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The Role of Attention in Ego-Depletion

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Abstract

The resource model of ego-depletion is unable to account for the results of several ego-depletion studies, whereas a recent mechanistic revision by Inzlicht and Schmeichel (2012) has focused on the role of attention and motivation in an effort to explain the phenomenon. Assessment of attention's role in restrained and unrestrained eaters may provide evidence that motivation and attention work in tandem to affect one's ability to exert self-control. In this experiment, college-aged females participated in two studies to examine the role of attention in ego-depletion effects. Study 1 evaluated the effect of ego depletion on attention via a dot probe task, while Study 2 assessed the effect of attentional bias on self-regulatory ability during an eating task. No ego-depletion effect was observed to affect attention toward reward cues or away from self-control cues in the first study, with ancillary evidence suggesting that the ego-depletion induction task was unable to induce a depletive effect which may have driven the observed results. The results of the second study indicate that orienting individuals toward reward cues impacted only the restrained eaters, thus implicating both attention and motivation in guiding eating behavior which is consistent with the components of the mechanistic revision of ego-depletion.

Keywords: *Attention, Ego-depletion, Eating, Dietary Restraint*

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Introduction

We all have the ability to control our impulses in an effort to achieve long-term goals. This ability is considered to be highly adaptive and allows individuals to regulate or modify their behavior to appropriately seek ideals, morals, situations and goals (Baumeister, Vohs, & Tice, 2007; Tangney, Baumeister, & Boone, 2004). This ability has been referred to by several terms, including self-control, self-regulation, and willpower (Baumeister, 2002). Deficits in the area of self-control have been linked to several domains of concern, including alcohol abuse, crime and violence, smoking, overspending, sexual impulsivity, obesity, and more (Baumeister, Heatherton, & Tice, 1994).

Research in the area of self-regulation has used a dual-task research paradigm, which involves tasks completed at two time points – at Time 1, an individual completes a task that requires the use of self-control, and at Time 2, the individual completes an additional self-control task, revealing a decline in the ability to self-regulate at Time 2 after having regulated at Time 1. This effect is the crux of the theory of ego-depletion (Baumeister, Bratslavsky, Muraven, & Tice, 1998), which states that the ability to self-regulate is a limited resource which is expended with each use of effortful self-control. However, rather than being a non-renewable resource, it is conceptualized to be more akin to a muscle (Muraven, Tice, & Baumeister, 1998) that allows for self-regulatory capacity to return to the individual after rest or relaxation, but repeated utilization of any self-regulatory system will diminish regulatory capacity for a short time (Tyler & Burns, 2008).

Recent conceptualizations of self-regulatory systems regard self-regulation to be one singular resource used across all domains rather than domain-specific regulatory systems operating in concert with one another (Baumeister et al., 1998; Gailliot et al., 2007; Inzlicht & Schmeichel, 2012). Primary evidence for a singular resource is the lack of specificity in the regulatory tasks used to induce ego-depletion at Time 1, such as alcohol use (Muraven & Shmueli, 2006), eating (Baumeister et al., 1998), and cognitively inhibitive tasks (Job, Dweck, & Walton, 2010), among many others. Moreover, the generalizability of ego-depletion effects stems from a similarly wide array of domains utilized for measurement of dependent variables at Time 2, such as eating (Vohs & Heatherton, 2000), cognitive distress tolerance (Baumeister et al., 1998), violent reactions (DeWall, Baumeister, Stillman, & Gailliot, 2007), and risk taking (Freeman & Muraven, 2010). Another piece of evidence supporting the idea of self-control as a singular resource is the pattern of self-regulatory failures throughout the day – very few failures occur in the morning or early afternoon, when individuals are typically most productive, but instead occur frequently in the evening or at night (Baumeister & Heatherton, 1996; Muraven, Collins, Shiffman, & Paty, 2005).

A meta-analysis by Hagger, Wood, Stiff, and Chatzisarantis (2010) revealed robust effects of ego-depletion on outcome tasks even after accounting for type of dependent measure, type of depletion task, source laboratory, and domain of both depletion and dependent tasks. Effect size was moderated by such items as depletion task duration, interim period between tasks, use of different experimenters between tasks, dependent task complexity, and domain of dependent tasks (cognitive or volitional tasks). These moderators are logically consistent with the resource model of ego-depletion, but the results of several studies cannot be entirely accounted for by the resource model. For example, studies that incorporated motivational

incentives between the depletion task and the dependent task have consistently found, at a minimum, a weakening of the ego-depletion effect (Molden et al., 2012; Muraven & Slessareva, 2003).

Efforts to examine the physiology behind ego-depletion have found evidence suggesting that blood glucose levels may be the physical resource behind the resource model (Gailliot & Baumeister, 2007; Gailliot et al., 2007). For example, in a study by DeWall, Baumeister, Gailliot, and Maner (2008), participants completed a depletion or non-depletion task at Time 1, drank lemonade with sugar or lemonade with sugar substitute during the interim period, and subsequently committed to volunteering their time to assisting a needy individual at Time 2. As hypothesized by the authors, depleted participants who drank sugar substitute volunteered fewer hours than depleted participants who consumed sugar. Consumption of sugar had no effect on the non-depleted participants, suggesting that glucose was able to restore a measure of self-control in participants who had already "used" self-control previously. The Hagger et al. (2010) meta-analysis revealed a large effect size for glucose supplementation, revealing a $d = 0.75$ effect size after amalgamating current studies of this phenomenon. However, this meta-analysis was only able to include the results of 5 experiments, and newer work has begun to challenge the glucose theory. Indeed, a recent study has revealed a similar restorative effect of individuals rinsing their mouths with a glucose-laden beverage without any ingestion (Molden et al., 2012). Similarly, an alternate theory states that it is not the availability of glucose in the blood which predicts the ability to maintain self-control, but it is instead the ability of the body to appropriately transport and allocate glucose correctly that corresponds to self-control ability (Beedie & Lane, 2012). Further work is needed to uncover the role of glucose in self-control, but available evidence suggests that it may only account for a portion of the ego-depletion effect.

In addition to glucose theory, several mechanisms through which the ego-depletion effect operates have been proposed, including motivation (Muraven & Slessareva, 2003), fatigue (Muraven, Gagne, & Rosman, 2008), and affect (Leith & Baumeister, 1996), among others. The existence of these alternate theories indicate that the resource model is not able to account for all ego-depletion research. Indeed, multiple studies have found either reduced ego-depletion between tasks (Muraven & Slessareva, 2003; Clarkson, Hirt, Jia, & Alexander, 2010; Job et al., 2010) or a reversal of the ego-depletion effect (Tice, Baumeister, Schmueli, & Muraven, 2007; Wan & Sternthal 2008) when manipulating facets of the dual-task paradigm. Muraven and Slessareva (2003) found that motivational incentives to perform a self-regulatory task at Time 2 significantly reduced the effects of ego-depletion, suggesting that there may be a central motivational component to ego-depletion effects. Similarly, Job, Dweck, and Walton (2010) found that implicit beliefs regarding the limited or unlimited nature of willpower moderate the ego-depletion effect, suggesting that an internalized belief about the ability of oneself to regulate behavior is also a key component of this effect, which is impossible given the restrictions of a resource model of ego-depletion. Wan and Sternthal (2008) found that feedback provided to an individual regarding performance was able to reverse the ego-depletion effect, revealing that individual differences and in self-monitoring as well as self-monitoring induced through feedback were able to quickly replenish the resource of self-control, thus uncovering the plausible role of self-monitoring and attention in the ego-depletion effect. Unfortunately, several alternate theories of ego-depletion are also unable to account for the myriad results within ego-depletion studies, and thus the resource model of self-control has continued to remain dominant in the field.

Recently, a theory by Inzlicht and Schmeichel (2012) has proposed a mechanistic revision to the theory of self-control as a resource, called the process model of ego-depletion. In this new theory, it is proposed that ego-depletion effects are the result of interconnected and iterative decreases in both motivation and attention, during which an individual experiences decreased motivation to engage in self-control behaviors and more motivation to approach reward after any exertion of self-control. This decrease in motivation is simultaneously accompanied by an attentional shift away from cues which suggest self-control and toward cues suggesting reward or pleasure. Additionally, motivational and attentional processes are hypothesized to influence each other through the use of monitoring discrepancies between long-term goal states and current states within the individual. Self-control is thought to be enacted when individuals attend to and find discrepancy between current and goal states. With less attention toward self-control cues, there will be fewer measurements of discrepancy, leading to a smaller possibility of enacting self-control behaviors (Carver & Scheier, 1981). Similarly, motivation is thought to affect behavior primarily through what have been termed motivational conflicts, or differences between short-term desires and long-term motivations, and denote the contexts in which self-regulation must occur (Baumeister & Vohs, 2007).

The process model of ego-depletion theoretically accounts for results that the resource model was previously unable to explain. For instance, the Muraven and Slessareva (2003) study, which found that motivation played an integral role in moderating the effect of ego-depletion, can be attributed to restoring the individual to a motivational state which allowed for sustained self-control performance. This is a much more parsimonious explanation than was previously espoused by the authors, which involved an extension of the resource model that utilized previously untapped willpower resources that the individual is able to draw upon when

motivated in a depleted state. Similarly, Job, Dweck, and Walton (2010) revealed the role of implicit theories of willpower within the context of ego-depletion effects. These results do not fit within the resource model of ego-depletion, as beliefs regarding self-control should not affect self-control itself; however, this study fits well into the process model, as implicit theories about willpower affect the motivation and attention systems driving the iterative process underlying the model. Additionally, Wan and Sternthal's (2008) experiments revealed how individuals utilize self-monitoring to create an ego-depletion effect. Utilizing motivational alterations in order to affect the self-monitoring behaviors in these studies indicated the use of both attention and motivation in the creation of an ego-depletion effect, revealing the essential mechanisms driving the process model of ego-depletion.

Although many of the previously discrepant results discovered in ego-depletion studies are potentially explained by the process model of ego-depletion, it is important to note that this theory has not been directly tested – it exists as a post-hoc explanation for a myriad array of phenomena that are not able to be reasonably accounted for by the resource model. As such, research must be conducted with the postulates of the process model driving testable hypotheses, and it is this intention which focuses the remainder of this study. Even though several of the above expounded studies have revealed the effects of motivation on ego-depletion, there is a distinct lack of research on the effect of attention. It is this component of the process model that requires more supporting evidence within the framework of ego-depletion research.

