels fluctuate throughout the day, participants were asked to fast three hours before the study in an effort to stabilize glucose levels.
Participants watched a six minute video (without sound) of a woman talking. In the bottom corner of the screen everyday words (e.g. hair, hat) appeared for approximately ten seconds each. Participants in the attention-control (depletion) condition were instructed to focus their attention only on the woman’s face and to avoid looking at the flashing words. Participants in the watch normally (control) condition were not given special instructions about how to watch the video. Blood glucose levels were again measured following the video task. The results of the study confirmed that the self-control task used up a relatively large amount of glucose. All participants watched the same video, but only participants in the attention-control condition exhibited a drop in blood glucose levels. This pattern of results was replicated using stereotype suppression as the depleting task. Participant’s who engaged in an interracial interaction exhibited drops in their blood glucose levels.

Gailliot et al. also found that low levels of blood glucose following an initial depletion task impaired performance on a subsequent task of self-control. In Studies 3 through 6 the authors tested the hypothesis that low levels of blood glucose following a self-control task would predict poor performance on behavioral measures of self-control. For example, initial blood glucose levels were assessed for each participant. Next, participants completed the same attention-control task mentioned above. All participants were instructed to focus on the woman speaking and to ignore the words flashing in the corner. Following this task, blood glucose levels were assessed a second time. Finally, participants completed the Stroop task. The amount of time that it took participants to complete the Stroop task and the number of errors were the dependent variables. The results showed that glucose levels at the start of the study did not predict Stroop performance; however lower glucose after having completed the attention-control task was associated with worse performance on the Stroop, even after controlling for initial glucose levels.
Studies 4 through 6 replicated these findings using different depleting tasks and different outcome variables, all with the same pattern of results. This series of well-controlled studies suggest that self-control requires a certain amount of glucose to operate unimpaired. Thus, when glucose is depleted by a single act of self-control, subsequent attempts at self-control are more likely to result in failure.

Dvorak and Simons (2009) also examined the role of glucose in the self-control strength model. At the outset of the study, blood glucose measures were taken from each participant. Participants in the control condition watched a video with no special instructions; however participants in the experimental condition were asked to suppress their emotional thoughts and reactions while watching the video. Each participant’s blood glucose level was again recorded. Finally, each participant completed an unsolvable anagram task. Persistence on this task was the dependent measure. As expected, emotional suppression led to a decrease in persistence on the anagram task. Additionally, participant’s blood glucose levels decreased significantly after being asked to suppress their emotional reactions to a film. The association between depletion and task persistence was partially mediated by decreases in blood glucose.

Understanding self-control has potential practical applications for everyday situations. Self-control is associated with good adjustment, secure attachments to other people, and favorable psychological states in general (Tangney et al., 2004). On the other hand, poor self-control is related to higher rates of psychopathology, increased vulnerability to substance abuse and eating disorders (Tangney, 2004). Ego depletion also contributes to excessive alcohol consumption (e.g. Muraven, Collins, & Nienhaus, 2002), sexual disinhibition (e.g. Gailliot & Baumeister, 2007), impulsive spending (Baumeister, 2002), romantic partner violence (e.g.
Finkel, DeWall, Slotter, Oaten, & Foshee, 2009), and overeating (Kahan, Polivy, & Herman, 2003; Vohs & Heatherton, 2000).

Muraven et al. (2002) examined the role of self-control failure in alcohol consumption. In this study male participants were recruited to participate in a study about perceptions of intoxication. They were told that they were going to sample two different beers and that after they drank the beer they would take a driving simulator test. They were also told that they could win a prize if they performed well on the driving test. Therefore, participants were encouraged and free to consume the beer but also were given a reason to restrain or regulate their intake. Participants were randomly assigned either to a depletion condition (suppress thoughts of a white beer) or a neutral task condition (solving simple arithmetic problems). Following the task, the participants entered the laboratory bar and were given two pitchers of beer. The amount of beer consumed was the outcome variable for the study. Individuals who had suppressed their thoughts consumed more and achieved higher blood alcohol levels than those who did arithmetic. The groups did not differ in terms of mood, arousal, or frustration.

Gailliot and Baumeister (2007) postulated that nonsexual depletion of self-control contributes to inappropriate sexual behaviors. Participants were recruited to participate in a study about the relationships between attitudes and behavior. They were randomly assigned to a depletion condition (asked to cross off all occurrences of the letter e except for e’s that were followed by a vowel or e’s that appeared in a word with a vowel appearing two letters before the e) or a control condition (asked to cross off all occurrences of the letter e with no further instructions). Following the task, participants were provided with a set of seven scenarios. They were supposed to imagine that they were in a committed, heterosexual romantic relationship for an extended period of time. Each scenario was an opportunity to engage in sexual behaviors.
outside of the relationship. They were asked to indicate their present likelihood of engaging in each behavior on a scale from one to nine. Depleted participants perceived themselves as being more likely to engage in sexual infidelity than non-depleted participants.

In the second study, the results were replicated using actual sexual and romantic behavior in the laboratory as the outcome variable. In this study romantic couples came in to the lab and were assigned to individually complete a depletion task (attention-control task) or a control task (watch normally). Afterwards the couples were reunited with each other and invited to engage in any act of physical intimacy. The dependent measure was the extent of participants’ sexual behavior. Depleted participants engaged in more sexual behaviors than non-depleted participants; however this was only the case if the participants were sexually inexperienced. These studies suggest that the strength model of self-control may be implicated in sexual restraint.

In a review article Baumeister (2002) argues that self-control failure is related to impulsive spending behavior. He argues that people in a state of ego depletion are more likely to yield to temptation and buy impulsively. Depleted consumers will be less able to regulate their behavior toward their long-range goals of saving their money and purchasing only things that will be of maximum advantage in the long run. When people are depleted as a result of changes they are trying to make (e.g. dieting, breaking habits, adopting an exercise regimen, or controlling their emotions) they are especially likely to engage in impulsive purchases.

Finkel et al. (2009) found that participants whose resources of self-control were depleted were more violent in response to partner provocation than were non-depleted participants. Both members of romantic couples attended the session together and were assigned to either a depleting (attention control) or non-depleting (watch normally) condition. The measure of
intimate partner violence was the duration for which participants assigned their partner to maintain physically painful body poses. The experimenter told participants that they would complete a two person task with their partner in which one would be the actor and the other the director, who would determine how many poses his or her partner must complete and for how long the partner must hold each of them. Participants who were in the depletion condition were more violent in response to partner provocation than were non-depleted participants.

The ego-depletion model of self-control has also been applied to eating behavior among restrained eaters and dieters. Restrained eating refers to the intentional effort to restrict one’s food intake with the goal being to control one’s body weight (Stroebe, 2008). Previously, Herman and Polivy (1984) described a boundary model of the regulation of eating. This model proposes that biological pressures work to maintain food intake within a certain range. The aversive qualities of hunger keep consumption above a certain minimum and the aversive qualities of satiety keep consumption below a certain maximum. Between these two extremes, there is a “zone of biological indifference.” Eating in this zone is regulated by secondary, non-physiological social and environmental influences.

According to Stroebe (2008), restrained eaters are assumed to differ from non-restrained eaters in two respects. First, restrained eaters impose a dietary boundary within their zone of biological indifference. This boundary consists of a set of dieting rules that specify the amounts and types of foods that individuals allow themselves. These dieting rules are used to regulate food intake to maintain or achieve desirable weight. Restrained eaters regulate their food intake cognitively through the application of these dieting rules. In contrast, unrestrained eaters are assumed to regulate their eating primarily through bodily feedback. They eat when they are hungry and stop eating when they are full. Secondly, restrained eaters have a larger zone of
indifference. All of their dieting has made them less sensitive to the biological cues of hunger and satiety. Dieters can be thought of as under less physiological control, whereas unrestrained eaters are unaffected by cognitive controls and driven by physiological ones. Thus, when dieters are motivated to concentrate on the regulation of their eating, they are successful. However if their motivation is impaired, physiological regulation again takes over and they eat to satiety. Herman and Polivy (1984) suggested that there are two sets of factors that can impair the ability and motivation of restrained eaters to regulate their food intake. The first is emotional distress and the second is actual or perceived dietary violation.

Other researchers have found limitations in the boundary model and instead postulate a goal conflict theory of eating (e.g. Stroebe, Mensink, Aarts, Schut & Kruglanski, 2008). According to this theory, the difficulty of restrained eaters in regulating their food intake is not due to their inability to recognize bodily cues, but to a conflict between two incompatible goals. The goal to control their weight conflicts with the goal to enjoy palatable food. Dieters can maintain their control for a long time, because generally weight control is their dominant goal. However, our environment is filled with stimuli signaling palatable food and chronic dieters are sensitive to such stimulation. These temptations activate automatic attempts to protect the goal of weight loss by suppressing thoughts about palatable food. Continued exposure to stimuli of palatable food, however, will continue to bring to mind the goal of eating enjoyable food. Eventually, with the continued presence of food stimuli, the goal to consume enjoyable food will become more dominant than the goal to control weight. People then “forget” their thoughts and strategies for weight control and are likely to overeat.

