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A Manipulation of Cognitive Restriction and Goal-Conflict: Mechanisms Underlying the Disinhibition Effect of Eating Behavior

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A Manipulation of Cognitive Restriction and Goal-Conflict: Mechanisms Underlying the Disinhibition Effect of Eating Behavior

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ABSTRACT

People are often faced with a self-control dilemma whenever the attainment of a long-term goal would come at the expense of an alluring temptation. The goal-conflict model of eating (Stroebe, van Koningsbruggen, Papies, & Aarts, 2013) suggests that restrained eaters (i.e., chronic dieters) experience self-regulation failure (e.g., overeating, or disinhibition) due to inner competing goals of eating enjoyment and weight control. The current study examined these concepts in a sample of people classified as unrestrained eaters (N = 123), allowing for an investigation of restricted cognitive focus as a causal mechanism of disinhibited eating. A 2 (restraint condition: restriction, intuitive eating) X 2 (temptation manipulation: temptation, no temptation) study design was used to manipulate cognitive restraint and temptation, thus modeling goal-conflict. Results of both a pilot study and the laboratory based experiment indicated the restraint manipulation was effective, such that those in the restriction condition showed greater resistance to eating and reported a greater positive change in desire to cognitively manage food intake at the end of the experiment; however, food consumption did not change based on temptation or restraint conditions. Though findings did not support predictions that a restricted cognitive focus is a causal mechanism of disinhibited eating, it appears restraint does operate on a cognitive level and additional work is needed to further examine the effects of time and context in the relation between cognitive restraint and eating behaviors.

Keywords: dietary restraint, cognition, eating behavior

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Imagine yourself staring through the window of a bakery on a frigid winter evening. The snow is falling and you longingly gaze at a counter of freshly baked blueberry muffins, imagining the warmth that would fill you with just one bite. *No*, you tell yourself. *You don't need to eat one.* You try to turn away but feel a pull – a tantalizing desire - that you can't seem to escape. Gravitating towards the door, you walk inside the bakery, order a muffin (or two), and like a tickle to your foot, fulfill your desire. You eat.

The experience mentioned above is a common one: Temptation is regularly experienced in everyday life, whereby people find themselves in the midst of a tug-of-war in which they long to give into their desires but also wish to refrain from doing so. People rarely desire one thing at a time and are often faced with a self-control dilemma whenever the attainment of a high-order, long term goal would come at the expense of a low-order, yet alluring temptation (e.g., Baumeister & Heatherton, 1996; Pelaez-Fenandez & Extremera, 2011;Veling, Aarts, & Papies, 2011). For instance, a dieter's desire to eat a blueberry muffin clearly contrasts with his desire to maintain a low-fat diet. Thus, the process of resolving inner conflict involves prioritizing the goal of upmost importance in the moment (Stroebe, van Koningsbruggen, Papies, & Aarts, 2013).

Self-regulation, or the capacity to control one's inner impulses and interrupt undesired behavioral tendencies (Baumeister, Bratslavsky, Muraven, & Tice, 1998), is viewed as desirable. However, self-regulation attempts frequently fail, and individuals aren't able to engage in effortful control in all situations. In the eating domain it has been well established that a broad range of related behavioral problems (e.g., dieting, eating restriction) have self-regulation failure

as a common core (Stroebe et al., 2013; Pelaez-Fernandez & Extremera, 2011; Johnson, Pratt, & Wardle, 2012), though the specific mechanisms contributing to this effect are less clear.

Restrained Eating

Literature identifies restrained eaters as a specific group of individuals who appear to be at-risk for failure in self-control (Stroebe et al., 2013; Heatherton & Wagner, 2011; Hofmann, Adriaanse, Vohs & Baumeister, 2013). Believed to be chronic dieters or weight suppressors, restrained eaters are assumed to cognitively manage their food intake for the purpose of weight loss or weight control (Herman & Polivy, 1980; Burger & Stice, 2011). Unlike unrestrained eaters who allow internal hunger cues regulate their food intake, restrained eaters adhere to self-set dieting rules and are characterized by restriction in their eating habits (Herman & Mack, 1975) yet ironically exhibit disinhibited eating behavior in certain situations (Coelho, Jansen, Roefs, & Nederkoorn, 2009) .

Overwhelmingly, evidence suggests that disinhibition is context-dependent (Blechert, Feige, Hajcak, & Tushcen-Caffier, 2010; Patel & Schlundt, 2001), such that restrained eaters are at risk for eliminating their chronic restraints in situations where they are in the presence of (or come into contact with) external cues (e.g., Herman & Polivy, 1980, 1984). Research investigating restrained eating often uses in-vivo food priming techniques (e.g., Stroebe, 2008; Papies & Hamstra, 2010; Rotenberg & Flood, 2000; Yum Sin & Vartanian, 2012; Polivy, Heatherton, & Herman, 1988), whereby participants consume a small amount of food (i.e., preload; often a calorically dense or palatable food) and are given access to ad-libitum food during a taste test. For restrained eaters, the food preload disinhibits participant's restriction, which results in increased food intake; however, for unrestrained eaters, the opposite pattern is

shown and less food is consumed following a preload (Stroebe, 2008; Urbszat, Herman, & Polivy, 2002; Herman & Mack, 1975).

Beyond effects of preload on eating behavior, cues themselves may be salient enough to induce disinhibition among restrained eaters. Research suggests that eating regulation can easily be disturbed by external food cues, which strongly influence appetite by way of increased craving and urges in restrained eaters (Green, Rogers, & Elliman, 2000). Studies show that restrained eaters display higher levels of salivation to the presence of palatable food (Brunstorm, Yates, & Witcomb, 2004) and to the smell of food (LeGoff & Spigelman, 1987), experience stronger urges to eat the cued food than unrestrained eaters (Fedoroff, Polivy, & Herman, 1997, 2003; Harvey, Kemps, & Tiggemann, 2005), and are more likely to show disinhibition when exposed to such food cues (Collins, 1978; Harvey et al., 2005; Fedoroff et al., 1997; Jansen & van den Hout, 1991). Such evidence suggests that appealing food cues have a strong impact on the eating behavior of restrained, compared to unrestrained, individuals.

The Goal-Conflict Model of Eating Behavior

As mentioned above, literature identifies the self-control dilemma (i.e., inner conflict between competing weight control vs. eating enjoyment goals when in temptation scenarios) as a key mechanism underlying self-regulation failure for individuals with high levels of eating restraint (Pelaez-Fernandez & Extremera, 2011). This mechanism provides important information regarding the disinhibition effect; however, the process by which the self-control dilemma arises and which goal will be acted on are less understood.

Recently, Stroebe and colleagues (2013) directly applied the self-control dilemma to eating domain. Their goal-conflict model of eating posits that the eating behavior of those trying to restrict or control food intake is determined by two conflicting goals: the goal of eating

enjoyment and the goal of weight control. The model explains that for some restrained eaters, behavioral restriction (e.g., low calorie consumption) is possible, whereby repeated successes in self-control increases the accessibility of the weight control goal and the likelihood that it will be pursued in temptation scenarios. For most restrained eaters, however, exposure to palatable food often increases the accessibility of the eating enjoyment goal (e.g., Papies et al., 2007), which results in an inhibition of the weight control goal (e.g., Stroebe et al., 2008).