There has been much relevant research within the attention domain that is applicable to the process model. The motivational intensity theory of emotion (Gable & Harmon-Jones, 2010b) suggests that individuals with a state of high approach motivation have a narrowed attentional focus (Chajut & Algom, 2003; Gable & Harmon-Jones, 2008; Harmon-Jones &

Gable, 2009), whereas individuals with a state of low approach motivation have a broad focus of attention (Gable & Harmon-Jones, 2008; Gable & Harmon-Jones, 2010a). Colloquially, it could be said that a state of high motivation such as anger or desire would narrow an individual's focus of attention toward the desired object, stimulus, or state. This is a logical deduction, given that an individual who is motivated to approach a stimulus will focus on information relevant to that stimulus while simultaneously filtering out irrelevant information; in short, narrowed attention would be useful while pursuing a goal (Easterbrook, 1959). An opposite effect can be seen in individuals who are in a state of low approach motivation and positive affective state, such that these individuals would experience attentional broadening, as they sort and filter information from their environments and are open to new opportunities (Carver, 2003). Gable & Harmon-Jones (2010b) have thus described the effect of motivation on the broadening or narrowing of attention. Rewording the process model using the terminology of Gable and Harmon-Jones (2010b), an individual increases in approach motivation towards reward thus narrowing attention toward reward cues and filtering out less desirable cues, particularly those associated with self-control; in this way, the iterative process of motivation affecting attention begins after effortful control is utilized.

One of the most frequently used research domains in ego-depletion studies is that of eating behavior, which has been utilized as both a depletion task (Baumeister et al., 1998; DeWall et al., 2007) as well as an outcome measurement (Fedoroff, Polivy, & Herman, 1997; Polivy, Coleman, & Herman, 2005; Tice et al., 2007; Vohs & Heatherton, 2000). Most of the work using eating as an outcome makes the important distinction between restrained and non-restrained (or dieting vs. non-dieting) eaters (Herman & Polivy, 1980), where restraint is conceptualized as a difference in the mechanisms in control of eating behavior. In non-

restrained eaters, hunger (and its cognitive components, such as attention to reward cues) is primarily controlled by biological mechanisms, whereas for restrained eaters, hunger (and its cognitive components) is primarily controlled by cognitive mechanisms. This is directly applicable to ego-depletion studies because the difference between restrained and non-restrained eaters is largely a function of motivation, where restrained eaters are motivated to regulate eating and lose/maintain weight while unrestrained eaters are not. In a study illustrating this point, Vohs and Heatherton (2000) revealed differences in eating outcomes between restrained and unrestrained eaters, with only restrained eaters experiencing ego-depletion effects when presented with food. Food presentation at Time 1 induced depletion only for restrained eaters, as their motivation to restrict eating required the use of self-control exertion in the form of motivational conflicts, whereas no such effect was seen in unrestrained eaters.

Restraint status has been examined in several studies, but the results have not yet been conclusive regarding its effect on attention. In a study conducted by Boon, Vogelzang, and Jansen (2000), no difference was found between restrained and non-restrained eaters towards or away from any food, weight/shape, or neutral words. However, restrained eaters needed less time to recognize food words than neutral words, suggesting faster processing of these word types with no difference in attention. Papies, Stroebe, and Aarts (2008) conducted two studies, the first of which revealed that restrained eaters displayed an attentional bias towards food items after they had been pre-exposed to food cues. However, their second study revealed no attentional bias towards or away from food items after having been primed with the concept of dieting. These studies may illustrate the attentional and motivational shift experienced by individuals through the process model, wherein the self-regulation required after exposure to food cues at Time 1 elicited a motivational shift and narrowed attention towards reward cues at

Time 2. Additionally, a meta-analysis regarding cognitive bias towards food stimuli revealed a small effect size of dietary restraint status on a Stroop task (d = .36) over nine studies, but found no significant effect size on a dot-probe task (d = .11) in one study (Brooks, Prince, Stahl, Campbell, & Treasure, 2011). Consistent with the process model of ego-depletion, it is clear from prior studies that motivation (in the form of restraint status) must be accounted for in studies of attention towards food stimuli.

Current Studies

These studies represent an experimental test of attention as a mediator of the ego-depletion effect. While statistical methods of testing mediation have been used to great effect in past research (Baron and Kenny, 1986), the incorporation of this causal chain approach to assessing mediation provides an excellent way to evaluate mediators in a controlled environment wherein these mediators are both easy to measure and easy to manipulate (Spencer, Zanna, & Fong, 2005). As such, I examined the attention component of the process model in two ways. First, I tested the process model's notion that an initial use of self-control resources causes shifts in attention, using a variant of the standard dual-task ego-depletion paradigm, in which individuals completed a depletion task at Time 1 and an attention test at Time 2. Second, I manipulated attentional focus to show that shifts in attention cause decrements in self-control. Together, these studies evaluate the role of attentional shifts in the ego-depletion effect, with study 1 examining the effect of ego-depletion on attentional bias and study 2 examining the effect of shifts in attention on self-regulatory behavior. Importantly, the manipulation of attention in study 2 allows for an evaluation of the role of attentional shifts in the ability to enact self-regulatory behavior. As such, positive results in study 2 will show that an inability to enact self-regulatory behavior may by due to shifts in attention induced by the ego-depletion effect

rather than an effect of ego-depletion itself. A pictoral representation of these studies can be found in Figure 1. These studies were conducted with a focus on eating behavior, using samples of restrained and non-restrained eaters, to at least minimally (at the trait level), control for motivational factors associated with self-control. Together, these studies attempted to demonstrate that the proposed attention shift within the process model not only occurs, but has measurable effects on self-regulatory behaviors.

To this end, this proposal had three primary hypotheses. Hypothesis 1: The ego-depletion effect was hypothesized to manifest in study 1 as a difference in attention towards reward cues. Specifically, I predicted that participants in the depletion groups would have faster reaction times to probes replacing reward images than probes replacing control or neutral images. Hypothesis 2: The ego-depletion effect in study 1 was hypothesized to induce attention away from self-control cues such that participants in the ego-depletion condition would have faster reaction times to probes replacing reward or neutral images when paired with control images. Hypothesis 3: The attention training task in study 2 was hypothesized to induce attention toward reward cues, with a predicted increase in the amount of food consumed by participants trained to attend reward cues compared to untrained participants.

While the first three hypotheses are independent of motivation, two additional hypotheses intended to reveal the moderating effect of motivation on the above predictions. Hypothesis 4: In study 1, restrained eaters were hypothesized to experience a greater depletion effect than unrestrained eaters, resulting in a larger difference in reaction times between the depleted and non-depleted conditions for restrained eaters compared to unrestrained eaters. Hypothesis 5: In study 2, I predicted that unrestrained eaters would consume similar amounts of food in both

conditions, while the restrained eaters in the reward-oriented condition would consume a greater amount of food than restrained eaters in the untrained condition.

Image Selection Study

The purpose of this study was two-fold. Firstly, this study was designed to verify that the images used in Studies 1 and 2 were valid attention cues and elicited the desired approach and avoidance reactions within participants. And secondly, this study was also intended to assist in selection of images for both Studies 1 and 2. Given a large pool of visual cues that could be used in experimental tasks, this study was used to select the most appropriate images.

Method

Participants

Participants were 20 adult community participants from the United Stated recruited via Amazon Mechanical Turk who had a quality score of 90% or above. Participants were between 24 and 70 years of age (M = 41.7 years, SD = 13.39 years). Participants were nearly equally represented regarding gender (9 male, 11 female). Participants were primarily Caucasian (75%), but the sample also included Hispanic/Latino (10%), and African American, Asian, and Other (5%). All participants had a high school diploma or greater, with 75% having a bachelors or advanced degree. Fourteen participants required the use of corrective lenses and reported that they used them consistently (70%), while the remaining 6 participants did not require their use (30%).

This study was approved by the Internal Review Board of a large mid-Southern university and all participants electronically signed an informed consent document. All participants were also presented with an electronic debrief after completion of the survey task.

Measures

Demographics: Participants were asked to provide demographic information about their sex, height, weight, age, vision, ethnicity, and current/past treatment for disordered eating. Information regarding visual impairment were assessed through two questions, "Do you have visual impairment requiring the use of glasses or contacts?" and "If so, do you wear your glasses or contacts?"

Image Ratings: Participants rated 120 images on five scales: the degree to which the image evoked Distress, Hunger, Food Craving, Arousal, and Desire to Eat. Of these 5 scales, Distress, Hunger, and Food Craving were rated on a scale of 0 to 6 (e.g., 0 "*Not Distressed*", 3 "*Somewhat Distressed*", 6 "*Very Distressed*"), while Arousal and Desire to Eat were rated on scales of -3 to 3 (e.g., -3 "*Strong Desire to Abstain From Eating*", 0 "*Indifferent*", 3 "*Strong Desire to Eat*"). Participants were unaware of the numerical scales utilized for each question and could only see seven radial buttons aligned horizontally, with three of the radial buttons labeled as shown.

Procedure

All images were gathered from either the International Affective Picture System (IAPS; Lang, Bradley, & Cuthbert, 1999) or from publically indexed images available online. The images used in the image rating task were separated into three primary categories: reward cues, neutral cues, and self-control cues. Each of these image types was constituted of 80 images within the image rating task. It must be noted that each of these image types was further broken down into two different categories: images of objects only and images that included people. As past research has not adequately addressed reactions to images that include more ecologically valid stimuli (i.e., a picture of someone eating a hamburger is more likely to be seen at a restaurant than just a hamburger sitting on a table), both subtypes of images were included within

each image type. Each image subtype included 40 images and was analyzed separately from the related subtype, as these image types may elicit differing reactions from participants and thus later data analysis in Studies 1 and 2 would need to keep them separated if later data analysis suggested that this was the case.

Reward cues were images of palatable food, as prior studies have shown that food images are able to act as reward cues which excite the reward centers of the brain (Schur, Kleinhans, Goldberg, Buchwald, Schwartz, & Maravilla, 2009). Attention research regarding reward images has utilized a variety of rewarding items as image targets, but by far one of the most popular has been images of food. Much of the research utilizing food images has separated food images into two categories, "high calorie" or "low calorie." For instance, Schur and colleagues (2009) used two categories of food images, "fattening" and "non-fattening." Other studies have used similar groupings of food images and have added an additional group of non-food or neutral images (e.g., Castellanos et al., 2009; Yokum, Ng, & Stice, 2011). It is worth noting that food cues in the environment not only include food itself, but many other visual situations involving food, including consumption by an individual. For this reason, I included images of high calorie, palatable food as well as images of individuals consuming palatable food items as visual reward cues.

Self-control cues included images of exercise equipment as well as images of individuals intentionally not consuming appetizing food. The use of these two types of self-control images is noteworthy, as each signifies a different form of self-control. Images of exercise equipment are indicative of long-term self-regulation, whereas images of individuals intentionally not eating palatable food are indicative of self-control in the moment. As both types of images are related

to the experience of self-control in general, and different types of self-control specifically, it is ideal that they were both included in this study.

Neutral cues, images neither associated with reward nor self-control, were matched as closely as possible to reward and control images in terms of content being people versus objects. These images were obtained exclusively from the International Affective Picture System (IAPS; Lang et al., 1999).