In addition to the two theories mentioned above, which are popular in the dieting literature, researchers in the area of ego-depletion have used the strength model of self-control to
try to explain dietary disinhibition in restrained eaters. Indeed, I would argue that the goal conflict theory of eating could actually be conceptualized as an ego-depletion model. Previous research has shown that suppressing and controlling thoughts deplete reserves of self-control. Therefore, when dieters are confronted with stimuli of palatable food, they have to suppress their thoughts about the eating goal, and instead think about their goal for weight control. Eventually this reserve weakens and they are no longer able to suppress their thoughts and retain self-control.

Kahan, Polivy, and Herman (2003) also theorized that many everyday self-regulatory tasks may deplete dieters’ ego strength and undermine their ability to maintain control over their intake in the period following such tasks of self-regulation. Sixty-two participants were randomly assigned to either the depletion group (visual perception task with pressure to conform to other participants) or the non-depletion group (visual perception – no conformity). Participants were classified as restrained or unrestrained eaters based on their scores on The Restraint Scale, a validated questionnaire assessing eating habits. Following the visual perception task they were presented with three types of freshly baked, palatable cookies and were asked to rate the cookies on various dimensions. The plate of cookies was weighed before and after the taste-test to measure the amount consumed. As the authors predicted, restrained eaters who were exposed to the ego-depletion condition ate significantly more than did restrained eaters who were not exposed to the ego-depletion condition. These results suggest that many everyday self-regulatory tasks may deplete restrained eaters’ ego-strength reserves, disabling continued attempts at dietary restriction. Additionally, the attempt to suppress eating will in itself make it difficult for dieters to maintain their restraint in the presence of food.
In two studies, Vohs and Heatherton (2000) also examined the effects of chronic inhibition in dieters in different situations that varied in terms of their demand for self-control. In the first study, the authors manipulated situation conditions to differ in temptation level by varying whether tempting foods were positioned within participants’ reach (high temptation) or across the room (low temptation). Pilot testing showed that this manipulation varied only in terms of temptation level, not in terms of mood or self-esteem. Participants were also given instructions either to help themselves to the snacks or to not touch the snacks. The authors predicted that the situational factors of availability and temptation would affect subsequent self-control among dieters only, not among non-dieters. They predicted greatest self-control resource depletion among chronic dieters who were seated next to the snacks and were told to help themselves. The results demonstrated that the manipulation of perceived availability and proximity of tempting snacks undermined subsequent self-control among dieters. Participants were only required to exert self-control in the condition where participants were asked to “help themselves,” and it was only in this condition that eating behavior was significantly affected by temptation level. For chronic dieters being told not to eat eliminated the need for effortful self-control.

In the second study, Vohs and Heatherton (2000) attempted to deplete self-control in chronic dieters using a self-regulatory task unrelated to food. Participants were assigned either to an emotion regulation condition or an “act naturally” condition. In the depletion condition, participants were instructed to inhibit their reactions to a sad video. Participants in the control condition were asked to act normally. Following the video, participants were asked to complete an ice cream taste test. They used the amount of ice cream eaten as the outcome variable. Results suggest that participants who were asked to inhibit their emotional reactions (depleted
participants) ate significantly more ice cream than those who were allowed to let their responses to the video occur naturally. The results of these studies support a strength model of self-control and suggest that this model can be used to explain dietary failure in restrained eaters.

Erskine (2008) examined the effects of ego-depletion on eating behavior in individuals who were not dieting. Participants were told that they were participating in a study to investigate how thinking can affect taste preference. They were asked not to eat one hour prior to the study. They were also told that there would be two periods of thought verbalization, during which they would verbalize their thoughts while alone. They were told ahead of time that they might be given specific topics to try to think or not think about. Participants were asked to verbalize their thoughts for five minutes for a tape recorder. In the suppression condition, participants were asked to try not to think about chocolate; however, if they did think about chocolate they pressed a buzzer. Participants in the expression condition were instructed to think about chocolate, whereas participants in the control condition were not given any special instructions before the thought expression task. All participants then completed a taste preference task during which they were given two bowls of chocolate and told to try as many chocolates as necessary to answer the questions, but to try at least one of each chocolate. The results showed that participants in the suppression condition ate significantly more chocolate than participants in the control group. These results also support a strength model of self-control in regard to eating behavior.

The strength model of self-control has been elaborated in terms of the mechanism behind the effect and its application to clinical issues. The research literature has also begun to explore potential ways to counteract this effect. Evidence suggests that practice can improve self-control over time, but how can people recover from this and become capable of self-control again
relatively quickly? Recently, researchers have begun to examine psychological phenomena that may be important in counter-acting or moderating depleted self-control, including inducing positive affect (Tice, Baumeister, Shmueli, & Muraven, 2007), giving material or social incentives (Muraven & Slessareva, 2003), or planning ahead (Webb & Sheeran, 2003). Self-control can also be replenished through physiological mechanisms, namely by increasing blood glucose levels (Gailliot et al., 2007).

More specifically, in a series of four experimental studies, Tice et al. (2007) attempted to restore a depleted ego by inducing positive affect. In each study, participants were randomly assigned to one of four groups (depleted/neutral affect, depleted/positive affect, non-depleted/neutral affect, non-depleted/positive affect). Initial tasks to deplete self-control for those in the ego-depletion group included thought suppression tasks, resisting tempting food, or forming a habit and then breaking it. Positive affect was induced through either a surprise gift or a comedy video. The outcome variable, participant performance on the second task of self-regulation, was measured by performance on a handgrip task, persistence on an unsolvable task, or how much of an unpleasant beverage could be consumed. After an initial act of self-regulation, participants who underwent a positive affect manipulation engaged in as much self-control as non-depleted participants and had better control than participants who received a neutral mood stimulus or a brief rest period.

Muraven and Slessareva (2003) conducted several experiments to explore whether individuals can compensate for a depleted ego if given sufficient incentive. In the first study, the authors hypothesized that participants would be more motivated if they believe that the outcome is important. Therefore, half of the participants were told that the study would help answer important questions about memory that may be useful in the treatment of Alzheimer’s dementia.
During the depletion phase participants completed a thought suppression task. The subsequent measure of self-control was the participants’ persistence on an unsolvable figure tracing task. The results of the first study suggested that individuals who are depleted can compensate if their motivation is great enough. Specifically, people who were depleted and believed that the task would benefit others performed better on a subsequent test of self-control than individuals who were depleted and not given the social incentive. In the second study the authors examined the effects of feedback about the participants’ chances of success on the task of self-control. They hypothesized that motivation decreases when the chance of success seems remote. Participants were asked to practice a frustrating task (rolling a ball around a maze by tilting the surface to avoid holes). Some of the participants were told that practicing might make a difference in their eventual performance on the game. Others believed that practicing would be of little benefit to their performance. Participants who believed that their practice efforts would benefit them performed better on a subsequent task of self-control than individuals who were led to believe that practice was fruitless. Overall, these studies suggest that depleted individuals may compensate for their lack of self-control when sufficiently motivated.

Webb and Sheeran (2003) examined the effects of forethought and planning ahead on individuals who are in a state of ego depletion. The authors used implementation intentions, defined as statements of the form: “As soon as Situation y occurs, I will initiate goal-directed Behavior x (p.280).” By specifying these intentions in advance and planning ahead, the need for cognitive control is passed to anticipated environmental cues. In the first study, participants in the ego-depletion condition were asked to complete the Stroop task and name the color the word was printed in as quickly as possible. Participants in the implementation intention group were also asked to name the ink color of each word; however they also formed an implementation
intention in advance. They were asked to tell themselves: “As soon as I see the word I will ignore its meaning (e.g. by looking only at the second letter) and I will name the color ink it is printed in” (p. 281). Participants who formed implementation intentions during the initial ego-depleting task subsequently showed greater persistence on an unsolvable puzzle task compared to participants who did not form implementation intentions. These findings were replicated in a second, similar study. Overall, the results suggest that planning reactions in advance enhance individuals’ ability to regulate their behavior.

These studies suggest that the effects of ego-depletion can be decreased using various psychological phenomena. However, Gailliot et al. (2007) also found that physiological interventions can decrease the effects of ego-depletion. As previously mentioned, Gailliot and colleagues conducted multiple studies suggesting self-control relies on glucose as a limited energy source. Acts of self-control reduce blood glucose levels and low levels of blood glucose after an initial self-control task predict poor performance on a subsequent self-control task. They also found that initial acts of self-control impaired performance; however, if participants consumed a glucose drink, impairments on subsequent tasks of self-control were eliminated. In studies seven through nine, the authors provide evidence of a causal relationship between blood glucose and self-control by having participants drink a glucose beverage. Participants in study seven first completed a task that required self-control (an attention control task) or a task that did not require self-control. Participants then drank Kool-Aid lemonade that had been sweetened either with sugar (glucose) or Splenda (placebo condition). The authors found a significant 2 X 2 interaction. Participants in the placebo condition who were depleted from controlling their attention, made more errors on the outcome measure of self-control (the Stroop task) than participants in the placebo condition who were not ego-depleted. This was not the case in the
glucose condition. A glucose drink eliminated the tendency for an initial self-control task to impair Stroop performance. This interaction was then replicated in study eight and nine using different acts of self-control (helping behavior and interracial interactions, respectively).