Group or cognitive process?

Extant research overwhelmingly investigates restrained eating through the lens of restrained eaters as a group (Herman & Polivy, 1980; Fedoroff et al., 1997, 2003; Green et al., 1994). However, there are two ways in which construing restrained eating as a trait taxonomy might be incorrect. First, given that restrained eaters are defined by a cutpoint (i.e., Revised Restraint Scale scores $\geq$ 16 for females, $\geq$ 12 for males), potentially valuable information about restraint as a dimensional characteristic is lost. While taxa differ from normality in kind, dimensions differ in degree. Considering restraint to be a grouping assumes it to be a discrete entity with absolute boundaries dividing it from non-restraint, thus implying individuals either possess restraint-like tendencies or they do not. Given evidence suggesting that restrained eating is often a precursor to disordered eating and even full eating disordered diagnoses (Heatherton & Polivy, 1992; Johnson, Pratt, & Wardle, 2012), it makes sense to consider it to be located on a spectrum, varying in degree of severity at the individual level.

Second, while it's possible restrained eating reflects a general, stylistic approach to eating; it may also be that restrained eating reflects momentary cognitive processing, which warrants future testing. Research on cognitive theories of eating pathology suggests that individuals with eating disorders have highly elaborate cognitive structures (i.e., schemas) that

focus on food, weight and shape information (Bemis-Vitousck & Hollon, 1990; Williamson, 1996). Overuse of these schemas can lead to information processing errors (e.g., selective memory and/or attention for schema-related cues) which may contribute to maladaptive behaviors, such as food preoccupation or overeating (Green et al., 2000).

Similar to individuals with clinical levels of eating pathology, high levels of dietary restraint have been associated with impairments in cognitive processing efficiency (Higgs, 2007; Green, Rogers, Elliman, & Gatenby, 1994; Mann & Ward, 2004). For example, restrained eaters exhibit poorer proof-reading performance in the presence of a food distractor (Herman, Polivy, Pliner, Threlkeld, & Munic, 1978), slower simple reaction times, poorer vigilance performance, and worse immediate recall than unrestrained eaters in the presence of food (Green et al., 1994), and slower reaction times on tasks completed while thinking about a favorite food (Fedoroff et al., 1997; Harvey et al., 2005).

Taken together, research indicates restrained individuals experience cognitive processing deficits when in the face of temptation (e.g., exposure to palatable food cues); however, it remains a question if these deficits are due to stylistic differences of restrained eaters, considered either as a trait group or varying on a dimension based on degree of restraint, or if cognitive restraint is actually a causal mechanism. The goal-conflict phenomenon was derived from research examining the disinhibition effect in restrained eaters. In other words, this theory is rooted in individuals who are grouped together based on an arbitrary cutoff score that suggests their eating behaviors reflect dietary restriction. To have goals, thoughts must first drive their existence, as goals are defined as cognitive representations of desirable outcomes (Aarts & Elliot, 2012**)**. Does goal-conflict exist solely in this group of people, or could it be that restraint based thoughts *produce* goal-conflict, which leads to self-control failure?

To begin addressing the above question, we must begin to understand the underlying cognitive mechanisms that may contribute to the observed difficulties in self-regulation among individuals high in eating restraint. As such, I will next review models of ego depletion, craving and hot/cold processing as possible elements that may contribute to disinhibition associated with restraint.

Ego Depletion

The theory of ego depletion states that all acts of self-control draw on a common limited resource that is akin to energy or strength, such that exerting self-control is followed by a period of diminished capacity to exert subsequent self-control (Muraven & Baumeister, 2000). For example, studies show that restrained eaters consume more food during instances in which they are mentally tired, such as when assigned to do a cognitively demanding task prior to a taste test (Hofmann, Rauch, & Gawronski, 2007; Ward & Mann, 2000) or are instructed to suppress emotional expression (Vohs & Heatherton, 2000, Study 3). This lesser ability to exert self-control might be attributed to cognitive load, or the total amount of mental effort being used in the working memory, whereby continuous exertion of mental effort leads to greater mental fatigue (i.e., depletion) and problems with subsequent self-control. If restrained eating reflects thought-based mechanisms like it is assumed to, it may be that cognitive processing impairments in temptation situations result from specific restraint-based thoughts that are prompted from exposure to food-cues, rather than from general mental fatigue. This model of ego depletion would support a goal-conflict model whereby conflicting mental goals contribute to subsequent disinhibition.

In contrast, the process model of ego depletion (Inzlicht & Schmeichel, 2012) holds that initial exertions of self-control influence motivation and attention, such that that exerting self-

control at one time point causes temporary shifts in both motivation (e.g., toward hedonic pleasure)and attention (e.g., toward reward, away from restraint) that undermine later instances of self-control. Thus, following depletion, individuals who cognitively restrict their food intake may find it increasingly difficult to control eating behavior when exposed to palatable food cues due to intrusive thoughts about eating enjoyment, which impairs their abilities to focus on eating control (Stroebe et al., 2013). As such, the process model of ego depletion would posit that goal-conflict, an effortful and taxing experience, would cause attention and motivation to shift towards the hedonic pleasure goal and away from the weight control goal, therefore contributing to later lapses in self-control (i.e., disinhibition).

Craving Mechanisms

An array of research suggests that the mere exposure to the smell or sight of palatable food triggers increased urges in individuals attempting to restrict their food intake (e.g., Fedoroff et al., 1997, 2003; Rogers & Hill, 1989). Literature identifies multiple theories of craving (see Drummond, 2001 for a review), with models illuminating how urges might predict the effect of craving in response to cues (i.e., cue-induced craving) on behavior. Though most models are situated in the realm of addictive behaviors, the cognitive processing model (Tiffany, 1990; Tiffany & Conklin, 2000) is relevant in examining the thought processes which occur in temptation scenarios. Originally developed to understand the process of craving in addicts, the cognitive processing model purports that long time users develop habitual and automatic processing for drug cues, which negates the necessity of craving to elicit behavior. In other words, cues (e.g., a commercial showcasing beer) may lead to target acquisition (e.g. retrieving a beer from the refrigerator) regardless of whether the individual is consciously craving or not. Conscious craving, then, is the result of non-automatic (i.e., effortful) processing when

accessibility is blocked due to external factors (e.g. the liquor store is closed and an alcoholic can't buy beer) or because of internal factors, like a desire to quit. This cognitive processing status of addicts has been made analogous to restrained eating (Overduin & Jansen, 1996), whereby individuals under conditions of restraint (e.g., internal weight control goals) should experience craving in the face of temptation (i.e., when experiencing goal-conflict), which would contribute to the disinhibition effect.