All self-report questionnaires were presented after the participants electronically signed an informed consent document. After questionnaires were completed, the images were presented individually, with each of the 240 images having its own separate webpage. Images were located at the top of the webpage and the five rating scales were located below them. Participants pressed a confirmation button to move through the individual image webpages. After completion of this task, all participants viewed a debriefing document online.

After data analysis, each of the three image types were reduced from pools of 80 to pools of 60, keeping only those images that elicited the desired reactions from participants. As such, the 30 reward object cues that elicited the greatest desire to eat were kept for future use, as were the 30 self-control object cues that elicited the lowest desire to eat. Similar exclusion rules were utilized for the 30 reward person and 30 self-control person cues. For neutral cues, the process was somewhat different, with the 5 images eliciting the lowest desire to eat being removed from both the object and person cue types, as were the 5 images eliciting the greatest desire to eat from both cue types. There were two reasons for using desire to eat ratings for the purpose of reducing the number of images. Firstly, this rating was used because not only was this variable similar to the concept of craving, which was also measured, but it can also be described as an intent to approach the cues within the images – in this case, food. Secondly, this rating was used

because self-control and neutral image ratings were consistently near-zero while the reward image ratings of desire to eat were greater than zero (on a -3 to +3 scale), which was neither the case for craving ratings nor hunger ratings due to scale restrictions.

After the image types had been reduced to groups of 60 for each of the overall reward, self-control, and neutral image types, repeated measures ANOVAs were conducted on each of the rating measures. Follow-up contrasts comparing the self-control and neutral image types to the reward image types were also conducted to confirm the direction of effects.

Results

For distress ratings, Mauchly's test indicated that the assumption of sphericity had been violated, $\chi^2(2) = 23.93$, $p < .001$, therefore Greenhouse-Geisser corrected tests are reported ($\varepsilon = .58$). The results of the repeated-measures ANOVA indicate that ratings of Distress were significantly different between image types, $F(1.15, 21.90) = 5.91$, $p = .02$. Contrasts indicated that reward images did not elicit significantly different levels of distress ($M = 0.72$) than self-control images ($M = 0.49$), $F(1, 19) = 3.05$, $p = .10$, but did elicit significantly greater distress than neutral images ($M = 0.17$), $F(1, 19) = 6.36$, $p = .02$.

For hunger ratings, Mauchly's test indicated that the assumption of sphericity had been violated, $\chi^2(2) = 40.51$, $p < .001$, therefore Greenhouse-Geisser corrected tests are reported ($\varepsilon = .53$). The results of the repeated-measures ANOVA indicate that ratings of hunger were significantly different between image types, $F(1.06, 20.06) = 27.47$, $p < .001$. Contrasts indicated that reward images elicited significantly greater levels of hunger ($M = 2.42$) than either self-control images ($M = 0.91$), $F(1, 19) = 30.6$, $p < .001$, or neutral images ($M = 0.36$), $F(1, 19) = 27.58$, $p < .001$.

For craving ratings, Mauchly's test indicated that the assumption of sphericity had been violated, $\chi^2(2) = 36.80$, $p < .001$, therefore Greenhouse-Geisser corrected tests are reported ($\varepsilon = .54$). The results of the repeated-measures ANOVA indicate that ratings of craving were significantly different between image types, $F(1.07, 20.32) = 35.47$, $p < .001$. Contrasts indicated that reward images elicited significantly greater levels of craving ($M = 2.49$) than either self-control images ($M = 0.79$), $F(1, 19) = 40.27$, $p < .001$, or neutral images ($M = 0.26$), $F(1, 19) = 35.37$, $p < .001$.

For arousal ratings, Mauchly's test indicated that the assumption of sphericity had been violated, $\chi^2(2) = 8.63$, $p = .01$, therefore Greenhouse-Geisser corrected tests are reported ($\varepsilon = .72$). The results of the repeated-measures ANOVA indicate that ratings of arousal were significantly different between image types, $F(1.45, 27.52) = 8.45$, $p = .003$. Contrasts indicated that reward images elicited significantly greater levels of arousal ($M = 0.96$) than either self-control images ($M = 0.55$), $F(1, 19) = 5.84$, $p = .026$, or neutral images ($M = 0.35$), $F(1, 19) = 12.08$, $p = .003$.

For desire to eat ratings, Mauchly's test indicated that the assumption of sphericity had been violated, $\chi^2(2) = 26.11$, $p < .001$, therefore Greenhouse-Geisser corrected tests are reported ($\varepsilon = .57$). The results of the repeated-measures ANOVA indicate that ratings of desire to eat were significantly different between image types, $F(1.13, 13.62) = 17.03$, $p < .001$. Contrasts indicated that reward images elicited significantly greater levels of desire to eat ($M = 1.0$) than either self-control images ($M = -0.1$), $F(1, 19) = 17.15$, $p = .001$, or neutral images ($M = -0.07$), $F(1, 19) = 18.55$, $p < .001$.

Discussion

Consistent with the two goals of this study, analyses revealed that Reward images elicited the greatest desire to eat, while the self-control images elicited the lowest desire. To facilitate the tasks in Studies 1 and 2, the images eliciting the most appropriate responses were used as visual stimuli during the tasks requiring imagery. As 30 images were taken from the original pools of 40 for each of the reward, self-control, and reward image types, I believe that the images used can be considered representative of their respective type of visual cue.

Study 1

Method

Participants

Each participant completed an online pre-screen survey which included the EDDS and the RRS along with demographic questions and information on eating disorder treatment history. From this pre-screen survey, two groups of participants were invited to participate in the laboratory experiment according to their responses on the Revised Restraint Scale. Restrained Eaters were individuals who scored 16 or above, whereas Unrestrained Eaters scored 15 or below (Polivy, Herman, & Howard, 1988). Not all individuals who completed the online screener were invited to participate in the laboratory experiment. All individuals who completed the online screener and did not receive class credit were entered into a raffle for a $5 gift card to Wal-Mart.

Consistent with prior research regarding restrained eating in college samples, we recruited college-aged females through the University of Arkansas psychology student subject pool. Each laboratory experiment lasted approximately 75 minutes and participants received course credit for participation. Participants were not notified of the purpose of the study prior to arrival at the laboratory. Exclusion criteria included: uncorrected visual impairment, prescreen

results indicative of disordered eating on the Eating Disorders Diagnostic Scale (Stice, Telch, & Rizvi, 2000), and current or past treatment for eating pathology. This study was reviewed and approved by the University of Arkansas Institutional Review Board.

A total of 112 participants participated in this study. Of these, the first 25 were removed due to a programming error within the dot-probe task that excluded 120 of the 180 dot-probe trials – this error was noted after the 25th participant and corrected. In addition, two participants were removed due to a software error that prevented the creation of data files for the dot-probe task and one participant's data was removed because the participant interrupted the depletion task to use the restroom. After data cleaning and removal, 84 participants were included in the analysis reported below.

Forty participants (47.6%) were classified as restrained eaters (20 in each depletion condition). There were 44 unrestrained eaters, 19 of whom were in the control condition and 25 were in the ego-depletion condition. All participants were female, enrolled in college, and primarily unmarried (97.6%). The mean age of the sample was 19.05 (*SD* = 1.64) and participants were mostly unemployed (78.6%) or employed part-time (21.4%). The ethnicity of the sample was primarily Caucasian (85.7%), with a minority of respondents selecting African American (2.4%), Asian (6.0%), Hispanic/Latino (3.6%), or other (2.4%).

Measures

Eating Disorder Diagnostic Scale. The Eating Disorder Diagnostic Scale (EDDS) is a brief 22-item screening measure used as a fast and reliable method of differentiating between the eating disorder diagnoses of Anorexia Nervosa, Bulimia Nervosa, and Binge Eating Disorder. It was developed utilizing a sample of females with and without eating disorders and has shown good test-retest reliability in prior studies (r = .87). In addition, the measure appears to

correspond well to diagnoses obtained by semi-structured interviews (Stice et al., 2000). Due to the timing of this study, the EDDS criteria were updated to reflect the changes in DSM-V for eating disorder diagnoses. To update this questionnaire, the amenorrhea criterion was removed for anorexia nervosa, the binge/purge frequency requirement was reduced for bulimia nervosa, and the binge frequency requirement was reduced for binge eating disorder.

ADHD Self-Report Scale. The Attention Deficit/Hyperactivity Disorder (ADHD) Self-Report Scale was created to effectively pre-screen adults for ADHD. This measure is 18 items in length, with each item rated on a 5-point scale (0 "*Never*": to 4 "*Very often*"). In a pilot validation study conducted by Adler et al. (2006), this scale was compared to the structured interview considered to be the gold-standard in the field, the ADHD Rating Scale, and was found to have good inter-rater agreement ($r = 0.84$). In the current study, the internal consistency was sufficient ($\alpha = 0.86$).

Positive and Negative Affect Schedule. The Positive and Negative Affect Schedule (PANAS) was created to assess the uncorrelated dimensions of positive and negative mood (Tellegen, Watson, & Clark, 1988). The PANAS is composed of 20 items split into two 10-item scales, each item from which is rated on a 5-point scale (1 "*very slightly or not at all*", 2 "*a little*", 3 "*moderately*", 4 "*quite a bit*" and 5 "*very much*"). The time period assessed by the PANAS is variable and has been altered in studies in order to assess its validity and reliability in assessing both enduring mood and mood states in the moment (Tellegen et al., 1988). Both the Positive Affect and Negative Affect scales had acceptable reliability in this study ($\alpha = .88$ & $.76$, respectively).

Restraint Scale. The Revised Restraint Scale (RRS) is composed of ten items. In this study, it had adequate internal consistency ($\alpha = .77$). The RRS classifies individuals with scores

of 15 and below as unrestrained eaters and those who score 16 and above as restrained (Herman & Polivy, 1980; Polivy, Herman, & Howard, 1988). It has been shown to have excellent test-retest reliability (r = .95). Correlations between the RRS and the Eating Inventory Disinhibition scale (r = .42) and the Multidimensional Assessment of Eating Disorder Symptoms binge eating scale (r = .54) reveal convergent validity of this scale's total scores (Williamson et al., 2007). This questionnaire was created to provide a short, reliable method of determining dietary restraint in individuals.

Demographics. Participants were asked to provide demographic information about their sex, height, weight, age, vision, and ethnicity. Information regarding visual impairment were assessed through two questions, "Do you have visual impairment requiring the use of glasses or contacts?" and "If so, do you wear your glasses or contacts?"

Procedure

Consistent with previous literature, participants were instructed to fast for a minimum of 3 hours prior to the study (e.g., Hollitt, Kemps, Tiggemann, Smeets, & Mills, 2010; Overduin, Jansen, & Eilkes, 1997; Vohs & Heatherton, 2000). Upon arrival to the laboratory, participants signed an informed consent document, completed baseline questionnaires, and were randomly assigned to ego-depletion condition.