All of the literature summarized above suggests that the strength model of self-control exists. It seems clear that when individuals engage in a task requiring good self-control, they are less successful at maintaining self-control during a subsequent (often unrelated) task requiring self-control. This phenomenon appears to have a physiological explanation, namely that engaging in self-regulation depletes the availability of blood glucose. Additionally, the strength model of self-control can be applied to clinical issues. The papers summarized above reflect the progression of this body of research. Studies of ego-depletion began as basic science, an attempt to explain human behavior. As the theory has gained more empirical support, psychologists have begun to try to apply it to human problems. The strength model of ego depletion seems to hold true, it can be reversed, and it can be applied to clinical/practical issues. All three of these findings have been examined in separate studies; however up to this point, no single study has attempted to tie all of these findings together.

The purpose of the current study was to apply the ego strength model of self-control to restrained eaters and to try to reverse depletion in this sample using the glucose model. I recruited participants who were restrained eaters, depleted their self-control, and then attempted to reverse the depletion. In other words, could increasing blood glucose be used as a “treatment” for dieters who had just depleted their reserve of self-control? I hypothesized that restrained eaters who were depleted by a task of self-control would exhibit more disinhibition on a taste-test task than would restrained eaters who were not depleted. However, if the participants were given glucose following the depletion task, then their self-control would be “repleted” and they
would exhibit similar control to that of the non-depleted participants. Figure 1 shows a graph of the hypothesized results. The study has potential implications for dieters. If the hypotheses are supported, the results suggest that dieters should be sure to maintain their blood glucose levels to avoid disinhibition. Obviously glucose contains some calories, but if the hypotheses are supported, consuming the relatively small amount of calories in glucose may be worth it to avoid a binge. Or, rather than consuming extra glucose, dieters could spread their meals out throughout the day to avoid dips in blood sugar levels. This study also addresses a gap in the literature and serves as a bridge between basic science and applied science.

Given the prevalence of overweight and obese individuals in the United States, research about the regulation of eating is incredibly important from a public health perspective. Indeed, the World Health Organization (WHO, 2000) describes overweight and obesity as worldwide problems. According to Ogden et al. (2006), over 30% of men and nearly 35% percent of women in the United States are obese. The consequences of overweight and obesity are numerous. Overweight and obese individuals are likely to face social consequences, including prejudice and discrimination (e.g. Brownell, Puhl, Schwartz, & Rudd, 2005; Kraha & Boals, 2011). Individuals who are overweight and obese are also more likely to experience body dissatisfaction (e.g. Vander Wal & Thelen, 2000), lower self-esteem (e.g. Miller & Downey, 1999), and depression (e.g. Roberts, Kaplan, Shema, & Strawbridge, 2000). Physical health consequences of being overweight and obese include decreased lifespan (e.g. Garrow, 1999), and increased risk for coronary heart disease (e.g. Hubert, Feinleib, McNamara, & Castelli, 1983), diabetes mellitus (e.g. Weinstein, Sesso, Lee, Cook, Manson, Buring et al., 2004), dyslipidemia (e.g. Pi-Sunyer, 2000), and cancer (e.g. Baik, Ascherio, Rimm, Giavannucci, Speigelman, Stampfer, et al., 2000).
CHAPTER 2 METHOD

Participants

Participants were recruited from the University of North Texas’ research subject pool. Participants received partial course credit for participating in the study. The first part of the study consisted of an online screening questionnaire. A total of 1,057 participants (332 males) completed the online screener. The average age of the participants was 21.4 years. Participants were also asked to report their race/ethnicity. Six participants (0.05%) were American Indian or Native Alaskan, 83 (7.8%) were Asian or Pacific Islanders, 150 (14.2%) were African American, 152 (14.4%) were Latino, 629 (59.5%) were White/Caucasian, and 32 (3.0%) reported their race/ethnicity as “other.”

From this larger sample restrained eaters were identified using the Restraint Scale (Herman & Polivy, 1980). As per Vohs and Heatherton (2000), participants with scores of 16 or higher on the Restraint Scale were recruited to participate in the study. If they qualified for the study, they were sent an email inviting them to sign up for the second portion of the study. A total of 436 (102 males) participants were invited to participate in the study. The average age of the participants was 22.1 years. Three participants (0.6%) were American Indian or Native Alaskan, 34 (7.8%) were Asian or Pacific Islanders, 42 (9.6%) were African American, 66 (15.1%) were Latino and 275 (63%) were White/Caucasian. Thirteen (3.0%) reported their race/ethnicity as “other.”

Of the participants invited to participate in the study, 105 (31 males) signed up and completed the full study. The average age of the participants was 21.9 years. Three participants (2.9%) were American Indian or Native Alaskan, 12 (11.4%) were Asian or Pacific Islanders, 6 (5.7%) were African American, 17 (16.2%) were Latino, and 67 (64%) were White/Caucasian.
Materials

*The Restraint Scale*

The Restraint Scale (RS) was originally developed by Herman and Mack (1975) to assess the degree of self-imposed restriction of food intake. The scale was then revised by Heatherton, Herman, Polivy, King and McGree (1988). Heatherton et al. examined the factor structure of the RS and identified two factors. The RS is a 10-item scale measuring weight fluctuation (4 items) (i.e.”In a typical week, how much does your weight fluctuate?”) and concern for dieting (6 items) (i.e. “how often do you diet?”). Restrained eating refers to the degree of chronic dieting. Concern for dieting includes attempts to restrict food intake below a normal or desired limit, and episodes when restraint is abandoned. The RS was included in the online screening questionnaire and participants with scores of 16 or higher were invited to participate in the lab portion of the study. Test-retest reliability over a one-month delay suggests that the measure is relatively stable across time (r = .64) (Scaglussi, Polacow, Cordas, Coelho, Alvarenga, Philippi et al., 2005).

*Need for Cognition Scale*

The Need for Cognition Scale (NCS; Cacciopo, Petty & Kao, 1994) was also included in the initial screening questionnaire. The NCS is an 18-item measure developed to assess an individual’s enjoyment of and likelihood of engaging in effortful cognitive activities. The scale asked participants the extent to which each description is characteristic of them on a 5-point Likert-type scale ranging from 1 (*extremely uncharacteristic of me*) to 5 (*extremely characteristic of me*). Example items include “I prefer simple to complex problems” and “I find satisfaction in deliberating hard and for long hours.” Nine items on the scale require reverse coding. Total scores on the NCS are calculated by summing the score on each item. Higher
scores indicate higher enjoyment for and likelihood of engaging in effortful cognitive activities. The NCS has been shown to have high internal consistency (alpha = .90; Cacciopo et al., 1994).

Health Questionnaire

Also included in the online screening questionnaire were questions about the participant’s medical history (Appendix A). Participants with diabetes or problems with their blood sugar were excluded from the study. Participants were also asked about the medical history of their first-degree relatives. Specifically, participants were asked, “Do you have high blood pressure, or has a doctor or health professional ever told you that you have high blood pressure or borderline high blood pressure?” Participants responded, “No, I do not have high blood pressure,” “Yes, I do have high blood pressure” or “I have been told I have borderline high blood pressure.” They were also asked, “Do you have diabetes, or has a doctor or health professional ever told you that you have diabetes or high blood sugar?” Participants respond, “No I do not have diabetes,” “Yes, I do have diabetes (Type 1 or Type 2)” or “I have been told I have borderline diabetes.” If participants had diabetes they were asked to specify which type.

Participants were asked the same questions in reference to a first-degree relative. A first-degree relative was described as “someone with whom you share half of your genetic material; first degree-relatives only include both of your biological parents, and your brothers/sisters who have the same two biological parents as you. Unless you have an identical twin, these are the people to who you are most closely related.” If participants had at least one first-degree relative with high blood pressure, they were then asked to specify how many and state if any of these relatives had died. If any had died, they were asked to specify how many. Participants were also asked, “Are you currently dieting?” and “Are you planning to diet?” They responded to these
questions with “yes” or “no.” They were asked to provide their height in feet and inches and their weight in pounds. Finally, participants were asked to provide demographic information including gender, age, and race/ethnicity.

**Thought Listing Activity**

Participants who qualified for and agreed to participate in the laboratory portion of the study were asked to complete a thought-listing task (Appendix B). Participants in the control group were not asked to engage in a task that required self-control during this portion of the study. They were given the following instructions, “The first part of the study will examine thought patterns. Unlike most experiments that ask you to write a paragraph about a specific topic, in this study you are being asked to write your thoughts as they occur to you. Please list your thoughts, with one thought per line, so that the experimenter can examine naturally occurring thought patterns. Please continue listing your thoughts until the experimenter returns to the room and asks you to stop.” Participants in the experimental condition were asked to suppress their thoughts. They received identical instructions as the control group; however they were given the additional task to try not to think about a white bear. They were told “to help you direct your thoughts, you are asked to try NOT to think about a white bear. However, if you do happen to think about a white bear, be sure to include it in your list of thoughts.”