Additionally, the Elaborated Intrusion Theory of Desire (Kavnaugh, Andrade, & May, 2005) distinguishes between basic, associative processes from higher level elaborative processes. Specifically, automatic processes associated with desire lead to spontaneous thoughts (i.e., intrusions) and an elaborative cycle is born, which encompasses the cognitive processes involved in retrieving information from memory and using that information to construct life-like images of the desired target. In this model, cognitive elaboration contains strong, affective links and increases the immediate likelihood of fulfilling one's desire. Thus, it may be that individuals high in eating restraint have strong, affective links to memories or thoughts of food, which strengthen the experience of temptation. The Elaborated Intrusion Theory would suggest that people experience intrusive, life-like images of temptation during moments of goal-conflict, which increase craving and contribute to subsequent disinhibition. Though researchers have studied desire in restrained and unrestrained eaters (Polivy, Coleman, & Herman, 2005; Fedoroff et al., 2003; Svaldi, Tuschen-Caffier, Lackner, Zimmermann, & Naumann, 2012), the theoretical restraint-based thoughts that may occur during temptation scenarios have yet to be fully explored.

Hot/Cool Cognitive/Affective Processing

Metcalfe and Mischel (1999) proposed a 2-system framework, the Hot/Cool-System, for better understanding the cognitive processes that enable – and undermine – self-control. The *hot emotional system* is specialized for quick emotional processing (i.e., the "go" system), and the cool cognitive system is specialized for complex spatiotemporal and episodic representation and thought (i.e., the "know" system). When these two systems interact, issues often arise with self-regulation and goal-oriented behavior (Metcalfe & Mischel, 1999). Because affect and cognition are controlled by two separate systems, individuals may act on emotions in certain situations if their emotions precede their knowledge due to the faster speed of the hot- compared to the cool-system response,. For those with eating restriction goals, then, situational aspects (i.e., food cues) are triggered, which may activate the "hot," emotional system, therefore overriding the long-term/weight-maintenance goal (i.e., the "cool" system) and causing them to act on emotion to fulfill the current desire. Thus, the Hot/Cool-system suggests the activation of the "hot" system is more likely to produce behavior, which highlights the importance of emotion in the experience of desire.

General Self-Control

While understanding the cognitive processes that undermine self-control is of fundamental importance, it is necessary to briefly review a basic model of self-control that most directly applies to goal-conflict. At the core of this model is motivation, otherwise known as a mechanism directing behavior toward obtaining satisfaction (Hofmann, Baumeister, Forster, & Vohs, 2012). Hofmann and colleagues' (2012) four-step model of motivated behavior integrates the components of desire, conflict, resistance (use of self-control), and enactment, such that desires vary in their potential to motivate behavior, and sometimes conflict with the person's

values and goals. Such conflict, according to this framework, is an important triggering mechanism for a person's active efforts at resisting desire. Using self-control, then, involves the effortful prevention of enacting the desire and depends on the degree of conflict experience. Thus, the association between conflict and behavioral enactment is best understood as mediated through the recruitment of self-control (i.e., resistance), such that greater conflict prompts greater behavioral resistance, which decreases the likelihood of behavioral enactment. In other words, this model suggests that goal conflict would *reduce* disinhibition, because it prompts self-control and increases behavioral resistance.

However, there is an important distinction to be made in the conceptualization of resistance via the Hofmann and colleagues (2012) model and resistance in the proposed research mentioned here. Behavioral resistance (e.g., refusing a slice of cake), as depicted through models of self-control, is qualitatively different than cognitive resistance, or restraint (e.g., thinking you shouldn't eat cake because you need to watch your weight). Specifically, cognitive restriction may result in one of two outcomes: the act of behavioral restriction or indulgence in temptation. Thus, behavioral and cognitive restrictions appear to be rather different from one another, such that behavioral restriction is one of two byproducts of cognitive restriction.

When cognitive resistance is experienced consciously in temptation situations, behavioral resistance often follows. However, there are two instances in which behavioral resistance may not be acted upon. First, cognitive restraint may be experienced at the subconscious level, which may not be salient enough to produce desired behavior (i.e., resistance). Second, cognitive resistance may be weaker than the impulse to indulge in temptation and therefore not effective in altering behavior. Thus, it's certainly possible that internal conflict may lead to actively resisting a particular temptation; however, it would also make sense that actively trying to cognitively

resist palatable food while being surrounded by it should create mental goal-conflict (e.g., Hofmann et al., 2012), which may contribute to the disinhibition effect.

Current Study

Overall, more evidence is needed to fully understand how restraint operates on a cognitive level and what effect it has on eating behaviors. If the disinhibition seen in restrained eaters is based on cognitive mechanisms, then those mechanisms can likely be modeled and manipulated in unrestrained eaters to test the causal effects of a restrained mindset on eating behavior.

The aim of this research was to extend previous findings by studying these concepts in an unrestrained sample and to investigate restricted cognitive focus as a causal mechanism of disinhibited eating. An online pilot study was first developed to test the effectiveness of the restraint manipulation used in the main laboratory based study. The pilot study randomly assigned participants to restraint condition, and results were used to determine what changes needed to be made prior to beginning the laboratory study. The laboratory based study used a 2 (restraint condition: restriction, intuitive eating) X 2 (temptation manipulation: temptation, no temptation) study design, whereby both cognitive restraint and temptation were manipulated, thus modeling goal-conflict.

The current study tested a series of predictions. First, I predicted that people guided to think in a restricted mindset would exhibit more disinhibition (i.e., greater food consumption) after being exposed to food temptations as compared to neutral temptations, whereas people guided to think in an unrestrained or intuitive eating mindset would consume equal amounts of food following an initial exposure to food and neutral temptations. Such findings would suggest that being exposed to a food-cue while thinking about food in a restrictive way creates goal-

conflict by activating the "eating enjoyment" goal, thereby resulting in greater food consumption.

Second, I predicted that those guided to think restrictively about food would report lower levels of positive and greater levels of negative affect compared to those guided to think intuitively about food. Additionally, I anticipated negative mood would increase and positive mood would decrease over time for those guided to think restrictively about food, whereas negative mood should remain constant or decrease and positive affect should increase for those guided to think intuitively about food. I predicted positive affect would be higher following exposure to food temptation for those guided to think intuitively about food; however, I anticipated positive affect would be lower following food temptation exposure for those guided to think restrictively about food. Such predictions would indicate that thinking in a restrictive way about food is unpleasant and has a downstream effect on affective states that changes as a function of situational factors (e.g., temptation).

Third, I predicted that levels of craving and resistance would be higher among those guided to think restrictively about food compared to those guided to think intuitively during exposure to food temptations; however, after being exposed to neutral objects, I anticipated only resistance would be significantly higher for those guided to think restrictively about food compared to those guided to think intuitively about food. Results in support of this prediction would suggest that a restricted mindset, in conjunction with exposure to palatable food and temptation, would heighten both craving *and* resistance, providing evidentiary support for the goal-conflict model of eating behavior.

Should predictions not be supported, it may suggest that other common factors among restrained eaters, rather than the theoretical cognitive control of food intake and internal goal-

conflict, are better (yet less known) predictors of overeating behavior that warrant further investigation.

Experiment 1: A Pilot Study

Prior to testing the main hypotheses outlined above, I designed a pilot study to test the materials used in the restraint manipulation. The overall aim of the pilot study was to test whether a restrained eating manipulation would be effective in shifting individuals' self-reported strategies used to guide their eating behaviors. Specifically, the overall goal of the pilot study was to assess whether reading an article designed to influence thoughts regarding eating behaviors would be effective at altering participant's desires to allow intuitive eating or cognitive restraint to guide their eating.