All participants completed a two-step stimulus detection task that has been used in many prior ego-depletion studies (Baumeister et al., 1998; Job et al., 2010), where participants were first instructed to cross out each 'e' on a printed page of text (hereinafter called the "crossing out e's" task). The second step of this task involved a manipulation of experimenter instructions according to participant condition. In the control condition, participants once again crossed out every 'e' on a second page of text, whereas in the ego-depletion condition, participants only

crossed out every ‘e’ if it was not next to another vowel or separated by an additional character from another vowel (for example, the participant would only cross out the first ‘e’ in ‘deplete’ but not the second or third ‘e’). Additionally, the ego-depletion copy of the second page of text was printed a lighter shade than the control condition, intentionally making the task more difficult by imitating common issues in scanning and copying paper documents (Baumeister et al., 1998). This form of ego-depletion induction has reliably been shown to effectively deplete individuals, having an average effect size of $d = 0.77$ (Hagger et al., 2010).

After completing the “crossing out e’s” task, all participants completed a PANAS in order to assess for any possible effects of the depletion task on mood. Afterwards, participants conducted a dot-probe task to assess attentional bias. The dot-probe task has been used as a dependent variable in several prior studies involving attention and cue reactivity to appetizing foods (e.g., Johansson, Ghaderi, & Andersson, 2004; Shafran, Lee, Cooper, Palmer, & Fairburn, 2007; Wagner, Boswell, Kelley, & Heatherton, 2012). For this task, a fixation cross was presented at the center of the screen for 500ms (Amir, Weber, Beard, Bomyea, & Taylor, 2008). At the moment of fixation cross termination, two images appeared on the left and right side of the computer monitor, each equidistant from the prior position of the fixation cross. These images were presented for 500ms, as set forth in Amir and colleagues (2008). After termination of the image set, a probe (in this case, the letter E on the left or the letter F on the right) appeared in the center of the area previously occupied by either the left or right image. Upon termination of the images, the participant then pressed either E or F, depending upon which letter was present on the screen, and reaction time between the termination of the images and moment of the key press was measured. There was a 1000ms intermission between the key press and presentation

of the next fixation cross (See Figure 2 for an example). The attentional bias dot-probe task was administered using E-Prime (Schneider, Eschman, & Zuccolotto, 2002).

Images used within the dot-probe task included the reward cues, neutral cues, and self-control cues that were identified in the Image Selection Study. Reward cues were images of palatable food, while self-control cues included images of exercise equipment as well as images of individuals intentionally not consuming appetizing food. The two subtypes of images were matched to reward images for data analytic purposes (exercise equipment images matched to food images, images of individuals intentionally not consuming food matched to images of individuals consuming food).

Neutral cues, images neither associated with reward nor self-control, were matched as closely as possible to reward and control images in terms of content being people versus objects.

A total of 180 images were used in this study: 60 neutral images (30 images of objects and 30 images including people), 60 food-related images (30 images of palatable food and 30 images of individuals eating palatable food), and 60 control-related images (30 images of exercise equipment and 30 images of individuals intentionally not eating palatable food). This allowed me to conduct 180 randomized trials, as each of these trials included pairs of images that were presented twice, with the locations of each image mirrored. Images were presented in a manner that allowed assessment of the nature of attentional shifts by examining whether attention shifts away from self-control cues, towards reward cues, or both. In order to accomplish this, there were 3 image-type combinations in this study: reward/neutral, control/neutral, and reward/control.

All slides were presented in a randomized order for each participant. After completing all tasks in this study, participants were debriefed on the purpose of the experiment and compensated for their time.

Data cleaning and preparation

To remove data inconsistencies from the dot-probe attention tasks, methods similar to those set forth in Amir and colleagues (2008) were used. All trials with erroneous responses were removed (e.g., pressing the left response key when the probe was on the right side of the screen), which amounted to 81 individual trials, or 0.5% of total trials. In addition, as set forth by Amir and colleagues (2008), reaction time data was examined using box and whisker plots, with the upper and lower extreme values used as cutoff scores for reaction times. For this sample, trials with latencies greater than 759 or less than 149 were excluded from analysis (471; 3.12%). Prior studies (e.g., Smeets, Roefs, van Furth, & Jansen, 2008) excluded individual participants who had levels of incorrect and out-of-bounds trials exceeding 25%, but no participants in this sample met this criteria for exclusion.

All response time data was calculated through standardized formulas used in previous research in this domain (e.g., Mogg & Bradley, 1999; Pine et al., 2005). For Hypothesis 1, the standard formula subtracted the mean reaction time on trials wherein the reward image and the response probe appeared on the same side of the display from the mean reaction time on trials wherein the reward image and response probe appeared on opposite sides of the display. The formula used was:

$$M(\text{Reward x Non-Reward Probe}) - M(\text{Reward x Reward Probe}) = RT_{Difference}$$

This formula allowed the positive or negative sign of the resulting value to denote an individual's tendency to attend to the reward stimulus (positive RT Difference) as opposed to bias away from the reward stimulus (negative RT Difference).

For Hypothesis 2, the formula was similar and only required replacing the reward response times with self-control response times. For this formula, positive RT Difference scores suggest attentional bias toward self-control images, while negative RT's suggest attentional bias away from self-control images. This formula was as follows:

$$M(\text{Control x Non-Control Probe}) - M(\text{Control x Control Probe}) = RT_{\text{Difference}}$$

As set forth previously, two subtypes of both reward and control images were included in this study. These subtypes were matched together for image presentation during the dot-probe task. The first type of images were dubbed "Object Images" and included reward images of palatable food and self-control images of exercise-related objects. The second type of images were referred to as "Person Images" and included reward images of individuals consuming palatable food and self-control images of individuals either not consuming palatable food or intentionally consuming less palatable food (i.e., salads, broccoli, etc.). Prior to testing central study hypotheses, trials using each of these image subtypes were compared for equivalence, as the different subtypes of images may induce different reaction times from participants. The results of these analyses denote whether the different types should have been collapsed an analyzed together (if there were no significant differences) or analyzed separately (if there were significant differences).

Results

Image Type Analyses

While prior research using images within the dot-probe task utilized only images of objects, this study used two different image subtypes: images of objects only (object images) and images of individuals interacting with objects within natural scenes (person images). Person images were more visually complex, but also more ecologically valid, suggesting uncertainty regarding reaction time differences between these two image types. To determine whether these two image subtypes should be collapsed for data analysis, the two subtypes were compared to one another in two ways. First, the object and person images were compared using paired samples *t*-tests on trials assessing attention toward or away from reward images (calculated by subtracting reaction time [RT] toward reward from RT toward non-reward images, the resulting RT difference score would be positive for individuals attending reward images and negative when attending non-reward images). Utilizing RT difference scores, it was found that there was a marginally significant difference of reaction times toward reward between trials using object or person images, $t(83) = 1.87$, $p = .07$. Second, similar analyses were conducted on attention toward or away from self-control images, and no difference was found between object and person images, $t(83) = .70$, $p = .49$. While the analysis for reward images was approaching significance, the effect was not great enough to necessitate separate analyses for object and person images. As such, the analyses for this study were conducted from combined reaction time scores using both object and person images.

Covariates

Several 2 (group: restrained versus unrestrained) x 2 (condition: depletion versus non-depletion) factorial ANOVAs were conducted to assess whether to include age, BMI, time since last meal, or level of Attention-Deficit Hyperactivity Disorder symptoms as covariates. Age was found to not differ significantly by eating status, $F(1,79) = .00$, $p = .97$, or condition, $F(1,79) =$

.26, $p = .61$. BMI did not differ by eating status, $F(1,80) = .26$, $p = .61$, or condition, $F(1,80) = .99$, $p = .32$. Time since last meal did not differ by eating status, $F(1,79) = 2.35$, $p = .13$, or condition, $F(1,79) = .01$, $p = .92$ ($M = 8.35$ hours, $SD = 4.79$). ADHD symptoms also did not differ by eating status, $F(1,80) = .31$, $p = .58$, or condition, $F(1,80) = .36$, $p = .55$. The variables of ethnicity (Caucasian or Non-Caucasian), and employment status (employed or unemployed) were recoded to be dichotomous for Chi-squared analyses of the same. Ethnicity was found to vary significantly according to eating status, with the restrained eaters in this sample having greater numbers of non-Caucasian participants, $\chi^2(1) = 4.21$, $p = .04$, but it did not vary by condition, $\chi^2(1) = 2.59$, $p = .11$. Employment status did not vary according to eating status, $\chi^2(1) = .05$, $p = .82$ or condition, $\chi^2(1) = .12$, $p = .73$. In an effort to control for any differences in mood after the ego-depletion induction task, an ANOVA was conducted assessing the effect of condition on both positive and negative mood ratings on the PANAS (measured after the "crossing out e's" task). This analysis revealed no significant difference in positive mood according to condition, $F(1,82) = 0.10$, $p = .75$, but did reveal a significant difference in negative affect, with the depleted group experiencing more negative affect than the non-depleted group, $F(1,82) = 3.94$, $p = .05$. In accordance with these results, ethnicity and the negative affect subscale of the PANAS were included as covariates in all analyses for Study 1. It must be noted that while ADHD symptoms were not significantly different across groups, attention difficulties would directly affect reaction time to images, so to ensure that reaction time measurements included no trait differences in degree of ADHD symptoms between groups, this variable was also included as a covariate.

ANCOVA Results

It was anticipated that participants in the ego-depletion condition would attend reward cues to a greater degree than participants who had not been depleted. First, reaction times were averaged for trials wherein the probe appeared behind reward images and another average was created for trials wherein the probe appeared behind non-reward images (including both neutral and self-control images). RT difference scores were then calculated by subtracting the mean reaction time of reward probe trials from the mean reaction time of non-reward probe trials. The resulting RT difference score would then be positive if participants were attending reward images and negative if they were attending non-reward images. Using these RT difference scores, a 2 (eating status: restrained versus unrestrained) x 2 (condition: depletion versus non-depletion) ANCOVA revealed no significant main effect for restraint status, $F(1,77) = .06$, $p = .81$, $\eta_p^2 = .00$, and no interaction was found between restraint status and condition, $F(1,77) = .30$, $p = .59$, $\eta_p^2 = .00$. Hypothesis 1, which predicted a difference between control and depletion condition on reward scores, was not supported by an analysis of the main effect of condition, $F(1,84) = 2.28$, $p = .14$, $\eta_p^2 = .03$.