**Taste Test Task**

The primary dependent variable was the weight of cookies consumed by participants during a “taste test” portion of the study. Participants were told that the study was examining thought patterns and taste perception. Therefore, there were two taste test portions of the study.
Participants were asked to taste and rate various characteristics of cookies as well as characteristics of the juice (which delivered the glucose or placebo) (Appendix C). In regard to the beverage, they were asked to rate their overall liking for the drink from 1 (strongly dislike) to 5 (like a lot). They were also asked to rate the sweetness of the drink from 1 (very sweet) to 5 (not sweet) and the bitterness of the drink from 1 (very bitter) to 5 (not bitter). They were asked to rate their liking for the consistency of the drink from 1 (strongly dislike) to 5 (like a lot). Finally, they were asked if there was anything they would do to improve the drink, and if so, what would improve it.

Participants were asked similar questions about their liking for the three varieties of cookies (chocolate chip cookies, sugar cookies and oatmeal cookies). They were asked to rate their overall liking for the cookies, their liking for the texture of the cookies, and their liking for the smell of the cookies from 1 (strongly dislike) to 5 (like a lot). They were also asked to rate the sweetness of the cookies from 1 (not at all sweet) to 5 (very sweet). Finally, they were asked if there was anything they would do to improve the cookies, and if so, what would improve them.

Other Variables

Participants were also asked to rate their fatigue on a scale from 1 (not at all fatigued) to 10 (extremely fatigued). They were asked to rate how effortful they found the thought listing exercise be on a scale from 1 (not at all effortful) to 10 (extremely effortful). This variable was included as a manipulation check. They were also asked to provide the time since their last meal in hours and to rate their hunger on a scale from 1 (not at all hungry) to 10 (extremely hungry). See Appendix D.
Procedure

The study consisted of two sessions. The first session was the online screening questionnaire, which consisted of the RS, the NCS, the Health Questionnaire and demographic questions. Participants who scored 16 or higher on the RS were invited via email to participate in the laboratory portion of the study. At this time they were informed that they would need to fast for three hours prior to the study. This was to stabilize the participants’ blood glucose levels. In this email they were also informed that the study would require three measurements of the their blood glucose levels, which requires a minor finger stick. See Appendix E for the full recruitment email.

The second session of the study took place in the experimental laboratory. Participants were told that the study was examining thought patterns and taste perception. After completing informed consent (Appendices F & G), participants were randomly assigned to one of four conditions: a depleted/glucose condition, a depleted/no glucose condition, a non-depleted/glucose condition, and a non-depleted/no glucose condition. There were 26 participants per condition, except the depleted/glucose condition, which had 27 participants. Measurements of the participants’ blood glucose were taken at three different points in the study. Readings were taken using an OneTouch UltraMini blood glucose monitoring system. This system works by taking a very small amount of blood (approximately 1 microliter) by finger stick. Participants were asked to wash and dry their hands with warm water. Their finger was then cleaned using an alcohol pad. Participants were also asked to shake their hands to dry the alcohol and increase blood flow to the fingertips. Experimenters also washed their hands before and after the procedure and wore disposable surgical gloves. All lancets were disposed of in a Sharps medical waste container. Gauze, alcohol pads, and testing strips were disposed of in a biohazard bag. The
study met the requirements of the University of North Texas’ Institutional Biosafety Committee. The first blood glucose reading was taken following informed consent.

To manipulate ego-depletion, half of the participants (those in the depleted/no glucose and those in the depleted/glucose condition) completed a thought suppression task, as described above. Participants in the non-depleted conditions were asked to simply list their thoughts with no suppression. The thought listing task lasted 5 minutes. A second measurement of blood glucose was taken following the task.

To manipulate glucose levels, participants in the glucose conditions received 14 ounces of fruit punch flavored Kool-Aid sweetened with sugar and those in the placebo conditions received 14 ounces of fruit punch flavored Kool-Aid sweetened with Splenda (as per Gailliot, 2007). Participants were instructed to drink the entire quantity of juice. They were then asked the taste test questions about their liking for the drink. Evidence suggests that glucose is absorbed into the bloodstream at a rate of 30 calories per minute and after 10 minutes can be metabolized in the brain (Donohoe & Benton, 1999). Therefore, to allow the glucose to metabolize, participants watched a slideshow of neutral pictures, which lasted for 10 minutes.

After the slideshow, the third and final measurement of blood glucose was taken. Participants were then asked to complete a “taste test” of three different types of palatable cookies using the same methodology as Kahan et al. (2003). Participants were told that they could eat as many cookies as they wanted and they were asked to rate them on different characteristics (i.e. texture, sweetness). Participants were given a large Tupperware container filled with cookies so that it was not immediately obvious to the experimenter how many cookies they had eaten. The taste test was also conducted in a private room, so that there would be no social pressure to restrict cookie consumption. Additionally, participants were offered milk or
water so that they would not restrict consumption based on thirst. The dependent variable was the weight of cookies consumed (in grams). The container of cookies was weighed before and after the taste test portion of the study using a sensitive kitchen scale. Finally, participants were given a debriefing form (Appendix H).
CHAPTER 3

RESULTS

Descriptive Statistics

Sample demographics are described in detail above. Participants were predominately young, female and White/Caucasian. Fifty participants (47.6%) reported they were dieting at the time of the study whereas 54 (51.4%) denied current dieting. Seventy-six participants (72.4%) reported they were planning to diet. Ninety participants (85.7%) denied having high blood pressure, whereas eight participants (7.6%) reported they had high blood pressure and seven (6.7%) reported having borderline high blood pressure. Ninety-nine participants (94.3%) reported they did not have Type 1 or Type 2 diabetes; however five participants (4.8%) stated they had borderline diabetes or high blood sugar. Body mass index (BMI) was calculated for each participant. The mean BMI for the sample was 26.3. Based on the current classification system published by the World Health Organization (WHO, 2000), this statistic suggests that the sample, in general, was overweight. Additionally, most participants had a family history of high blood pressure. Fifty-eight (55.2%) participants had at least one first-degree relative with high blood pressure and three participants (2.9%) had a first-degree relative with borderline high blood pressure. Ten participants (9.5%) were unsure and 34 participants (32.4%) denied family history of high blood pressure. Overall, these results suggest that our participants were relatively healthy. Descriptive statistics for all other variables are included in Table 1.

All measures were evaluated for the presence of extreme values. To assess for outliers all scores were converted to Z-scores. All Z-scores greater than 3.0 were considered extreme cases and were removed from the sample. This resulted in the removal of nine values. Two values on the baseline glucose measurement and two values on the second glucose measurement were
removed. One value each on weight, cookies consumed, total consumption, BMI and total RS score was removed. Missing values were not included in the data analyses. Missing values resulted because one participant refused the blood glucose measurements and three glucose readings could not be obtained following the thought-listing task. This resulted due to difficulty getting enough blood for the test strip. Experimenters were instructed not to prick a participant’s finger more than two times per test to avoid undue stress to the participants. One participant did not report his or her height and therefore BMI could also not be calculated for this individual. Two participants were unable to complete computerized ratings of current fatigue, effort required to complete the task, hours since last meal, or current hunger due to computer problems. Participants were given the option to drink milk or water and only thirty-two participants elected to drink milk, which resulted in the largest number of missing values.

The accuracy of random assignment to condition was also assessed. The experimental conditions were equivalent in terms of gender, $\chi^2(3, N = 105) = 2.81, p = .42$ and in terms of race/ethnicity, $\chi^2(12, N = 105) = 10.84, p = .54$. The conditions were also equivalent in terms of age, $F(3, 101) = .91, p = .44$. These findings suggest that the experimental groups were equivalent and random assignment was successful. One-way analyses of variance (ANOVAs) were conducted to check for differences between the four conditions in terms of fatigue, hunger and hours since last meal. There were no statistically significant differences between groups in terms of hunger, $F(3, 99) = .76, p = .521$, fatigue, $F(3,99) = .152, p = .93$, or hours since last meal, $F(3, 99) = .018, p = .99$. These results suggest that any differences in self-regulation during the taste-test portion of the study were not due to hunger or fatigue, but rather to effort required to exert self-control.
An independent samples $t$-test was conducted as a manipulation check to examine how effortful each group (depleted versus control) found the initial self-regulatory task to be (i.e. “how effortful was the thought-listing activity that you just completed”). It was expected that participants in the thought suppression (depletion) group would report the task required more effort than participants in the control group. Contrary to expectations, there was no difference between groups on how effortful they found the task $t(101) = -.18, p = .86$. As an alternative manipulation check, it was expected that participants in the depletion group would have lower blood glucose readings following the self-control task than did the control group. However, the two conditions did not differ in terms of glucose reading following the thought-listing task $t(100) = -.229, p = .82$. Overall, these results suggest that the thought suppression task did not require more effort than the thought-listing exercise, indicating that the manipulation was not successful.