Method

Participants

Undergraduate psychology subject pool participants (N = 123, 65.9% female) were awarded ½ credit to complete a short online study which they believed was designed to examine their reactions to research related to achieving a healthy lifestyle. Because the purpose of this initial pilot study was to assess the effectiveness of the restraint manipulation for all people, individuals were not screened based on eating history and there were no exclusionary criteria. Restrained eating status was assessed on the day of the pilot study to allow a full and comprehensive assessment of the manipulation's effectiveness as a function of restrained eating status.

Measures

The Revised Restraint Scale (RRS; Polivy, Herman, & Howard, 1988) is a ten-item measure of restrained eating behaviors (i.e., altering or limiting eating behavior as a result of

image or weight perception). Ratings are completed on a 5 point Likert-type scale (0 = *never* to 4 = *always*) and are summed to produce a total score ranging from 0 to 40, with higher total scores indicating greater restrained eating behavior. Subjects with scores of 15 or lower were considered to be unrestrained eaters (Polivy et al., 1988). The internal consistency of the Revised Restraint Scale for the pilot study was α =.76.

Eating Strategy. Participants completed two separate questionnaires to assess the strategy they use to manage their eating behavior. The first questionnaire was completed prior to the manipulation and asked participants to "Please rate the strategy you use to guide your eating behavior" on a 9-point Likert-type scale (0 = *mentally plan when and how much I should eat* to 8 = *let my internal sensations of hunger*). The second questionnaire was completed post-manipulation and asked participants to "Please rate the strategy you WANT to use to guide your eating behavior" in a similar 9-point Likert-type scale.

State Assessment. Participants reported state levels of craving, positive affect, negative affect and resistance (e.g., "RIGHT NOW, how much do you want to resist eating?") on visual analogue scales ranging from 0 (*no current craving, not at all positive, not at all negative, no desire to resist*) to 100 (*extreme craving, extremely positive, extremely negative, extreme desire to resist*).

Procedure

Prior to manipulation participants completed an initial eating strategy measure. Participants were then randomly assigned to restraint condition (restriction, intuitive eating) in which they read a research study indicating that cognitively restricting and controlling their food intake (restriction condition), or allowing their internal cues of hunger and fullness (intuitive eating condition) was found to be most beneficial in helping people achieve a healthy lifestyle

(See Appendix A). Following the restraint manipulation, participants completed a quiz to test their recollection of article material. Participants who failed the quiz by answering less than 5 out of the 6 total questions correctly were redirected to the article and instructed to read it again before taking the quiz a second time. Those who failed the quiz on the second trial completed the duration of the study but were excluded from data analysis. Following the quiz, participants were asked to write a short description of "How you can use the ideas presented in the article in your life" to foster cognitive elaboration on the material presented and then were asked to rate the strategy they want to use to guide their eating behavior. Finally, participants completed a state assessment of positive affect, negative affect, craving, and resistance before completing the Revised Restraint Scale to assess restrained eating status. Participants were then debriefed and received credit for their participation.

Results

Manipulation Checks

Content quiz manipulation check

I first examined participant's scores on the Revised Restraint Scale. Of the 123 participants who completed the pilot study, 44 had RRS scores of 16 or higher (M = 19.11, SD = 2.70) and were categorized as restrained eaters. The average RRS score for unrestrained eaters (n = 72) was 9.36 (SD = 3.60).

I first examined participant's scores on the content quiz following the restraint manipulation. Of the 123 participants, 12 were excluded from further data analysis because they did not read the manipulation carefully enough to achieve a score of 5 or greater. There were no significant differences in excluded participants based on restraint condition. Both restrained and unrestrained eaters were included in subsequent analyses to evaluate the effectiveness of my

manipulation as a function of restrained eating status. Thus, the remaining participants (n = 109, 64.2% female, M_{age} = 20.29, 85.3% white) were included in the following analyses.

Eating strategy manipulation check

I performed a 2 (restraint condition: restriction, intuitive eating) X 2 (eating status: restrained eater, unrestrained eater) X 2 (time: pre-manipulation, post-manipulation) between-subjects factorial ANOVA on eating strategy. There was a significant main effect of time, $F(1,104)=7.43$, p = .008, such that participants decreased their use of intuitive eating to guide their eating behaviors from baseline (M = 5.60, SD = 2.34) to post-restraint manipulation (M = 4.80, SD = 3.11). This main effect was qualified by a significant interaction between time and condition, $F(1,104) = 129.31$, $p < .001$. Eating strategy scores changed such that participants in the intuitive eating condition increased their intuitive eating from baseline (M = 5.76, SD = 2.42) to post-restraint manipulation (M = 7.78, SD = 1.52),$F(1,48) = 31.84$, $p < .001$. However, for those in the restriction condition, eating strategy scores decreased in intuitive eating (i.e., scores increased in restrictive eating) from baseline (M = 5.47, SD = 2.28) to post-restraint manipulation (M = 2.22, SD = 1.29), $F(1,56) = 116.94$, $p < .001$(See Figure 1). There was not a significant interaction between time and eating status, nor was there a significant 3-way interaction between time, condition, and eating status. This suggests the manipulation was equally effective, irrespective of classification as a restrained or unrestrained eater.

State Assessment

In terms of state resistance to eating I performed a 2 (restraint condition: restriction, intuitive eating) X 2 (eating status: restrained eater, unrestrained eater) between-subjects factorial ANOVA on state resistance. There was a significant main effect of eating status, such that restrained eaters (M = 51.34, SD = 38.12) reported greater state-level resistance toward eating

than unrestrained eaters (M = 31.92, SD = 33.33), $F(1,101) = 8.69$, $p = .004$. There was also a significant main effect of condition, such that those in the restriction condition (M = 48.02, SD = 36.24) reported greater resistance than those in the intuitive eating condition (M = 29.40, SD = 34.20), $F(1,101) = 5.08$, $p = .03$. There was a marginally significant interaction between eating status and condition $F(3,101) = 3.19$, $p = .08$ (See Figure 2). Follow-ups revealed that unrestrained eaters, as expected, in the restriction condition reported a greater desire to resist eating (M = 44.82, SD = 34.34) than unrestrained eaters in the intuitive eating condition (M = 17.30, SD = 25.60), $t(62) = 3.60$, $p = .001$. However, restrained eaters showed little differences in resistance to eating between the restriction (M = 52.74, SD = 39.17) and intuitive eating (M = 49.56, SD = 37.78) conditions, $t(39) = .26$, $p = .79$. There were no significant main effects or interactions when examining positive affect, negative affect, or craving.

Discussion

Taken together, results indicate the manipulation was effective. Regardless of restrained eating status, participants in the restriction condition reported a greater desire to cognitively manage and control their food intake at the end of the study compared to those in the intuitive eating condition, despite that there were no differences prior to the manipulation. Additionally, positive affect, negative affect, and craving were not affected based on the manipulation, as evidenced by no significant main effects or interactions between study variables on these outcomes. This suggests the research articles designed to induce a restrictive mindset toward eating were powerful enough to do so. This was apparent across multiple measures of resistance (i.e., self-reported eating strategy, state-level eating resistance), and changes in eating strategy occurred without similar changes in other important state-level variables that may influence self-reported restriction (e.g., craving, positive affect, negative affect). Thus, the changes in eating

strategy and resistance outcomes appear due to the manipulation and not due to alternative mechanisms.