It was also hypothesized that participants in the ego-depletion condition would shift attention away from self-control cues compared to participants who had not been depleted. Reaction times were calculated in the same way as in the previous analysis, with negative RT difference scores showing that participants were not attending self-control images, while positive scores suggest that participants were paying attention to self-control images. A factorial ANCOVA revealed no significant main effect for restraint status, $F(1,77) = 2.73$, $p = .10$, $\eta_p^2 = .03$, and no significant interaction between depletion condition or restraint status for attention away from self-control images, $F(1,77) = 0.01$, $p = .92$, $\eta_p^2 = .00$. Hypothesis 2, which predicted that attention toward self-control images would be different for depleted and non-depleted

participants, was also not supported by analysis of the main effect of depletion condition, $F(1,77) = 2.51$, $p = .12$, $\eta_p^2 = .03$. All mean reaction time difference scores are presented in Table 1.

Of note, the reaction time difference scores toward/away from reward and self-control images were moderately negatively correlated, $r = -.46$, $p < .001$, suggesting that attention toward reward does coincide with attention away from self-control. Interestingly, this correlation was found to vary by condition, with non-depleted individuals evidencing a high correlation between attention bias scores, $r = -.59$, $p < .001$, while depleted individuals' reaction time difference scores did not significantly correlate with one another, $r = -.20$, $p = .18$. To assess whether these correlations were different from one another, each correlation coefficient was converted to a *z*-score and compared using an online calculator (Preacher, 2002). This analysis revealed that these correlation coefficients were significantly different ($z = -2.09$, $p = 0.03$), suggesting that ego-depletion affects the normal functioning of the attentional system.

Discussion

The results of study 1 indicate that attention was not significantly altered toward reward cues or away from self-control cues in individuals who completed an ego-depletion task compared to those who completed no depleting task. These non-significant differences in reaction times between conditions could be theorized to be due to one of several different reasons.

It is possible that the depletion manipulation simply did not work as intended. While we have no direct method of testing this as there was no manipulation check in this study, there is indirect evidence to suggest that this may be the case. Data analysis revealed that this study was vastly underpowered (Attention toward reward $d = .25$; attention away from self-control $d = .31$) and that the observed effect size of the depletion manipulation was much lower than was

reported by a recent meta-analysis of the "crossing out e's" task (Hagger et al., 2010). It is unclear at this point why the "crossing out e's" task may have been ineffective, given that published results have seen comparatively robust effect sizes. One possibility is that there is a "file drawer effect," wherein there have been many unpublished studies that have simply been filed away due to a lack of observed effects, while the studies that have significant effects are put to print. Additionally, while the guidelines set forth in the methods sections of prior studies were followed (e.g., Baumeister et al., 1998), it is also possible that one of several events occurred, even after following the methods of prior research. First, an important detail may have been left out of the task that was responsible for the ego-depletion effect above and beyond the actual completion of the task itself. Second, while participants were provided standardized instructions for this task, they may have chosen to ignore them in pursuit of better subjective performance on this task using improper methodologies such as reading text backwards thus circumventing ego-depletion induction. Third, prior research suggests that rest time is an important factor in observation of an ego-depletion effect (Hagger et al., 2010), so it is possible that participants were allotted too much time to complete the task itself or were given too much time between the task and measurement of attention to observe an effect. Additionally, the PANAS was completed immediately after the "crossing out e's" task, which may have not only provided additional time for individuals to regain self-control, but the act of completing another questionnaire after ego-depletion induction may have directly influenced the results as well. Future research utilizing this manipulation may well be informed by the possible weaknesses identified herein.

It also must be noted that the nature of a reaction time measurement task induces relatively large standard deviations, which makes it significantly more challenging to detect

significant effects due to the nature of significance tests. In an effort to circumvent this issue, researchers have developed many novel methods of analyzing dot-probe data in ways that not only examine issues of interest, but also reduce the inherent variability that the task confers upon the data. One such method examines attentional bias within the trial rather than as an overall mean between trials (Zvielli, Bernstein, & Koster, 2014). While these alternative methods of data analysis show promise, the gold standard remains the reaction time difference score.

Additionally, it is possible that an image presentation time of 500ms was not ideal for use with visual cues in the dot-probe task. While this task has been used in a variety of research areas, the domain of anxiety has the largest background of studies from which the dot-probe task can be evaluated. A recent publication (Frewen, Dozois, Joanisse, & Neufeld, 2008) showed a meta-analysis of response biases for high- and low-anxiety individuals, with each group evidencing different patterns of response biases across three image presentation timings (150ms, 500ms, 1000ms). This evidence suggests that different image presentation times will elicit differing reactions, with the longer presentation times allowing for greater control of attentional focus. Simply put, a presentation time of 500ms may have been too short or long for proper observation of attentional bias in this sample. While the meta-analysis by Frewen and colleagues (2008) showed attentional bias toward images of threat at the 500ms presentation time, they also showed a bias away from threat at 1000ms. As I am unaware of any studies evaluating attentional bias using reward images, it may be that 500ms was too long a presentation for this form of visual stimuli, which may have elicited a similar attentional bias away from images of interest that was presented in the meta-analysis.

It is also possible that these null results may be due to an incompatibility between the attentional mechanism and the attempt to manipulate it such that attention may be implicated in

the ego-depletion effect, but this attempt using the "crossing out e's" task was unable to affect the attentional system in the predicted way. The "crossing out e's" task has been used in several studies as an ego-depletion induction task (e.g., Baumeister et al., 1998; Job et al., 2010) and it has been shown to reliably induce a depletive effect according to a meta-analysis conducted by Hagger and colleagues (2010). Even considering the possibility of a file drawer effect, it is unlikely that a correctly performed "crossing out e's" task would simply not work. Thus, the task may have been performed correctly but was unable to alter the attentional system. If true, it may denote that the attention measurement task was inappropriate or ineffective – while several past studies have utilized the dot-probe task in a variety of settings, the majority of these studies have used verbal cues rather than image cues and there exists research to suggest that the dot-probe task itself lacks test-retest reliability (Schmukle, 2005). Alternatively, the results of this study may indicate that ego-depletion had been induced, but attention toward or away from reward/self-control cues was unaffected because attention is not a mechanism within ego-depletion. At this time, there exists little direct evidence of this, as Inzlicht and Schmeichel (2012) were able to present very few studies directly examining the effect of ego-depletion on attention or vice-versa – the case for attention in their article is made primarily by reinterpretation of prior study results and by applying theories from the field of attention onto the field of self-control. Of course, the lack of evidence is likely due to the recent development of the process model (Inzlicht & Schmeichel, 2012) and the current study is one of the first to directly test one of the primary tenets of the model, so null results may or may not be representative of the role of attention within ego-depletion – further study will be required to examine the effect more thoroughly.

Dietary Restraint

In this study, there was no significant main effect of restraint, nor was there a significant interaction of restraint with manipulated depletion condition. These are unexpected findings, given the cognitive restraint directed toward food objects evidenced by restrained eaters (Boon et al., 2000). This result may be due to several potential mechanisms, the first of which is loss of variability within subjects when they are artificially grouped together. While restraint theory has been grouping individuals according to the "hard and fast" rule of a score cutoff (Polivy, Herman, & Howard, 1988), many other studies have used mean scores as the grouping variable (e.g., Boon et al., 2000), and still others have simply used the restraint measure as a continuous variable (e.g., Papies et al., 2008). Each of these methods has strengths and weaknesses, but the use of the prescribed score cutoff in this study may have limited variability in the sample, which may have resulted in the nonsignificant differences between restrained and unrestrained eaters.

A similar idea can also be introduced by the goal conflict model of eating, which states that self-regulation of eating behavior is greatly impacted by external food cues (Stroebe, van Koningsbruggen, Papies, & Aarts, 2013). According to this theory, external reward cues are able to either activate or inhibit the goal of avoiding food, with those individuals whose goals become activated when they observe reward cues being more successful at avoiding food-related stimuli in their environment. Expanded to incorporate restrained eaters, this model would suggest that the most successful restrained eaters would be those whose food avoidance goals are activated upon observation of food cues. Given this, it is possible that the restrained eating group contained both types of individuals - those for whom external cues either activated or inhibited food avoidance goals - which may have led to nonsignificant differences in attention on the dot-probe task. Alternatively, it is possible that restrained and unrestrained eaters may be too alike in their attentional processes to be distinguished from one another. This is made more likely due to

the rigorous exclusion criteria for this study which may have inadvertently removed individuals who evidenced the greatest levels of dietary restraint, which is discussed in greater detail within the General Discussion.

Attention Between Condition

While participant attention toward or away from reward and self-control cues were somewhat differentiated, detailed interpretation of these results must be tempered by the fact that both main effects and the interactions were not found to be significant. However, it is noteworthy that the self-control and reward reaction time difference scores were not significantly correlated for depleted participants, while a moderate correlation was observed between attention toward reward and away from self-control for non-depleted participants. This may be evidence of a differential effect of attention between reward and self-control cues for individuals who have attempted to exert self-control. The lack of correlation between image type reaction times also speaks to the variability within the individuals in the depletion condition, suggesting that individuals may experience attentional shifts in different ways after self-control exertion. These results indicate that some individuals may become oriented both toward reward and away from self-control, while others may experience attentional shifts toward self-control and away from reward.

Image Type

An interesting finding in this study was the non-significant difference between object and person image types. While prior research using visual cues have primarily utilized object images that are visually simple (i.e., a slice of cake on a plate, placed on a table), this study included more complex images that used more ecologically valid visual information (i.e., a male sitting at a table with his mouth open, moments prior to biting into a large cheeseburger). Assessment of

object and person images separately revealed similar reaction time results across participants, which was somewhat surprising, given the more complex nature of the person images and the relatively short amount of time to process this information (500ms image presentation in all trials). While there is little information regarding the validity of image cues used in studies of this nature, this result appears to be consistent with literature regarding craving. For example, one study conducted a hierarchical cluster analysis of craving ratings after a 6 second image display and found that object-only smoking cues clustered with object cues that included a human component (e.g., a hand with a burning cigarette; Carter et al., 2006). Another study examine attention and craving within two virtual reality environments, one including only cannabis paraphernalia and another including people at a party with cannabis paraphernalia (Bordnick et al., 2009). This study found that subjective attention and craving ratings were not significantly different between the two environments. While these studies do not match perfectly with the dot-probe paradigm due to the restrictive nature of the task, it does provide some evidence that these cue types may not differ from one another. However, the lack of direct validity research in visual cues indicates an area of future study, as it is unclear at this time why participants evidenced no significant difference of reaction times between these image types for food-related images.

Study 2

Method

Participants

The recruitment methods, group identification procedures, and pre-screen measures were the same as in Study 1, with the addition of recruiting college-aged females from the university-

wide student population via flyers and e-mail in addition to recruitment of students from the psychology department subject pool. These community participants received $10 for their participation rather than course credit.

A total of 87 participants were recruited for this study. One participant's data was unusable due to a measurement error while weighing the candies prior to food administration and one further participant had reaction times that were out of bounds for greater than 25% of trials (50.5%), leaving a total of 85 participants in the data analysis for Study 2. No participants from Study 1 participated in Study 2. Of these 85 participants, 6 were recruited via posters in the community and university-wide e-mail recruitment.