To test the treatment (glucose/placebo) manipulation, an independent samples $t$-test was conducted to test for blood glucose differences at the third measurement between the placebo and control group. The result was significant, $t(101)=4.71, p < .001$. Participants who received the Kool-Aid sweetened with glucose had significantly higher levels of blood glucose levels following a ten-minute delay than did participants who had the Kool-Aid sweetened with Splenda. Participants in the glucose condition also experienced a greater change in blood glucose level between the second measurement (right before the Kool-Aid) and the third measurement (ten minutes after the Kool-Aid), $t(100) = -7.31, p < .001$. Therefore, participants in the glucose condition experienced a significantly greater spike in glucose levels following the Kool-Aid than did participants in the placebo condition. These findings suggest that the treatment manipulation was successful. It is worth noting that the mean baseline glucose level in the current study is about ten points lower than the mean baseline glucose levels reported in the Gailliot et al.
studies. This is likely a significant difference, as glucose differences of only five points were statistically significant in the Gailliot et al. article. This suggests that the participants in the current study had fasted longer than the participants in the Gailliot studies.

**Primary Data Analysis**

The primary hypothesis was that restrained eaters who were depleted by a task of self-control would exhibit more disinhibition on a taste-test task than would restrained eaters who were not depleted. However, if the participants were given glucose following the depletion task, then their self-control would be “repleted” and they would exhibit similar control to that of the non-depleted participants. This hypothesis was testing using a 2 (Depletion/No-depletion) X 2 (Glucose/Placebo) ANOVA. The means and standard deviations are shown in Table 2. See Figure 2 for a bar chart of the results. Contrary to the expected results, the main effect for depletion condition was not statistically significant, $F(1, 103) = 3.12, p = .08$ and neither was the main effect for treatment condition (glucose vs. placebo), $F(1, 103) = 3.33, p = .07$. The interaction term was also not significant, $F(1, 103) = .40, p = .53$. Although the main effects approached significance, the differences were not in the expected direction, as can be seen in Table 2. The primary data analysis was also conducted with extreme values excluded and with extreme values replaced with the $Z$-score equivalent of 3.0 rather than removed. In all three ANOVAs the results were non-significant. The same analysis was conducted using just the weight of cookies (rather than cookies and milk) as the dependent variable. Again, the main effect for depletion condition, $F(1, 104) = 1.96, p = .17$ and the main effect for treatment condition, $F(1, 104) = .277, p = .6$ were not significant. There also was not a significant interaction, $F(1, 104) = .43, p = .51$. 

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As an alternative analysis, only participants who were currently dieting were included in the 2 (Depletion/No-depletion) X 2 (Glucose/Placebo) ANOVA. Again, there was no difference in weight consumed between those who completed the depletion task and those who had completed the control task, $F(1, 49) = .723, p = .4$. There was no difference between those who had received the placebo juice and those who had received the glucose drink, $F(1, 49) = .65, p = .43$. There was also no interaction effect, $F(1, 49) = .009, p = .93$.

I was also interested in possible relationships between the continuous variables included in the study, so bivariate correlations were conducted. As can be seen in Table 3, the results suggest that there are significant correlations between BMI and fatigue and between BMI and weight fluctuation. There is also a significant negative correlation between concern for dieting and total weight consumed during the taste test. Not surprisingly, hunger was correlated with hours since last meal. Interestingly, there was no correlation between hunger and consumption between time three glucose readings and consumption. As a follow-up analysis, concern for dieting was used in a linear regression equation to see if it predicted total consumption. Concern for dieting significantly predicted total consumption, $\beta = -.25, t(1, 103) = -2.58, p < .05$. Concern for dieting also explained a significant proportion of variance in total consumption, $R^2 = .06, F(1, 102) = 6.65, p < .05$. Although concern for dieting predicted consumption of milk and cookies during the taste test, there was no difference between dieters and non-dieters in terms of weight consumed $t(101) = -.13, p = .90$.

Due to the fact that concern for dieting was correlated with consumption of milk and cookies, the primary data analyses were re-run with concern for dieting as a covariate. A 2 (Depletion/No depletion) X 2 (Glucose/Placebo) ANCOVA was conducted controlling for concern for dieting. The main effect for depletion condition was not significant, $F(1, 104) = 2.71$,
$p = .1$ and the main effect for treatment condition only approached significance, $F(1, 104) = 3.45, p = .07$. The interaction term was also not significant, $F(1, 104) = .8, p = .38$. As before, the same analysis was conducted using just the weight of cookies (rather than cookies and milk). Again, there was no significant main effect for depletion condition, $F(1, 104) = 2.62, p = .12$, or for treatment condition, $F(1, 104) = .05, p = .83$, and the interaction was not significant, $F(1, 104) = .54, p = .47$. 
CHAPTER 4

GENERAL DISCUSSION

The purpose of the current study was to apply the ego strength model of self-control to restrained eaters and to try to reverse depletion in this sample using the glucose model. The strength model posits that self-regulatory operations consume a limited resource that is left depleted following the exertion of self-control. This theory states that when people override their impulses and temptations, they are less successful at overriding these responses on subsequent tasks requiring self-control, even when the task is unrelated to the first act of self-control. The theory implies that some resource similar to energy or strength is actually consumed during the process of exerting self-control. Recently, researchers have postulated that the resource consumed is glucose in the blood stream (Gailliot et al). This assertion seems intuitive. It is the frontal lobe of the brain that is primarily responsible for executive functioning, which would include overriding impulses. Of all areas of the brain, the frontal lobe also consumes the most and requires the most glucose to optimize functioning. In the current study, these findings were applied to restrained eaters and glucose was used as a potential treatment for the ego-depleting effects of exerting self-control.

The hypothesis was that participants who completed a depletion task would exhibit less restraint during a mock taste test than participants who were not depleted; however depleted participants who had glucose re-administered to their bloodstream would become “repleted” and therefore, be able to resist the impulse to eat the cookies. Contrary to expectations however, there were no differences between groups in the amount of food consumed. There were no main effects and no interactions. These results are likely explained by the fact that the experimental manipulation was unsuccessful. Participants did not find the thought suppression task to be
particularly effortful or fatiguing. In fact, they found the task to be just as fatiguing and effortful as the control participants who were simply asked to list their thoughts rather than suppress them. Because the participants were not depleted by the task, it is not surprising that the results of the current study are non-significant. The white bear task is a widely used measure of self-control; however some elements of the task were different in the current study than in previous studies. For example, researchers often have the participants write out (with pen and paper) their thoughts. This way they are asked to write “white bear” if they think about one, but also to put a check mark in the margins. Some researchers also had participants ring a bell if they thought of a white bear. Perhaps the task would have been more difficult if it was not computerized or if it had more requirements. Additionally, the task could be performed for longer than five minutes or with an experimenter in the room reminding them not to think about a white bear. These differences seem relatively minimal; however, given the fact that the white bear task has been used successfully in many other studies (i.e. Baumeister et al. 2007; Erskine, 2008; Gailliot et al. 2007; Erskine, 2008; Muraven et al. 1998; Muraven & Slessareva, 2003)

The second manipulation did appear to be successful. Participants who received the Kool-Aid flavored with sugar had significantly higher levels of blood glucose ten-minutes after the administration than did participants who received the placebo juice. They also experienced greater change in their blood glucose levels between the second measurement (right before drinking the Kool-Aid) and the third measurement (ten minutes after drinking the Kool-Aid). Interestingly; however, the amount of blood glucose in the system right before the taste test was unrelated to the total weight consumed. Several interesting relationships emerged as part of this study. While blood glucose levels and hunger were not related to amount of cookies and milk consumed, concern for dieting, a subscale of the Restraint Scale, was significantly negatively
correlated with total weight consumed. Participants who reported a high concern for dieting tend to diet more often, are more affected by a five-pound weight fluctuation, are likely to eat sensibly in front of others, feel guilty about overeating and are highly conscious of what they are eating. It makes sense then that participants who have a high concern for dieting would be more conscious of the amount of cookies that they would consume.

The results of the current study should be considered in light of several limitations. First, participants were college undergraduates, and therefore, the findings are not generalizable to other populations. In addition, the sample size was relatively small. When controlling for concern for dieting the results of the analyses approached significance, suggesting that there may be a small effect. However, previous studies used similar or even smaller sample sizes. Future studies may consider including more participants. It is also possible that a different food besides cookies would be more appropriate. Cookies are high in fat and sweets (particularly chocolate), and tend to have a lot of stigma to people attempting to diet. Perhaps another snack choice would be more appropriate. Additionally, people may be more likely to crave a salty snack after consuming a sweet beverage. Pretzels or chips may have produced different results. Another limitation is that participants completed the online screener several weeks before they came to the lab to complete the laboratory portion of the study. It is possible that their dieting status had changed significantly between the time they completed the screener and the time they were recruited for the study.