The goal of the current study was to model and manipulate a restricted cognitive focus toward eating. While there were no main effects of restrained eater status on desire to use intuitive eating or cognitive restraint to guide eating behavior following the restraint manipulation, results do suggest restrained eaters may be influenced by the manipulation differently than unrestrained eaters. Specifically, restrained eaters reported greater end of the study state-level resistance toward eating than unrestrained eaters (irrespective of restraint condition), which suggests they may be more likely to change their strategy to guide their eating behavior as a function of their restrained eating history and not solely based on the study manipulation. This is problematic, given the overall aim of this research is to model and manipulate a restrictive approach toward eating. Additionally, in the intuitive eating condition, restrained eaters reported a greater desire to resist eating than unrestrained eaters, which suggests they may be unwilling and/or unable to think in a different way about eating. Thus, these results suggest that restrained eaters should not be included in the laboratory based study, and recruiting individuals who did not have a baseline predisposition to restrict food intake and control their eating behavior was therefore of utmost importance.

Experiment 2: A Laboratory-Based Manipulation of Goal-Conflict

Method

Participants

A total of 1,312 psychology subject pool participants completed a set of pre-screening questions to determine their eligibility. Participants completed the Revised Restraint Scale (RRS) to assess their eating status and were categorized as unrestrained eaters with scores of 15

or below. As a goal of this study was to investigate the study hypotheses in a healthy sample to focus exclusively on the impact of cognitive restraint in individuals without clinically significant psychopathology that might impact the study results, pre-screening questions also inquired about common mental health problems. Individuals with a self-reported current or former eating diagnosis (a response of 'yes" to the question "Have you ever been diagnosed with an eating disorder?") were not eligible to participate. In addition, participants were also excluded if they reported current milk, dairy, nut, or gluten allergies, as the study involved interacting with and consuming different foods. Of the 1,312 participants screened, 988 were eligible to participate. An overall sample of 158 participants (M_{age} =19.47, 62% female, 74.2% white) completed the laboratory based study.

Measures

The Revised Restraint Scale (RRS; Polivy, Herman, & Howard, 1988) was administered on the prescreening questionnaire and showed an internal consistency for the total restraint score of $\alpha = .75$. Participants with scores of 15 or less were classified as unrestrained eaters and were invited to complete the laboratory based study. The RRS was again administered during the laboratory session to verify restraint status.

The *Brief Self-Control Scale* (BSCS; Tangney, Baumeister, & Boone, 2004) measures dispositional self-regulatory behaviors using 13 items rated on a 5-point scale, ranging from 1 (*Not at all like me*) to 5 (*Very much like me*). Example items are "People would say that I have iron self-discipline" and "I often act without thinking through all the alternatives." The BSCS has been shown to positively correlate with binge eating behaviors ($r = .35$) (Tangney et al., 2004) and demonstrated adequate internal consistency in the current study ($\alpha = .81$)

The *Evaluative Space Grid* (ESG; Larsen, Norris, McGraw, Hawkley, & Cacioppo, 2009) was used to assess mixed positive and negative affect. The measure is displayed graphically in a 9 X 9 matrix, with current level of positivity (0 to 8) on the *X*-axis and current level of negativity (0 to 8) on the *Y*-axis (See Appendix A). The ESG thus provides a measure of positivity (0 to 8) and negativity (0 to 8) and a combined mixed affect score can therefore be calculated. Because single item ratings are made over time, psychometric properties (e.g., alpha) are not calculable, though the measure has been used in several other studies (Larsen & McGraw, 2011; Veilleux, Conrad, & Kassel, 2013; Wardle & de Wit, 2012). The ESG was administered at 4 time points: baseline, post-restraint manipulation, post-temptation manipulation, and post taste-test.

The *Goal-Conflict Grid* was used to assess mixed craving and resistance (i.e., goal-conflict). I amended the ESG (Larsen et al., 2009) to create this measure, which is also displayed graphically in a 9 X 9 matrix, with current level of resistance (0 to 8) on the *X*-axis and current level of craving (0 to 8) on the *Y*-axis. Similar to the ESG, the Goal-Conflict Grid provides a measure of craving (0 to 8) and resistance (0 to 8) and a combined goal-conflict score can therefore be calculated. The Goal-Conflict Grid was also administered at 4 time points with the ESG: baseline, post-restraint manipulation, post-temptation manipulation, and post taste-test

State Food Measures. Participants' state-level craving, resistance, hunger, and satiety were assessed with one item questions: "How much are you craving food right now?";"How much do you want to refrain from eating right now?"; "How hungry are you right now?"; and "Rate your current level of satiety." Participants responded on a 10-point Likert-type scale, with higher scores indicating greater craving, desires to resist eating, hunger, and satiety. These items were integrated into the food task rating sheets.

Eating Strategy. Participants completed two separate questionnaires to assess the strategy they use to manage their eating behavior. The first questionnaire was completed prior to the restraint manipulation and asked participants to "Please rate the strategy you use to guide your eating behavior" on a 9-point Likert-type scale (0 = *mentally plan when and how much I should eat* to 8 = *let my internal sensations of hunger determine when and how much I should eat*). The second questionnaire was completed post-restraint manipulation and asked participants to "Please rate the strategy you WANT to use to guide your eating behavior" on a similar 9-point Likert-type scale.

Procedure

Eligible participants were invited to sign up for a 90-minute laboratory session. Participants were instructed not to eat for 2 hours prior to their appointment to control for hunger, following previous research that uses similar methodology (e.g., Fedoroff et al., 1997; 2003; Ferriday & Brunstrom, 2008; Kroese, Evers, & De Ridder, 2009). Participants arrived to the laboratory, completed informed consent, and then completed a short food-rating task in which they consumed 3 Triscuit crackers during a 5 minute period to control for baseline hunger. Following the initial taste-rating, participants were asked to complete the Evaluative Space Grid questionnaire (ESG; Larsen et al., 2009) and adapted Goal-Conflict Grid at the baseline time point to assess positive and negative affect, and craving and resistance, along with two additional items asking about current levels of hunger and satiety (refer to Table 1 for study timeline).

After completing these items, participants were randomized to one of two conditions designed to manipulate cognitive restraint. Individuals in the restriction condition were seated in a "diet salient" room (e.g., scale on the floor, dieting books and food magazines in sight) and read an experimentally designed article they believed was pulled from an online blog that

included personal testaments indicating the best way to achieve a healthy lifestyle was by cognitively restricting food intake. Individuals in the intuitive eating condition were seated in a room with intuitive eating materials (e.g., Intuitive Eating book, gardening magazines) and no scale in sight, with the article suggesting that attending to physiological hunger signals was most beneficial for healthy living. Previous research (Mann & Ward, 2004) used a similar room setup to test the attentional myopia model of behavioral control in a study of food consumption by chronic dieters and found that using a "diet salient" room was effective in priming dieting behavior among participants. Thus, this room set-up was used to strengthen the restriction manipulation beyond merely telling participants what to think.