In this sample, 40 participants were classified as restrained eaters. Of these, 19 were trained to attend reward cues (reward condition), while 21 were untrained (control condition). There were 45 unrestrained eaters, 23 of whom were in the reward condition and 22 were in the control condition. Similar to study 1, all participants were female and primarily unmarried (98.8%). Unlike study 1, one participant was not currently enrolled in college (1.2%). The mean age of the sample was 19.52 (*SD* = 1.46) and participants were mostly unemployed (62.4%) or employed part-time (29.4%), all of which is consistent with college student samples. The ethnicity of the sample was primarily Caucasian (82.4%), with a minority of respondents selecting African American (4.7%), Asian (1.2%), Hispanic/Latino (8.2%), or other (1.2%).

Measures

All measures from Study 1 were administered in the same order and in the same format in Study 2, with the following additions.

State Hunger. Consistent with prior research with restrained and unrestrained samples, state hunger was assessed through a ten point scale, from 1 "*Not At All Hungry*" to 10 "*Extremely Hungry*" (Herman, Fitzgerald, & Polivy, 2003).

Chocolate Craving. Trait craving for chocolate was assessed verbally using one item rated from 1 "*never desiring chocolate*" to 7 "*consistent desire to eat chocolate*".

Food-Cravings Questionnaire – Trait. The FCQ-T is a 37 item scale which contains 9 independent factors. Internal consistency is excellent, with $\alpha = .93$ and subscale alphas ranging from .81-.94. Test-retest reliability overall is very good ($r = .88$), with moderate individual subscale test-retest reliability ranging from $r = .49$-.74 (Cepeda-Benito, Gleaves, Williams, & Erath, 2001). The FCQ-T asks individuals to rate each question on a 6-point scale, based on how true each statement is for them. For example, an item from the FCQ-T is "I daydream about food." In response to this question, each participant would rate on the scale from 0 "*never* (or *N/A*)" to "*always*." This scale was devised to assess and individual's stable craving traits which would not fluctuate over time.

Food-Cravings Questionnaire – State. The Food-Cravings Questionnaire – State (FCQ-S) is made up of 15 items and contains 5 factors. Internal consistency was excellent in this study, with an alpha of .91 and individual subscale alphas ranging from .73 to .86. Test-retest reliability is $r = .56$, suggesting that this questionnaire is, as intended, more sensitive to changes over time. In prior research, low correlations between the FCQ-S and the FCQ-T with the Eating Inventory suggest high discriminant validity (range .04 to .41; mean $r = .15$ [SD = .12]) between the three scales. A test of construct validity has also been conducted, with the FCQ-S completed before and after a meal. In concert with their predictions, the subscales of the FCQ-S were significantly different between time points (Fs(1,102) > 11.4, ps < .001), with d indexes of effect

sizes of mean differences ranging from 0.68 to 1.43 (Cepeda-Benito et al., 2001). The FCQ-S, like the FCQ-T, asks individuals to rate their responses on a 6-point scale from "*never*" (or N/A) to "*always*". An example of one of the items on the FCQ-S is, "I have an urge for [one or more specific foods]." The intention of this scale is to determine the individual's state of craving within the moment, as opposed to more consistent trait-level craving.

Procedure

Participants in the laboratory experiment were instructed to avoid eating for a minimum of 3 hours prior to arrival in the laboratory. Upon arrival, participants were randomly assigned to either a reward-focused condition or a non-focused condition. After consenting to participate, participants completed baseline questionnaires.

Consistent with the use of the causal chain approach to experimental mediation, study 2 utilized attentional training methods to alter attentional bias. While study 1 was designed to show that ego-depletion induced attentional shifts, study 2 was designed to show that these shifts are responsible for differences in behavior. As such, the manipulation in study 2 was shifted attentional bias induced via an attentional training task to show that attentional shifts towards reward cues, as predicted by Inzlicht and Schmeichel (2012), cause changes in behavior. Thus, participants in the reward-focused condition conducted an attention training task which utilized a modified dot-probe methodology, while participants in the non-focused condition conducted the standard dot-probe attention task from Study 1. As outlined in Amir et al. (2008) and Macleod, Mathews, and Tata (1986), a dot-probe task similar to the task utilized in Study 1 was used to focus the attention of participants toward reward cues by manipulating the frequency with which the reward images were paired with the response probe (Amir et al., 2008). In deviation from prior attention training studies, we did not train participants to attend control cues in the

comparison condition. As we are interested in the effect of attention towards reward cues on an index of self-regulation (e.g. eating behavior), we compared the reward-oriented individuals to non-oriented individuals in an effort to make the comparison between conditions as valid as possible. This required no attentional training to take place in the non-focused condition, so participants assigned to this condition simply carried out the dot-probe attention task conducted in Study 1. Similar to the first study, 180 trials were utilized in this attention training task, once again breaking down to 60 neutral, 60 reward, and 60 control images.

Prior research utilizing this attentional training paradigm in the area of anxiety revealed the possibility that the training task may have simply induced an anxious response which then oriented individuals towards anxiety cues (Macleod et al., 1986). To assess this possibility, Macleod et al. (1986) included state anxiety and depression measurements throughout the attentional training procedure. In order to properly assess the outcome of interest in this study, the Food Cravings Questionnaire-State (FCQ-S) was administered 3 times throughout the laboratory experiment.

To assess the effect of attentional focus on ability to enact self-restraint while eating, the dependent variable of Study 2 was the amount of food eaten. As the type of food items used in cue reactivity and ego-depletion research has been quite varied, it was to our benefit to use a palatable, easily measurable, and simple-to-eat snack. Several food items, such as ice cream (Vohs & Heatherton, 2000) and pizza (Sobik, Hutchison, & Craighead, 2005) have been used previously, but the food chosen for the outcome variable of Study 2 would ideally be something more easily stored and measured in a laboratory. As such, I used chocolate M&M's, which is consistent with prior work in this area (Drobes, Miller, Hillman, Bradley, Cuthbert, & Lang, 2001; Hofmann, Rauch, & Gawronski, 2007). After each participant conducted their respective

attention task, the experimenter led them to an adjacent table and instructed the participant to wait for a period of five minutes while the experimenter prepared the next part of the study. This was a deception, as the final task of the study was engaging in the eating task. On this table, there was a pre-weighed bowl of chocolate M&M candies within arm's reach of the area participants will be directed to sit. Consistent with prior research (Vohs & Heatherton, 2000), participants were instructed to eat as much of the provided candies as they like to facilitate their ratings of the candies during a taste test. The taste test was another deception and included in this study as a method of promoting engagement in the eating task. The experimenter returned after five minutes, debriefed the participant, and allowed them to leave. The experimenter then weighed the bowl of candies in order to assess how much food the participant ate during the deceptive taste test.

Results

Covariates

Several 2 (condition: reward versus control) x 2 (eating status: restrained versus unrestrained) were conducted to assess whether the continuous factors of age, BMI, trait desire for chocolate, trait food craving, current level of hunger, time since last meal, and level of Attention-Deficit Hyperactivity Disorder symptoms should be included as covariates. Age was found to not differ significantly by eating status, $F(1,80) = 1.19$, $p = .28$, or condition, $F(1,80) = 1.03$, $p = .31$. BMI was found to differ significantly according to eating status, $F(1,81) = 14.15$, $p < .001$, with restrained eaters having a higher BMI ($M = 26.2$) than unrestrained eaters ($M = 22.11$). BMI was found not to differ by condition, $F(1,81) = 0.95$, $p = .33$. Trait desire for chocolate did not differ by eating status, $F(1,81) = 0.85$, $p = .36$, or condition, $F(1,81) = 0.00$, $p = .98$. Trait food craving was found to differ significantly only by restraint status, $F(1,81) = 10.32$,

p = .002, with restrained eaters having greater levels of food cravings (M = 56.48) than unrestrained eaters (M = 42.87), but it did not differ according to condition, (1,81) = 0.06, p = .80. Level of hunger was found to not differ according to eating status, $F(1,81) = 1.52$, p = .22, or condition, $F(1,81) = 0.42$, p = .52. Time since participant's last meal did not differ according to eating status, $F(1,81) = 0.00$, p = .99, or condition, $F(1,81) = 0.64$, p = .43. ADHD symptoms also did not differ by eating status, $F(1,81) = 2.92$, p = .09, or condition, $F(1,81) = 0.71$, p = .40. Additional variables were recoded to be dichotomous prior to chi-squared analyses to determine covariates: ethnicity (Caucasian or Non-Caucasian) and employment status (employed or unemployed). Ethnicity was not found to vary according to eating status, $\chi^2(1) = 0.01$, p = .97, or condition, $\chi^2(1) = 0.06$, p = .82. Similarly, employment did not vary according to eating status, $\chi^2(1) = 0.76$, p = .38, or condition, $\chi^2(1) = 0.96$, p = .33. Due to these results, the covariates of BMI and trait food craving were included as covariates in data analysis.

In addition to these possible covariates, prior research evaluating response to threat utilized measures of anxiety to ensure that their dot-probe tasks did not simply induce anxiety, which would artificially inflate responses (Macleod et al., 1986). In that spirit, I included measures of state craving at several time points during this study to ensure that the dot-probe training task did not simply induce craving which would drive the results. The first measure of state craving occurred prior to attentional training on the dot-probe and did not correlate significantly with the weight of candy consumed (weight after – weight before), r = .16, p = .14. Time 2 state craving scores were obtained immediately after the attentional training task and correlated marginally with the weight of candies consumed, r = .21, p = .053. Time 3 state craving was measured after the eating task and was not significantly correlated with the amount of candies eaten, r = .09, p = .42. In accordance with these results, state food craving

immediately following the attentional training task was also included as a covariate, in addition to BMI and trait food craving.

ANCOVA Results

The amount of candies eaten in study 2 was computed by subtracting the weight of candies after food administration from the weight of candies pre-administration. The distribution of the amount of candies eaten was found to be non-normally distributed, and was both positively skewed and leptokurtotic (skewness: 3.29, kurtosis: 14.30) and while ANOVA is robust enough to be relatively unaffected by this issue, the data was also found to have unequal variances between groups according to Levene's Test, $F(3,80) = 3.84$, $p = .01$. As such, the amount of candies eaten by individuals was transformed using a square root function The resulting data was more normal (skewness: 1.17, kurtosis: 2.36) and was found to have nonsignificantly different variances between groups according to Levene's Test, $F(3,80) = 2.03$, $p = 0.12$.