In light of these limitations, the current findings are not totally out of line with the other side of the glucose and self-control literature. The fact that glucose levels were unrelated to the weight of cookies consumed and that there was no change in glucose level following the self-control task is inconsistent with the glucose model of self-control. This model has only recently
become popular in the area of self-control and ego-depletion. In the past, the resource consumed had been left vague, such as “willpower” or an analogy between self-control and a fatigued muscle. Gailliot et al. attempted to make the energy consumption assertion more concrete in a series of nine studies examining the relationship between glucose and self control. These studies asserted that glucose is a resource necessary for and depleted by, acts of self-control. The general design of these studies was similar to the current study. First, participants were asked to perform a self-control task followed by a second, unrelated self-control task. In these studies, compared to controls, participants who completed an initial self-control task had reduced performance on the second task. A commonly used explanation for this effect has been that a resource was depleted by the first task, leaving less of that resource available for the second task.

Kurzban (2010) conducted a re-analysis of the data presented in several of the original Galliot et al. studies. The author states that, for the glucose explanation to be applicable, two propositions must be true. The first is that “performing a self-control task reduces glucose levels relative to a control task” and the second that “performing a self-control task reduces glucose levels relative to glucose levels before the task” (p. 245). If either of these propositions are not true than the difference in performance observed cannot be due to a reduction in glucose. The glucose model of self-control is based on the idea that self-control tasks result in depletion because of energy consumption by the brain, but makes no mention of glucose consumed by other vital organs in the body’s periphery, such as the heart. In fact, Scholey, Harper, and Kennedy (2001) found a drop in peripheral glucose when participants completed difficult cognitive tasks. Compared to a 5-minute key-pressing task (control), participants who completed a 5-minute serial sevens task did show reductions in glucose levels. However, the authors also measured heart rate and found that the participants who completed the serial sevens task also
experienced in increase in heart rate. An increase in heart rate also requires glucose, and therefore, the idea that differences between the computational requirements of the brain between the two tasks is responsible for the drop in glucose becomes problematic.

Additionally, other researchers have reported findings inconsistent with the glucose model. For example Fairclough and Houston (2004) obtained a baseline measurement of participants’ glucose levels and then had them complete one of two versions of the Stroop task for 45 minutes. The control group completed the congruent Stroop, meaning that the words and the color of the words were the same, whereas the experimental group completed the incongruent Stroop, in which the word and the color of the word were different. Additional glucose measurements were taken at 15, 30 and 45 minutes. Changes in blood glucose levels were larger for the participants who completed the incongruent Stroop; however task performance was unrelated to glucose level. Marcora, Statiano, Manning (2009) had participants complete a 90-minute continuous performance test. Measures of blood glucose were recorded before and after the task. They found that blood glucose levels were not sensitive to cognitive effort, although the participants reported a state of subjective mental fatigue.

Gibson and Green (2002) state that overall the body of evidence concerning glucose and cognition is small and inconsistent. In their review of several previous studies examining food deprivation, glucose and cognition, they found no consistent evidence that performance deficits were due to falls in blood glucose. Some studies found no association between ingestion of glucose and cognitive function or negative associations between cognitive performance and increased blood glucose. Others found that improvements in performance were associated with both rising and falling glucose. In summary, some research evidence suggests that the relationship between performance on self-control tasks and blood glucose drops appears in some
cases, but not in others. Even if glucose levels do drop, the reason for these changes is unclear and could have to do with use of glucose by other areas of the body rather than brain exertion.

Gibson (2007) suggests that the relationship between blood glucose and mental functioning is more complex than a matter of more effortful processes leading to the use of more blood glucose by the brain. The author also points out that research in this area is based on the assumption since glucose is the major source of fuel for the brain, any alterations of blood plasma levels of glucose will result in alterations in brain levels of glucose. This makes sense from a common-sense perspective, but is not necessarily supported by the scientific evidence. Raichle and Mintun (2006) conducted a review of brain imaging and suggested that regional increases in brain blood flow rarely affect overall rate of brain blood flow even during the most vigorous of physical activity. They also state that relative to the continuous energy use of the brain, regional energy consumption as a result of a particular task could be as low as one percent. Indeed, Kurzban (2010) states that the entire brain consumes about one quarter of one calorie per minute. Given that, the consumption rate for a single portion of the brain involved in self-control would logically be much smaller than one quarter of one calorie per minute. A one percent increase in effort across the entire brain during a 5-minute task would consume only about .0125 calories. This finding questions the possibility of self-control tasks effecting circulating glucose levels as well as glucose levels in the entire brain. Madsen et al. (1995) directly measured the difference in the concentration of glucose going into and coming out of the brain. They measured the glucose in arteries entering the brain compared to veins leaving the brain 41 times before, during and after a 10-minute Wisconsin Card Sort Task. They found no change from baseline, suggesting that overall the brain was not soaking up more glucose from the blood during the cognitively demanding task.
Kurzban re-analyzed the original data from the Gailliot et al. studies 3-6. In these studies, participants’ glucose was measured before they completed a self-control task. Following the task, another measure of blood glucose was taken. Participants then completed a second self-control task to assess the relationship between performance on the second task and the level of glucose at the second reading, controlling for the baseline glucose level. Kurzban argues that using the drop in glucose rather than the absolute measure as the predictor variable is inconsistent with the stated theory, which is that glucose is a limited resource. Therefore, performance depends on the amount of the resource; however Gailliot and colleagues present data suggesting that performance depends on the recent change in glucose. Kurzban re-analyzed the data and found that in all four studies, the reduction in glucose following the task did not replicate. The mean glucose levels were not significantly different from before the task to after the task. The author suggests that Gailliot and colleagues reported only data consistent with their prediction, whereas the complete dataset undermines the hypothesis that these tasks reduce the level of peripheral glucose. He states the failure to find this effect should not be surprising given what neuroscientists know about brain metabolism. As discussed above, the difference in glucose consumption by five minutes of self-control tasks is unlikely to be significant. Kurzban explicitly states “the weight of evidence implies that the glucose model of self-control ought to be carefully rethought (p. 256).”

The results of the current study are inconsistent with the current glucose model of self-control. When the research summarized above is further considered, it makes sense from an evolutionary perspective that the brain would be relatively invulnerable to short-term changes or deprivation of blood glucose. It would not be very adaptive for human cognitive functioning, particularly the executive functions, to fall to pieces a few hours after a meal.
With that being said future research should examine different types of relationships between glucose and self-control. For example, Chambers, Bridge and Jones (2009) investigated the effect of a glucose-rich beverage compared to placebo placed in cyclists mouths and spit out rather than consumed. They found that the act of simply putting the glucose in their mouths improved the cyclists performance, suggesting that it activated certain brain regions. Additionally, Carter, Jeukendrup, Mann and Jones (2004) found that infusing glucose into the blood does not improve performance, suggesting it is the stimulus rather than the glucose itself that drives performance. The relationship between self-control and the perception of glucose should continue to be explored in future studies. The findings of the current study may also be different if participants had not been asked to fast or if the self-control task was perceived as more difficult. This topic offers a wealth of opportunities for collaboration between psychologists, neuroscientists, biologists and dietitians. In the future, it would likely be helpful to have other scientists involved in the study design and conduction.

Considering the epidemic of obesity in this country, it is important to continue to conduct research that would benefit restrained eaters. Although the current study does not support a glucose model of self-control (or even an ego-depletion model), it is clear from the literature that research findings in this area are inconsistent. Future research should continue to attempt to clarify the likely complex relationship between glucose and self-control, as the practical implications would be significant.
Table 1

*Descriptive Statistics for All Measures*

<table>
<thead>
<tr>
<th>Measure</th>
<th>Mean</th>
<th>Standard Deviation</th>
<th>Range</th>
<th>N</th>
</tr>
</thead>
<tbody>
<tr>
<td>Height (inches)</td>
<td>66.18</td>
<td>3.21</td>
<td>60-75</td>
<td>104</td>
</tr>
<tr>
<td>Age</td>
<td>21.90</td>
<td>5.0</td>
<td>18-49</td>
<td>105</td>
</tr>
<tr>
<td>Weight (pounds)</td>
<td>164.37</td>
<td>41.87</td>
<td>108-296</td>
<td>105</td>
</tr>
<tr>
<td>BMI</td>
<td>26.28</td>
<td>5.61</td>
<td>18-43</td>
<td>104</td>
</tr>
<tr>
<td>Fatigue</td>
<td>4.84</td>
<td>2.26</td>
<td>1-10</td>
<td>103</td>
</tr>
<tr>
<td>Task Effort</td>
<td>4.08</td>
<td>2.25</td>
<td>1-10</td>
<td>103</td>
</tr>
<tr>
<td>Hours since meal</td>
<td>8.81</td>
<td>5.43</td>
<td>1-20</td>
<td>103</td>
</tr>
<tr>
<td>Hunger</td>
<td>5.46</td>
<td>2.15</td>
<td>1-10</td>
<td>103</td>
</tr>
<tr>
<td>Baseline glucose reading</td>
<td>92.77</td>
<td>11.43</td>
<td>71-130</td>
<td>103</td>
</tr>
<tr>
<td>Glucose following task</td>
<td>93.63</td>
<td>12.64</td>
<td>71-134</td>
<td>102</td>
</tr>
<tr>
<td>Gluc after juice</td>
<td>102.81</td>
<td>16.91</td>
<td>73-146</td>
<td>103</td>
</tr>
<tr>
<td>Total RS</td>
<td>20.61</td>
<td>3.88</td>
<td>16-31</td>
<td>104</td>
</tr>
<tr>
<td>Concern dieting (RS)</td>
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<td>3.48</td>
<td>2-19</td>
<td>105</td>
</tr>
<tr>
<td>Wt. Fluctuation (RS)</td>
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<td>2.5</td>
<td>3-16</td>
<td>104</td>
</tr>
<tr>
<td>Need for Cognition Scale total</td>
<td>60.56</td>
<td>10.74</td>
<td>33-88</td>
<td>104</td>
</tr>
<tr>
<td>Weight of cookies consumed (g)</td>
<td>66.27</td>
<td>25.31</td>
<td>7-144</td>
<td>104</td>
</tr>
<tr>
<td>Weight of milk consumed (g)</td>
<td>68.93</td>
<td>111.81</td>
<td>0-390</td>
<td>105</td>
</tr>
<tr>
<td>Total consumed (g)</td>
<td>135.91</td>
<td>117.36</td>
<td>7-489</td>
<td>104</td>
</tr>
</tbody>
</table>
Table 2