Following manipulation to condition, participants again completed the ESG(Larsen et al., 2009) and amended Goal-Conflict Grid at the post-restraint manipulation time point before they were exposed to one of two cue types (non-food or food related) as a temptation manipulation. The experiment was presented as an investigation of sensory perception and taste ratings of everyday objects. Those receiving non-food cues were seated at a table with three different elementary school supplies (e.g., paper clips, erasers, tape). Participants were asked to write about a neutral perceptual experience for 7 minutes (i.e., what they might see, hear, or smell if they were to go back to visit their elementary school building) and rated the school supplies based on their perceptual qualities (i.e., the look and feel of the items). Participants receiving food-cues were exposed to three different palatable (Skittles, Oreo cookies, peanuts), which were presented in small dishes, and were instructed to spend 7 minutes writing their thoughts about these foods and rating their perceptual qualities (i.e., the look and smell of the foods) but *not* consuming them. Two additional items assessing current level of craving and resistance for each food were embedded in the perceptual rating form.

Following manipulation to temptation condition participants again completed the ESG (Larsen et al., 2009) and amended Goal-Conflict Grid at the post-temptation manipulation time point. After completing these questionnaires, the experimenter brought in a tray of food and informed participants they would be completing a taste perception task. Participants were instructed to try each of the foods and rate them on their perceptual qualities (e.g., the look and smell of the foods) and taste quality (e.g. "How much did you like the taste of this food?"), as well as rate their current levels of craving and resistance to each food. Participants were given 10 minutes to complete their ratings and were invited to help themselves to as much food as they liked to help them make their ratings. Participants were presented with large bowls of snack foods with food items varying on two factors: Taste (sweet or salty) and Fat Level (low or high). The four items rated were plain M&M chocolate candies (sweet, high fat), honey-flavored Teddy Grahams (sweet, low fat), plain potato chips (salty, high fat), and pretzels (salty, low fat). These items were chosen following Habhab and colleagues (2009) who standardized these four items to ensure they had similar crunchy, non-moist textures. Participants were given 200 calories worth of each food to standardize food administration. Each food was weighed after the taste task to measure the total amount of food consumed. Participants again completed the ESG (Larsen et al., 2009) and Goal-Conflict Grid at the post-taste test time point, with two additional items assessing current hunger and satiety. Participants finally completed a set of individual difference measures, including measures of eating (e.g. Revised Restraint Scale), and trait self-control (BSCS), before being debriefed and awarded credit (See Table 1 for study timeline).

Analytic Strategy

Prior to the primary data analyses, preliminary analyses were conducted to investigate changes in restrained eating scores (RRS) between the pre-screener and laboratory based study to

identify participants who no longer met inclusionary criteria (i.e., only participants with RRS scores of 15 or below were included). To ensure participants had paid adequate attention to the manipulation used in the current study, the content quiz was analyzed and frequencies of the total scores by condition were investigated to identify participants to be excluded. As greater resistance in the restriction condition compared to the intuitive eating condition was expected, in addition to greater craving in the temptation condition compared to the no temptation condition, 2 (restraint condition: restriction, intuitive eating) X 2 (temptation condition: temptation, no temptation) between subjects factorial ANOVAS were conducted and the interactive effects of restraint and temptation conditions on craving and resistance were analyzed as manipulation checks (i.e., craving was expected to be higher in the temptation compared to no temptation condition; resistance was expected to be higher in the restraint compared to intuitive eating condition).

Major hypotheses were investigated using 2 (restraint condition: restriction, intuitive eating) X 2 (temptation condition: temptation, no temptation) ANOVAs on overall food consumption, each food independently, as well as combinations of high fat and low fat foods, and sweet and salty foods. To analyze changes in affect and craving and resistance throughout the study, 4 (time: baseline, post-restraint manipulation, post-temptation manipulation, post taste-test) X 2 (restraint condition: restriction, intuitive eating) X 2 (temptation condition: temptation, no temptation) mixed models were conducted on positive affect, negative affect, craving, and resistance.

Additionally, craving and resistance scores to the food presented in the taste-test were calculated by averaging responses to each food type. Two 2 (restraint condition: restriction, intuitive eating) X 2 (temptation condition: temptation, no temptation) between subjects factorial

ANOVAs were conducted on self-reported resistance and craving. Finally, goal- scores were calculated post-temptation task and post-taste test to assess whether the restraint manipulation, in conjunction with being exposed to palatable food cues and tasting different foods, created goal-conflict. Following previous work (Shimmack, 2001), I used the MIN statistic to conservatively quantify the intensity of mixed feelings of craving and resistance. For ratings of craving and resistance, MIN assumes the value of the lower rating at which both factors are elevated. For example, if a participant reports feeling neither craving nor resistance, the MIN would indicate that the participant does not feel mixed feelings of craving and resistance and would therefore receive a value of 0. Even when a participant reports feeling extreme craving *without* resistance, MIN would indicate that this individual does not feel mixed feelings, as MIN assumes the value of the lower rating at which both factors are elevated. If a participant reports feeling craving at a 6-level of intensity and resistance at a 2-level of intensity, the MIN score would therefore be 2, which is the highest level at which both craving and resistance are elevated.

A hierarchical linear regression was computed to assess the causality of a restricted mindset on goal-conflict post-temptation manipulation and post-taste test. Regression analyses were *not* performed at baseline or post-restraint manipulation, as theory indicates that goal-conflict should not manifest without a situation (e.g., temptation) that contrasts with eating restriction.

Results

Differences in Revised Restraint Scale Scores

The intent of the current study was to obtain a clean sample of unrestrained eaters; thus, participants were recruited based on restrained eating status from the pre-screener and RRS scores were verified at the lab session to confirm eligibility. Revised Restraint Scale (RRS)

scores were missing from 3 of the 158 participants on the day of the study, resulting in the exclusion of those participants. A paired samples *t*-test on RRS scores at both time points revealed the difference in pre-screener and laboratory based restraint scores was statistically significant, $t(154)=-3.40$, $p < .01$. Specifically, restrained eating scores were higher ($M = 11.17$, $SD = 4.30$) the day of the lab study compared to the day of the pre-screener ($M = 9.97$, $SD = 3.63$). The day of the study, 27 participants identified as restrained eaters (scores greater than 15; $M_{age} = 19.47$ ($SD = 1.87$), 60.9% female, 72.7% White), and 128 identified as unrestrained eaters ($M_{age} = 19.44$ ($SD = 1.70$), 74.1% female, 81.5% White). Chi-square analyses revealed no significant differences in demographics across restrained and unrestrained eaters. The only significant difference among these groups was on the average restraint score at the lab session. The average RRS score for people classified as unrestrained eaters was 9.79 (SD = 3.27), whereas the average restraint score for people classified as restrained eaters was 17.70 ($SD = 1.92$). To assess whether there were differences in the proportion of restrained and unrestrained eaters based on restraint condition, a chi-square test of independence was performed to examine the relation between restrained eating status and restraint condition. The relation between these variables was not significant, $\chi 2\ (2, N = 155) = 2.05$, $p = .15$. Because this study sought to manipulate a restricted mindset in people classified as *unrestrained* eaters, all 27 of restrained eating participants were excluded from analyses, leaving a sample of 123 clean unrestrained eaters.