It was hypothesized that individuals who were trained to attend reward cues would eat a greater amount of candy-coated chocolate than those who were not trained to attend any type of visual cue. A 2 (restraint status: restrained versus unrestrained) x 2 (attention condition: reward-oriented versus non-trained) factorial ANCOVA using the square root transformed data indicated that there was a significant main effect of restraint status, $F(1,77) = 10.65$, $p = .002$, $\eta_p^2 = .12$, such that restrained eaters consumed a greater amount of food ($M = 18.41$) than unrestrained eaters ($M = 9.82$).

Hypothesis 3 predicted a difference between reward-focused and non-focused conditions on the amount of candies eaten, but the difference between the attention conditions was found to be nonsignificant, $F(1,77) = 1.91$, $p = .17$, $\eta_p^2 = .02$.

Further, it was anticipated that restraint status would interact with condition, and examination of the interaction between eating status and condition was found to be significant, $F(1,77) = 4.53$, $p = .04$, $\eta_p^2 = .06$. In accordance with this hypothesis, planned contrasts revealed a significant difference between condition for restrained eaters, $F(1,78) = 5.52$, $p = .02$, $\eta_p^2 = .07$, with the restrained eaters in the reward-oriented condition consuming more candies than those in the untrained condition, while there was no significant difference between condition for unrestrained eaters, $F(1,78) = 0.32$, $p = .58$, $\eta_p^2 = .00$. A graphical representation of the amount of candies eaten is presented in Figure 3.

Discussion

Study 2 assessed the effect of attention directly upon eating behavior. If attention truly mediates the relationship between self-control use and the iterative loss of self-control, attention must be shown to independently affect self-regulatory behaviors without having been induced by the ego-depletion effect. Unfortunately, no significant main effect of condition was found in this study. However, there appeared to be a significant main effect of dietary restraint status on eating behavior, with restrained eaters consuming a significantly greater volume of candies than unrestrained eaters. While the literature regarding the relationship between dietary restraint and food intake is somewhat contentious (e.g., Laessle, Tuschl, Kotthaus, & Prike, 1989; Westerterp-Plantenga, Wouters, & Hoor, 1991), this result provides further evidence that restrained eaters may be prone to consuming greater amounts of food than unrestrained eaters after a period of fasting (this study required a minimum of 3 hours, but the average reported was 8.35 hours [SD = 4.79]), which coincides with literature that suggests restrained eaters consume more food after periods of fasting than unrestrained eaters (Polivy et al., 2005).

A secondary hypothesis for study 2 stated that there would be a significant interaction between condition and dietary restraint, such that there would be no significant difference in amount of candies eaten between attention conditions for unrestrained eaters, but restrained eaters who were trained to attend reward would eat a significantly greater amount of candies than unrestrained eaters in the same condition. This interaction was found to be significant, suggesting that attentional training had a greater effect on restrained eaters than on unrestrained eaters. This result not only reveals the effect of attention on directing behavior, but also implicates the motivational component that is included within the process model of ego-depletion (Inzlicht& Schmeichel, 2012). While ego-depletion was not induced in study 2, the interaction between restrained eating and attentional training condition provides evidence that, at minimum, these two components are both involved in the exertion of self-control relating to food consumption. This result is consistent with prior literature showing that restrained eaters are more likely to consume food after consuming a preload (Herman & Mack, 1975), exerting self-control on an unrelated domain (Vohs & Heatherton, 2000), or experiencing negative mood induction (Schotte, Cools, & McNally, 1990). The attentional component of this interaction may suggest, further, that it may be one of the basic processes through which individuals are less able to exert control on their eating behavior. Finally, it must be noted that the inclusion of state craving as a covariate in data analysis is particularly notable, as it allows for the effect of attentional training to be considered on its own rather than simply inducing a desire to approach rewarding food objects.

General Discussion

These two studies set out to examine the role of attention as a mediator of the relationship between the ego-depletion effect and loss of subsequent self-control, consistent with the Inzlicht

and Schmeichel process model (2012). The first examined whether an ego-depletion induction task affected subsequent reaction time to visual reward and self-control cues. The second examined the direct effect of attention on a self-regulatory activity – namely, eating behavior. Evaluation of attention using food-related visual cues as well as an eating task also allowed for control and examination of trait motivation by specifically recruiting participants by their status as individuals who do or do not cognitively restrain their food intake.

Strengths

This study has several strengths worth mentioning. Notably, this is one of the first studies attempting to examine the attention component of the mechanistic revision of ego-depletion (Inzlicht & Schmeichel, 2012) while controlling for trait motivation. It is important to note that while the ego-depletion effect is domain general, examination of this effect within the domain of eating behavior may represent an ideal platform due to the wealth of research examining both cue reactivity and eating motivation. A unique component of this set of studies was the ability to control for trait motivation through accounting for cognitive attempts at restraining food intake. Through accounting for trait motivation to restrain eating, a more direct measurement of the attentional component of self-control exertion was able to be made. The inclusion of self-control images is also a notable strength, as the measurement of attention toward/away from self-control cues is a unique contribution that these studies can make to the literature. While prior studies have not clearly outlined a definition for what constitutes a visual self-control cue, this study may be one of the first. Additionally, the use of images within the dot-probe task is a strength simply because it is a more ecologically valid stimulus than words, which are used in many prior studies (Dear, Sharpe, Nicholas, & Refshauge, 2011).

Limitations

There are also limitations of this research in addition to its strengths. First, as already discussed, there is much evidence suggesting that the ego-depletion manipulation did not work in study 1 – whether this is due to an incompatibility between the "crossing out e's" task and the attentional component of ego-depletion or a failure of the "crossing out e's" task to effectively induce ego-depletion is unclear and unable to be evaluated in this study. Due to this issue, the mediational effect of attention within ego-depletion was unable to be adequately tested - an issue that is compounded by the lack of a manipulation check. Within both study 1 and study 2, it must be stated that self-control cues have not been adequately defined in prior research, so a greater amount of work establishing what may constitute a self-control cue may make future work in this area more robust.

Bias must also be addressed, as these studies utilized a sample of convenience composed of college-aged females who are primarily Caucasian. While this would heavily bias results in many studies, attentional systems are theorized to work consistently across ages, ethnicities, and many other demographic variables, so this weakness must be tempered by that knowledge. Furthermore, the observed results may have been biased by the exclusion of participants who met criteria for an eating disorder. The relatively strict criteria may have inadvertently excluded individuals who scored most highly on dietary restraint, which would have increased homogeneity between the restrained and unrestrained groups. This idea is supported by a meta-analysis of risk and maintenance factors for eating pathology (Stice, 2002) which revealed that dietary restraint was a likely risk factor for disordered eating behavior. An additional limitation of this research is that the outcome measure for study 2 was chocolates with candy coating, which limits the generalizability of the results for study 2 to other types of food. Future research would be well-served by examining the effect of attentional training on eating behavior in more

ecologically valid environments with a variety of food outcome measures in order to increase generalizability of the effect.

A final limitation has broader implications for research regarding the mechanistic revision of ego-depletion as presented by Inzlicht and Schmeichel (2012) within the domain of eating behavior, as prior research has shown that restrained and unrestrained eaters evidenced no difference on reaction time away from positive body shape words while eating disordered individuals differed significantly from both groups (Reiger et al., 1998), while still other studies have shown that restrained and unrestrained participants simply did not differ significantly in reaction times to food- and body-related words (e.g., Boon, 2000). Further, a review conducted by Faunce (2002) stated that nonclinical samples using restrained eaters as measured by the RRS have shown inconsistent attentional bias on stroop tasks. Collectively, this may evidence a lack of control of the motivational component of Inzlicht and Schmeichel's (2012) model within these studies, which may have skewed results. As such, future studies may benefit from alternate methods of attempting to control for the motivational component within the ego-depletion revision, whether through a different measurable trait component or via a manipulation of state motivation. This being said, it is important to note that an interaction between dietary restraint status and attentional training condition was found in study 2, suggesting that the construct of dietary restraint may exist as an adequate control for motivation until future exploratory research is able to identify a new construct.

Importance of Findings

While there are several interesting findings stemming from this experiment, the primary outcome of interest is the role of attention in guiding eating behavior within the context of the ego-depletion effect. While the results from study 1 were inconclusive, this standalone finding

must, of necessity, not include any interpretations of its role within ego-depletion due to the potential ineffectiveness of the "crossing out e's" task to induce an ego-depletion effect. However, it is clear from study 2 that restrained eaters trained to attend reward images did eat a greater amount of candy covered chocolates than any other group. This outcome creates a point from which future research can more adequately examine the effect of ego-depletion on attention and further experimentation will provide valuable insight into what may be an integral mechanism governing self-control ability.

One important note must be made regarding the different effects of restraint status on the outcome variables of reaction time (nonsignificant in study 1) and eating behavior (significant in study 2). While interesting that these results were found, particularly considering the mixed literature for both the relationship between dietary restraint and attentional bias (for a meta-analysis, see Dobson & Dozois, 2004) as well as dietary restraint and food intake (e.g., Laessle et al., 1989; Westerterp-Plantenga et al., 1991), the results in study 1 provide an adequate justification for including restrained eating as a control of trait motivation within the Inzlicht and Schmeichel (2012) model, as restraint status without prior presentation of reward cues was not a significant predictor of attentional bias on its own. The results of study 2, on the other hand, suggest that the very act of presenting reward cues to restrained individuals may cue them to become more reactive to environmental stimuli, which may have been the mechanism driving their increased food intake, as predicted by the Goal Conflict Model of Eating (Stroebe, van Koningsbruggen, Papies, & Aarts, 2013).

Finally, the use of two different image types, object images and person images, the reaction time differences of which were not significantly different, is an important finding, as the majority of cue-reactivity research has included only object images. The inclusion of more

ecologically valid and visually complex images in these types of studies could provide a boost to ecological validity of these laboratory studies, which is potentially quite helpful to future researchers who will be able to generalize these results beyond the laboratory.

Conclusion

In conclusion, although evidence in the first study did not support a direct effect of depletion on attention toward reward or away from self-control, the manipulation of attention in the second study did influence subsequent self-control exertion on an eating task, which constitutes partial support for the role of attention within the process model. This result is consistent with the idea of both attention as a potential mechanism guiding self-control ability as well as restrained eaters' sensitivity to reward cues guiding eating behavior after their sensitivity to reward stimuli in their environments has been elicited.

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Appendix. *IRB Acceptance Letter.*

Office of Research Compliance
Institutional Review Board

September 3, 2013

MEMORANDUM

TO:	Garrett Pollert Jennifer Veilleux Katherine Sosna
FROM:	Ro Windwalker IRB Coordinator
RE:	New Protocol Approval
IRB Protocol #:	13-08-046
Protocol Title:	*Reactions to Food Images*
Review Type:	☐ EXEMPT ☒ EXPEDITED ☐ FULL IRB
Approved Project Period:	Start Date: 08/30/2013 Expiration Date: 08/29/2014

Your protocol has been approved by the IRB. Protocols are approved for a maximum period of one year. If you wish to continue the project past the approved project period (see above), you must submit a request, using the form *Continuing Review for IRB Approved Projects*, prior to the expiration date. This form is available from the IRB Coordinator or on the Research Compliance website (http://vpred.uark.edu/210.php). As a courtesy, you will be sent a reminder two months in advance of that date. However, failure to receive a reminder does not negate your obligation to make the request in sufficient time for review and approval. Federal regulations prohibit retroactive approval of continuation. Failure to receive approval to continue the project prior to the expiration date will result in Termination of the protocol approval. The IRB Coordinator can give you guidance on submission times.