*Mean (SD) Consumption of Cookies and Milk by Depletion Condition and Treatment Condition*

<table>
<thead>
<tr>
<th>Depletion Condition</th>
<th>Treatment Condition</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Glucose</td>
</tr>
<tr>
<td>Depleted</td>
<td>125.92 (105.48)</td>
</tr>
<tr>
<td>Non-Depleted</td>
<td>178.19 (121.49)</td>
</tr>
</tbody>
</table>

Table 3

*Pearson r Correlation Matrix*

<table>
<thead>
<tr>
<th></th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
<th>8</th>
<th>9</th>
<th>10</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 Fatigue</td>
<td>--</td>
<td>.19</td>
<td>.14</td>
<td>.19</td>
<td>.09</td>
<td>-.01</td>
<td>-.25*</td>
<td>-.05</td>
<td>.001</td>
<td>-.00</td>
</tr>
<tr>
<td>2 Task effort</td>
<td>--</td>
<td>-.00</td>
<td>.06</td>
<td>.05</td>
<td>.16</td>
<td>-.04</td>
<td>.06</td>
<td>.17</td>
<td>.19</td>
<td></td>
</tr>
<tr>
<td>3 Hours since meal</td>
<td>--</td>
<td>.28**</td>
<td>-.14</td>
<td>-.01</td>
<td>-.06</td>
<td>.02</td>
<td>-.10</td>
<td>-.05</td>
<td></td>
<td></td>
</tr>
<tr>
<td>4 Hunger</td>
<td>--</td>
<td>-.14</td>
<td>-.18</td>
<td>.04</td>
<td>-.11</td>
<td>-.18</td>
<td>.03</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5 Gluc after juice</td>
<td>--</td>
<td>.10</td>
<td>-.03</td>
<td>.13</td>
<td>-.02</td>
<td>.08</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>6 Total RS</td>
<td>.45</td>
<td>.10</td>
<td>.77**</td>
<td>.52**</td>
<td>-.08</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>7 BMI</td>
<td>--</td>
<td>-.11</td>
<td>.36**</td>
<td>.04</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>8 Concern dieting</td>
<td>.62</td>
<td>-.09</td>
<td>-.25*</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>9 Wt. fluctuation</td>
<td>.42</td>
<td>.17</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>10 Total consumed</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

>Note. Values reported on the diagonal represent Cronbach’s alpha for calculated scores.*p<.05, **p<.01
**Figure 1.** Predicted results. Cookies consumed (oz.) by depleted and non-depleted restrained eaters given glucose versus those not given glucose.

**Figure 2.** Number of participants at each stage of the study.
Figure 3. Actual results. The weight of cookies and milk consumed (g) by depleted and non-depleted restrained eaters given glucose versus those not given glucose.
APPENDIX A

HEALTH QUESTIONNAIRE
Do you have high blood pressure, or has a doctor or health professional ever told you that you have high blood pressure or borderline high blood pressure?
___ no, I do not have high blood pressure.
___ yes, I do have high blood pressure.
___ I have been told I have borderline high blood pressure.

Do you have diabetes, or has a doctor or health professional ever told you that you have diabetes or high blood sugar?
___ no, I do not have diabetes.
___ yes, I do have diabetes (Type-1 or Type-2.
___ I have been told I have borderline diabetes.

If you have diabetes, is it Type-1 or Type-2 diabetes?
___ Type-1, ___ Type-2, ___ I am not sure

The next two questions ask about first-degree relatives. A first-degree relative is someone with whom you share half of your genetic material; first-degree relatives only include both of your biological parents, and your brothers/sisters who have the same two biological parents as you. Unless you have an identical twin, these are the people to whom you are most closely related.

Does a first-degree relative (biological parent, brother/sister with the same two biological parents as you), either living or dead, have/had high blood pressure?
___ no, none of my first-degree relatives has/had diabetes
___ yes, at least one of my first-degree relatives has/had high blood pressure.
___ yes, at least one of my first-degree relatives has/had borderline high blood pressure.
___ I am not sure, but I think at least one of my first-degree relatives has/had high blood pressure.

How many of your first-degree relatives (either living or dead) has/had high blood pressure? _____.

Have any of these first-degree relatives with high blood pressure died? ___ no, ___ yes.

If yes, who died? ____________________________________________________________
Are you currently dieting?
___ Yes
___ No

Are you planning to diet?
___ Yes
___ No

Height ___ ft, ___ ins

Weight ___ lbs.

What is your age?

Gender:
___ Male
___ Female

Race/Ethnicity:
___ American Indian or Native Alaskan
___ Asian or Pacific Islander
___ African-American
___ Hispanic
___ White, Caucasian
___ Other
APPENDIX B

THOUGHT LISTING INSTRUCTIONS
Control Group

The first part of the study will examine thought patterns. Unlike most experiments that ask you to write a paragraph about a specific topic, in this study you are being asked to write your thoughts as they occur to you. Please list your thoughts, with one thought per line, so that the experimenters can examine naturally occurring thought patterns. Please continue listing your thoughts until the experimenter returns to the room and asks you to stop.

Thought Suppression Group

The first part of the study will examine thought patterns. Unlike most experiments that ask you to write a paragraph about a specific topic, in this study you are being asked to write your thoughts as they occur to you. Please list your thoughts, with one thought per line, so that the experimenters can examine naturally occurring thought patterns. Please continue listing your thoughts until the experimenter returns to the room and asks you to stop. To help you direct your thoughts, you are asked to try **NOT** to think about a white bear. However, if you do happen to think about a white bear, be sure to include it in your list of thoughts. Additionally, please make a check mark in the margin if you do think about a white bear.
APPENDIX C

TASTE TEST QUESTIONS
Please answer the next few questions in regards to the beverage that you just drank.

1) How would you rate your overall liking for the drink?
   
   1  2  3  4  5
   
   Strongly     Like a lot
   Dislike

2) How would you rate the sweetness of the drink?
   
   1  2  3  4  5
   
   Very       Not Sweet
   Sweet

3) How would you rate the bitterness of the drink?
   
   1  2  3  4  5
   
   Very       Not Bitter
   Bitter

4) How would you rate your liking for the consistency of the drink?
   
   1  2  3  4  5
   
   Strongly     Like a lot
   Dislike

5) Would you do anything to improve the drink? If so, what?

Please answer the following questions in regards to the chocolate chip cookies

1) How would you rate your overall liking for the cookies?
   
   1(strongly dislike)  2  3  4  5 (Like a lot)

2) How would you rate the sweetness of the cookies?
   
   1(not at all sweet)  2  3  4  5 (Very sweet)

3) How would you rate your liking for the texture of the cookies?
Please answer the following questions in regards to the sugar cookies:

1) How would you rate your overall liking for the cookies?
   1(strongly dislike)  2  3  4  5 (Like a lot)

2) How would you rate the sweetness of the cookies?
   1(not at all sweet)  2  3  4  5 (Very sweet)

3) How would you rate your liking for the texture of the cookies?
   1(strongly dislike)  2  3  4  5 (Like a lot)

4) How would you rate your liking for the smell of the cookies?
   1(strongly dislike)  2  3  4  5 (Like a lot)

5) Would you change anything to improve the cookies? If so, what?

Please answer the following questions in regards to the oatmeal cookies:

1) How would you rate your overall liking for the cookies?
   1(strongly dislike)  2  3  4  5 (Like a lot)

2) How would you rate the sweetness of the cookies?
   1(not at all sweet)  2  3  4  5 (Very sweet)

3) How would you rate your liking for the texture of the cookies?
   1(strongly dislike)  2  3  4  5 (Like a lot)

4) How would you rate your liking for the smell of the cookies?
   1(strongly dislike)  2  3  4  5 (Like a lot)

5) Would you change anything to improve the cookies? If so, what?
APPENDIX D

OTHER QUESTIONS
Please rate your current level of fatigue:

1  2  3  4  5  6  7  8  9  10
Not at all fatigued  Moderately fatigued  Extremely fatigued

How effortful was the thought listing exercise?