The final sample of participants was thus a total of $n = 123$, with 61 in the Intuitive Eating condition (temptation condition $n = 31$; no temptation $n = 30$) and 62 in the Restriction condition (temptation condition $n = 32$; no temptation $n = 30$). There were no significant differences in restrained eating scores based on temptation (temptation: $M = 9.65$, $SD = 3.31$; no

temptation: M = 10.03, SD = 3.24) or restraint (restriction: M = 9.58, SD = 3.38; intuitive eating: M = 10.10, SD = 3.16) conditions. Similarly, there were no significant differences on any of the demographic variables based on restraint or temptation conditions (See Table 2).

Manipulation Checks

Content quiz manipulation check

Of the people who completed the study, 25 people had scores of 4 or lower on the quiz assessing understanding and mastery of material presented on the article read in the restraint manipulation and were instructed to re-read the article before completing the quiz again. Of the 25 participants, 16 were in the restriction and 9 were in the intuitive eating condition. A chi-square test of independence was performed to examine the relation between people who failed the manipulation check quiz and restraint condition, and the relationship between these variables was not significant, χ^2 (2, N = 158) = 1.69, p = .37, suggesting that quiz failure did not occur due to significant differences in level of quiz difficulty across restraint conditions. Five participants (4 in the restriction condition, 1 in the intuitive eating condition) failed the quiz upon completing it the second time and were therefore excluded from analyses.

Eating strategy manipulation check

Analyses were conducted on the change in participant's self-reported strategy used to guide their eating behaviors to assess whether changes occurred as a function of manipulation to restraint condition. A 2 (time: baseline, post-taste test) X 2 (restraint condition: restriction, intuitive eating) X 2 (temptation condition: temptation, no temptation mixed model ANOVA was conducted on self-reported eating strategy (i.e., "Please rate the strategy you use to guide your eating behavior, with higher scores reflecting greater intuitive eating and lower scores reflecting greater cognitive control over eating behaviors") at baseline and post restraint manipulation. There was a main effect of time, F(1,119) = 9.92, p = .002, such that participants reported a

decrease in use of intuitive eating to guide their eating behaviors (M = 6.79, SD = 2.17) from baseline to post-restraint manipulation (M = 6.10, SD = 2.94). This main effect was qualified by a significant interaction between time and restraint condition, $F(1,119) = 92.68$, $p < .001$. Eating strategy scores changed such that participants in the intuitive eating condition increased in intuitive eating from baseline to post-restraint manipulation, $F(1,59) = 21.00$, $p < .001$. However, for those in the restriction condition, eating strategy scores decreased in intuitive eating (i.e., scores increased in restrictive eating) from baseline to post-restraint manipulation, $F(1,60) = 81.43$, $p < .001$ (See Figure 3). This result is notable, as it suggests the manipulation appeared to shift eating strategy goals for both the restriction and intuitive eating condition, as intended, in the directions anticipated. That is, there was an increase in desire to allow hunger to guide eating for people in the intuitive eating condition and a decrease in desire to allow hunger to guide eating behavior in favor of cognitively controlling food intake for those in the restriction condition.

Temptation manipulation check

Participants were asked to rate their desire to approach and avoid each object during the temptation task. Each participant rated 3 objects (e.g., food vs. school supplies, non-food), and I calculated average desire and average resistance scores across the 3 objects for each person. A 2 (restraint condition: restriction, intuitive eating) X 2 (temptation condition: temptation, no temptation) between subjects factorial ANOVA was conducted on average desires for the items rated during the temptation task. There was a significant main effect of temptation condition on average desires, $F(1,118) = 4.14$, $p = .04$. Those in the temptation condition (M = 5.55, SD = 2.00) reported greater desires for the items than those in the no temptation condition (M = 4.70, SD = 2.30). There were no significant main effects of restraint condition or interactions between

restraint and temptation conditions on average desires for the items. There was a marginally significant main effect of temptation condition on average desire to resist the rated items, $F(1,118) = 3.80$, $p = .05$. Those in the temptation condition ($M = 3.92$, $SD = 2.31$) reported a greater desire to resist the food items than those asked to rate school supplies ($M = 3.07$, $SD = 2.47$). There was no main effect of restraint condition on desire to resist or interaction between restraint and temptation conditions on desire to resist. This result is notable because it suggests that the temptation condition influenced desire and resistance goals, as intended, such that both desire *and* resistance goals were greater compared to the group which did not encounter temptation.

Average desire and resistance scores were created across the four foods participants rated (Teddy Grahams, pretzels, potato chips, M&M's) and a 2 (restraint condition: restriction, intuitive eating) X 2 (temptation condition: temptation, no temptation) between subjects factorial ANOVA was conducted on average desire and resistance scores to the food items during the taste task. There was a significant main effect of restraint condition on desires to resist the food, such that those in the restriction condition ($M = 4.14$, $SD = 1.92$) reported higher resistance than those in the intuitive eating condition ($M = 3.32$, $SD = 1.86$), $F(1,118) = 5.65$, $p = .02$. This result is worthy of notice, as it suggests the restraint manipulation influenced food resistance during the taste test as intended. No main effects of restraint or temptation condition or interaction between both conditions were significant for average desire scores.

Hunger and satisfaction manipulation check

A 2 (time: baseline, post-taste test) X 2 (restraint condition: restriction, intuitive eating) X 2 (temptation manipulation: temptation, no temptation) mixed model ANOVA was conducted on hunger and satisfaction scores. There was a main effect of time, such that hunger scores were

greater at the beginning of the study (M = 5.40, SD = 2.38) compared to post taste-test at the end (M = 4.15, SD = 2.06), $F(1,117) = 36.57$, $p < .001$. Similarly, there was a main effect of time on satisfaction scores, $F(1,115) = 29.05$, $p < .001$. Satisfaction scores increased from baseline (M = 5.22, SD = 2.27) to post taste-test (M = 6.44, SD = 2.09). There were no significant interactions between time and restraint or time and temptation conditions, nor were there significant 3-way interactions between time, restraint condition, and temptation condition on either hunger or satisfaction outcomes.

Central Analyses on Main Outcome Variables

Food consumption

Several 2 (restraint condition: restriction, intuitive eating) X 2 (temptation condition: temptation, no temptation) between subject factorial ANOVAs were conducted on food consumption variables. Food consumption variables were analyzed separately, and were also summed together to create total food, high fat, low fat, sweet, and salty combination outcomes. When considering total food consumed, there were no significant main effects of either condition or an interaction between independent variables. When considering each food separately, there were no significant main effects for either the restraint or temptation conditions on consumption of pretzels, M&M's or potato chips; however, those in the restriction condition (M = 12.10, SD = 11.48) consumed more teddy grahams than those in the intuitive eating condition (M = 8.26, SD = 7.95), $F(1,118) = 4.55$, $p = .03$. There were no significant main effects or interactions among conditions when considering high fat foods (chips & M&M's), low fat foods (Teddy Grahams & pretzels), salty (pretzels & chips) or sweet (M&M's & Teddy Grahams) as the outcomes (See Table 3 for food consumption totals, measured in grams).