This protocol has been approved for 520 participants. If you wish to make *any* modifications in the approved protocol, including enrolling more than this number, you must seek approval *prior to* implementing those changes. All modifications should be requested in writing (email is acceptable) and must provide sufficient detail to assess the impact of the change.

If you have questions or need any assistance from the IRB, please contact me at 210 Administration Building, 5-2208, or irb@uark.edu.

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Table 1. *Mean reaction time difference scores for images in Study 1.*

	Unrestrained		Restrained	
Image Type	Control	Depletion	Control	Depletion
Reward	5.21 (18.48)	-0.83 (14.51)	5.14 (20.52)	3.31 (14.69)
Self-Control	0.76 (21.13)	5.96 (11.27)	-5.3 (17.51)	-0.72 (12.52)

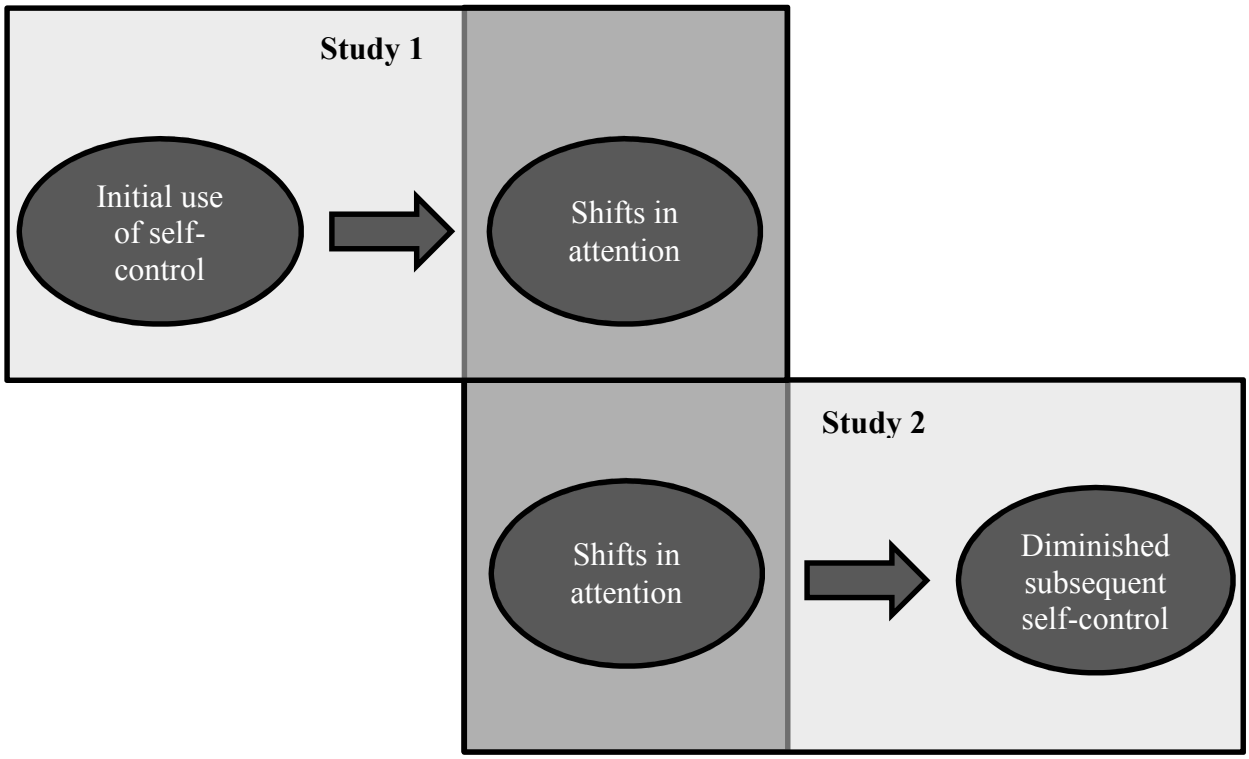

Figure 1. *A pictorial representation of studies 1 and 2.*

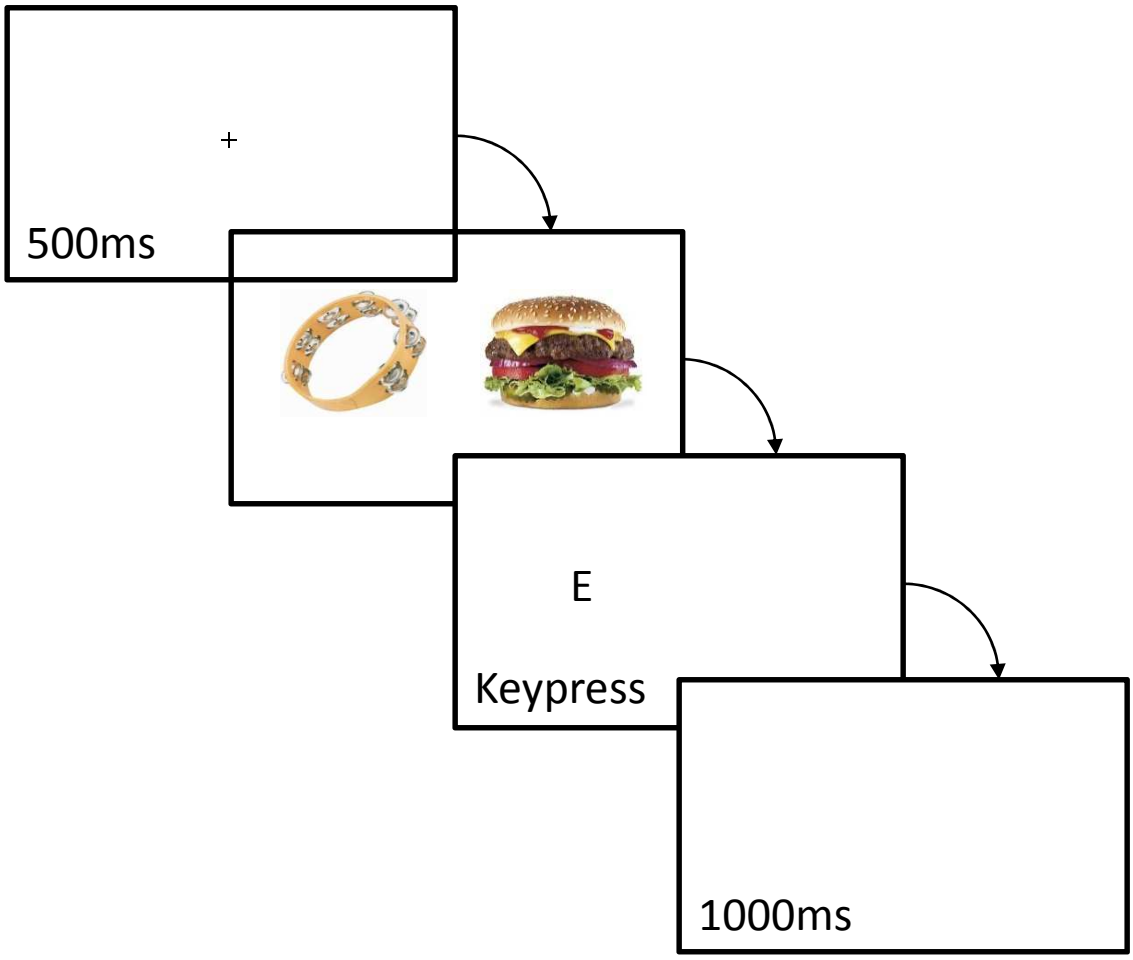

Figure 2. *Example presentation of the dot-probe task used in Studies 1 and 2.*

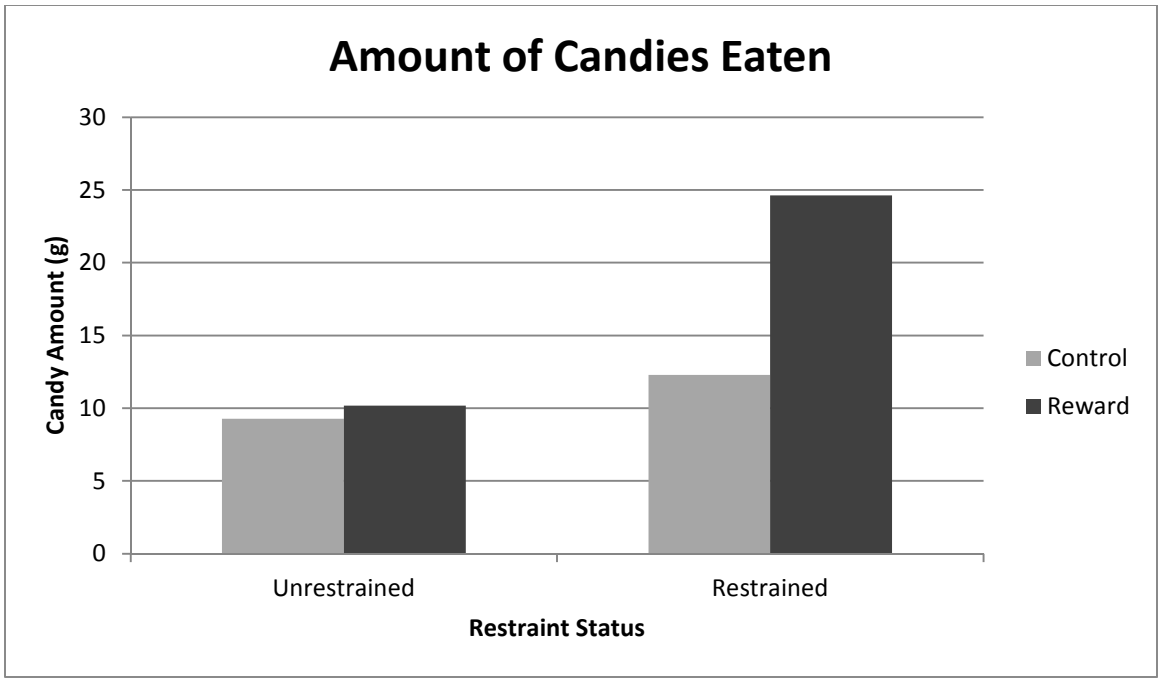

Figure 3. *Amount of candies eaten in Study 2*.