1  2  3  4  5  6  7  8  9  10
Not at all effortful  Moderately effortful  Extremely effortful

How many hours has it been since your last meal?

How hungry are you currently?

1  2  3  4  5  6  7  8  9  10
Not at all hungry  Moderately hungry  Extremely hungry
APPENDIX E

RECRUITMENT EMAIL
Participant name:

You recently participated in a study called “The Cookie Study: Online Screening Questionnaire.” Based on your responses to this portion of the study, you qualify to participate in the second part of the study. If you participate in this portion of the study you will receive 2 additional research credits. The second portion of the study will require approximately 35-40 minutes of your time.

I want to share a couple of important pieces of information with you about the study. As the study is in part about taste perception, we ask that you fast for three hours before arriving at the lab. You should also know that measurements of your blood glucose levels would be taken as part of the study. This requires a very minor finger stick using a One Touch Meter. The meter requires only a very small amount of blood to read your glucose level. It is less invasive than a finger stick you get when visiting a physician.

If you would like to earn 2 additional research credits, you can sign up for an open timeslot on SONA. The study is called “The Cookie Study.” The invitation code to participate is “cookies.” Please contact Lisa Hathaway at lisahathaway@my.unt.edu if you have any questions.

Thank you,
Before agreeing to participate in this research study, it is important that you read and understand the following explanation of the purpose and benefits of the study and how it will be conducted.

Title of Study: The Cookie Study: Online Portion

Principal Investigator: Adriel Boals, University of North Texas, Department of Psychology.

Purpose of the Study:
You are being asked to participate in a study that examines thought patterns and eating behavior. The study will be used as a screener study to identify individuals who may be eligible for a follow-up study. Hence based on your responses in this study, you may be contacted about participation in a follow-up study. You will not be required to participate in the follow-up study.

Study Procedures:
During this online session you will be asked to complete two online questionnaires. One of the questionnaires will ask about eating habits and one of the questionnaires will ask about your characteristic thought patterns. Completing this section should take approximately 10 minutes.

Foreseeable Risks:
There are no foreseeable risks in this study.

Benefits to the Subjects or Others:
This study is designed to help us better understand thought patterns and eating habits. There is little direct benefit to the participants; however the results may have practical implications for the larger population.

Compensation for Participants:
You will receive 1 credit as compensation for your participation in this portion of the study. Some participants will be invited to complete a second portion of the study for 2 additional research credits. As a reminder, you may participate in non-research related activities to earn equal credit. For example, you may write a one-page paper in response to a research article for equivalent credit.

Procedures for Maintaining Confidentiality of Research Records:
Your participation in this study will be confidential. You will be assigned a study ID number and you will not be identified by name in any of the data recording or analysis kept in computers. Your name and corresponding ID number will kept in a file, which will be stored separately from your responses and kept in a locked file. Your name will also be on this consent form that will be kept in a separate place from the data. The confidentiality of your individual information will be maintained in any publications or presentations regarding this study.

Questions about the Study
If you have any questions about the study, you may contact Dr. Adriel Boals at telephone number 940-369-8443.

**Review for the Protection of Participants:**
This research study has been reviewed and approved by the UNT Institutional Review Board (IRB). The UNT IRB can be contacted at (940) 565-3940 with any questions regarding the rights of research subjects.

**Research Participants’ Rights:**
Your agreement to participate below indicates that you have read or have had read to you all of the above and that you confirm all of the following:

- You understand that you do not have to take part in this study, and your refusal to participate or your decision to withdraw will involve no penalty or loss of rights or benefits. The study personnel may choose to stop your participation at any time.
- You understand why the study is being conducted and how it will be performed.
- You understand your rights as a research participant and you voluntarily consent to participate in this study.
- You may print a copy of this form for your records

_____ Yes, I agree to participate
Before agreeing to participate in this research study, it is important that you read and understand
the following explanation of the purpose and benefits of the study and how it will be conducted.

**Title of Study:** The Cookie Study

**Principal Investigator:** Adriel Boals, University of North Texas, Department of Psychology.

**Purpose of the Study:**
You are being asked to participate in a study that examines thought patterns and taste perception.

**Study Procedures:**
During today’s session, we will ask you to complete a thought-listing exercise. We will ask you
to complete two different taste tests, one for a beverage, and one for cookies. You will also be
asked to watch a ten minute picture slideshow. We will take three different measurements of
your blood glucose levels using a OneTouch meter, which requires a mild finger stick. The study
will require 35-40 minutes of your time.

**Foreseeable Risks:**
There are minimal foreseeable risks in this study. Although two different blood glucose readings
will be taken, the amount of blood required (1 microliter) and the amount of pain involved in this
procedure is minimal. However, if you have a fear of needles, it is your right to decline
participation in this study.

**Benefits to the Subjects or Others:**
This study is designed to help us better understand thought patterns and taste perception. There is
little direct benefit to the participants; however the results may have practical implications for the
larger population.

**Compensation for Participants:**
You will receive 2 credits as compensation for your participation in this portion of the study. As
a reminder, you may participate in non-research related activities to earn equal credit. For
example, you may write a one-page paper in response to a research article for equivalent credit.

**Procedures for Maintaining Confidentiality of Research Records:**
Your participation in this study will be confidential. You will be assigned a study ID number and
you will not be identified by name in any of the data recording or analysis kept in computers.
Your name and corresponding ID number will kept in a file, which will be stored separately from
your responses and kept in a locked file. Your name will also be on this consent form that will be
kept in a separate place from the data. The confidentiality of your individual information will be
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**Questions about the Study**
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Review for the Protection of Participants:
This research study has been reviewed and approved by the UNT Institutional Review Board (IRB). The UNT IRB can be contacted at (940) 565-3940 with any questions regarding the rights of research subjects.

Research Participants’ Rights:
Your signature below indicates that you have read or have had read to you all of the above and that you confirm all of the following:

- Dr. Adriel Boals or a research assistant has explained the study to you and answered all of your questions. You have been told the possible benefits and the potential risks and/or discomforts of the study.
- You understand that you do not have to take part in this study, and your refusal to participate or your decision to withdraw will involve no penalty or loss of rights or benefits. The study personnel may choose to stop your participation at any time.
- You understand why the study is being conducted and how it will be performed.
- You understand your rights as a research participant and you voluntarily consent to participate in this study.
- You have been told you will receive a copy of this form.

________________________________
Printed Name of Participant

________________________________                                ____________
Signature of Participant                                                              Date

For the Principal Investigator or Designee:
I certify that I have reviewed the contents of this form with the subject signing above. I have explained the possible benefits and the potential risks and/or discomforts of the study. It is my opinion that the participant understood the explanation.

______________________________________                    ____________
Signature of Principal Investigator or Designee                            Date
APPENDIX H

DEBRIEFING FORMS
Previous research has shown that engaging in an initial task of self-control depletes a limited resource, resulting in less self-control on a subsequent, unrelated task. This is known as the strength model of self-control. Many different tasks require self-control, including controlling thoughts, controlling emotions, and resisting temptations. New studies suggest that blood glucose is the resource consumed during tasks of self-control. If people whose self-control has been depleted consume glucose, their resources are repleted and their performance on subsequent tasks of self-control is similar to that of people who were not originally depleted. This strength model of self-control has been applied to many practical, everyday situations, such as eating behavior among dieters. The current study aimed to examine the effects of the strength model of self-control on restrained eaters (individuals who engage in intentional efforts to restrict their food intake with the goal being to control body weight). The study attempts to answer the following question: “Could increasing blood glucose be used as a ‘treatment’ for dieters who have just depleted their reserve of self-control?”

All participants in the study were recruited to participate due to their higher scores on The Restraint Scale, a measure of concern for dieting and weight fluctuation. Participants were then randomly assigned to 1 of 4 conditions (depletion/placebo, depletion/glucose, control/placebo, control/glucose). Participants in the depletion conditions completed a 5 minute thought suppression task, during which they were asked not to think about a white bear. Participants in the control condition simply listed their thoughts for 5 minutes without specific instructions. To manipulate glucose levels, participants in the glucose condition received 14 oz. of Kool-Aid sweetened with glucose and those in the placebo condition received 14 oz of Kool-Aid sweetened with Splenda.
The variable of interest in this study was the weight of cookies consumed during the taste test portion of the study. The hypothesis is that restrained eaters who are depleted by a task of self-control will exhibit more disinhibition (eat more) during a taste-test task than will restrained eaters who are not depleted. However, if the participants are given glucose following the depletion task, then their self-control will be “repleted” and they will exhibit similar control to that of the non-depleted participants.

Thank you very much for your participation in this study. If you have any questions, please email Lisa Hathaway at lisahathaway@my.unt.edu. You may also contact Lisa Hathaway for information about specific study findings.
REFERENCES