A 2 (fat type: high fat, low fat) X 2 (restraint condition: restriction and intuitive Eating) X 2 (temptation manipulation: temptation, no temptation) mixed model was conducted on total food consumption. A marginally significant main effect of food type was found, $F(1,118) = 3.41$, $p = .07$, such that participants consumed more high fat ($M = 18.98$, $SD = 14.15$) food compared to low-fat ($M = 16.90$, $SD = 13.27$). A second 2 (taste type: sweet, salty) X 2 (restraint condition: restriction and intuitive Eating) X 2 temptation manipulation: temptation, no temptation) mixed model was conducted on total food consumption. A significant main effect of taste was found, $F(1,118) = 7.32$, $p = .008$, such that participants consumed more sweet foods ($M = 19.69$, $SD = 15.34$) compared to salty foods ($M = 16.20$, $SD = 12.59$). No interactions between temptation condition, restraint condition, fat or taste type were found on food consumptions, nor were other main effects significant.

State variables across time

Four 4 (time: baseline, post-restraint manipulation, post temptation manipulation, post taste-test) X 2 (restraint condition: restriction and intuitive Eating) X 2 (temptation manipulation: temptation, no temptation) mixed models were conducted on craving, resistance, positive affect and negative affect ratings. Where sphericity was violated, Greenhouse-Geiser corrections were used in reporting analyses. A significant 3-way interaction was found on resistance, $F(2.53, 301.79) = 3.11$, $p = .03$ (See Figure 4). To follow up this three-way interaction, follow-ups revealed the 2-way interaction between time and temptation condition on resistance was significant for the restriction condition, $F(2.64, 158.24) = 3.06$, $p = .04$, but was not significant for the intuitive eating condition, $F(2.41,142.03) = .61$, $p = .57$. In the restriction condition, those in the temptation condition reported a significant change in resistance over time. Specifically, repeated contrasts indicated that for those in the restriction and no-temptation

conditions, there was a significant decrease in resistance from post-restraint (*M* = 2.67, *SD* = 2.41) to post-temptation manipulation (*M* = 2.72, *SD* = 2.13), *F*(1,29) = 4.62, *p* = .04, and a significant increase in resistance between post-temptation and post-taste test (*M* = 3.16, *SD* = 2.10), *F*(1,29) = 6.51, *p* = .02. For those in the restriction and temptation conditions, the only significant change in resistance was an increase between baseline (*M* = 1.97, *SD* = 1.67) and post-restraint manipulation (*M* = 2.78, *SD* = 2.08), *F*(1,31) = 6.37, *p* = .02 (See Figure 4). This result suggests the temptation manipulation, *in addition to the restraint manipulation,* had an influence on resistance throughout the study, such that those who were led to cognitively control their food intake *and* were exposed to temptation had higher eating resistance post-taste test compared to baseline. This suggests that palatable food may have prompted eating regulation goals for those in the restriction condition.

When considering craving, there was a significant main effect of time on self-reported craving throughout the study, *F*(3,357) = 8.64, *p* < .001. Craving significantly decreased from post-temptation manipulation (*M* = 3.96, *SD* = 2.39) to post taste-test (*M* = 3.16, *SD* = 2.21), *F*(1,119) = 15.33, *p* < .001. There were no significant interactions between time and temptation condition, time and restraint condition, or a 3-way interaction between time, temptation condition, and restraint condition on self-reported craving.

In regards to positive affect, a significant main effect of time on positive affect was found, *F*(2.62,312.29) = 7.80, *p* < .001, such that positive affect increased over time. Specifically, positive affect increased from post-restraint manipulation (*M* = 5.81, *SD* = 1.55) compared to post-temptation manipulation (*M* = 5.98, *SD* = 1.51), *F*(1,119) = 5.02, *p* = .03, and from post-temptation manipulation to post-taste test (*M* = 6.20, *SD* = 1.51), *F*(1,119) = 4.72, *p* = .03. The main effect was qualified by a significant two-way interaction between time and

restraint condition on positive affect, $F(2.62, 312.29) = 2.26$, $p = .03$. Follow ups revealed that positive affect changed over time for people in the intuitive eating condition, $F(3,177)=10.99$, $p < .001$. Repeated contrasts revealed that for those in the intuitive eating condition, positive affect increased from post-temptation manipulation ($M = 5.69$, $SD = 1.67$) to post-taste test, $F(1,59) = 19.66$, $p < .001$. For those in the restriction condition, positive affect increased post-restraint manipulation ($M = 5.87$, $SD = 1.53$) compared to post-temptation manipulation ($M = 6.23$, $SD = 1.43$), $F(1,60) = 10.14$, $p = .002$.

In regards to negative affect, there were no significant main effects of temptation or restraint conditions, or interaction between temptation and restraint conditions, on negative affect.

Goal conflict

Goal-conflict was computed using the MIN approach (Shimmack, 2001) of co-occurring craving and resistance scores post-temptation task and post-taste test. There were no significant main effects or interactions among restraint and temptation conditions on goal-conflict post-temptation task. However, following the taste test there was a significant main effect of restraint condition, such that those in the restriction condition evidenced greater goal-conflict ($M = 2.03$, $SD = 1.72$) than those in the intuitive eating condition ($M = 1.34$, $SD = 1.61$), $F(1,119) = 5.20$, $p = .02$. Mixed affect was computed in the same way as goal-conflict (i.e., the MIN approach). There were no significant main effects or interactions among restraint and temptation conditions on mixed-affect post-temptation task. However, following the taste test there was a marginally significant main effect of restraint condition, such that those in the restriction condition evidenced greater mixed affect ($M = 1.87$, $SD = 2.07$) than those in the intuitive eating condition ($M = 1.25$, $SD = 1.63$), $F(1,119) = 3.39$, $p = .07$.

A hierarchical linear regression was conducted to assess the causality of a restrictive mindset towards eating on end of study (i.e., post-taste test) goal-conflict after controlling for gender and RRS restrained eating scores. A significant regression equation was found, $F(3,119) = 6.71$, $p < .001$, with an R^2 of .15. Specifically, with gender and restrained eating scores in the model, the restriction condition predicted higher levels of goal-conflict, $t(119) = 2.58$, , $p = .01$, $B = .74$. Restrained eating scores, defined via the RRS, were not significant predictors of goal-conflict in either step of the hierarchical model.

Conclusion

The aim of the current study was to glean a clearer and more in depth understanding of the cognitive pathways thought to underlie the regulation of eating behavior. In lieu of investigating restrained eating as an individual difference factor, the present work extended previous research (Herman & Polivy, 1980) that implies the regulation of eating behavior is controlled via cognitive mechanisms by empirically testing it in a laboratory setting. Thus, this study was designed with the intention of modeling the theoretical cognitive mechanisms of restraint in unrestrained eaters to investigate restricted cognitive focus as a causal mechanism of disinhibited eating and other non-eating outcomes thought to be associated with restrained eating, such as goal-conflict.

The study tested a series of predictions regarding food consumption. First, I predicted that individuals guided to think restrictively about food would evidence greater disinhibited eating after being exposed to food temptations compared to neutral temptations, whereas individuals guided to think intuitively about food should not consume different amounts of food as a function of temptation exposure. This prediction was not supported, and in fact the only food consumption variable that significantly differed based on condition was teddy grahams, whereby

individuals in the restriction condition exhibited greater disinhibited eating than those in the intuitive eating condition. As noted, results from both the pilot and experimental studies both indicated the restriction manipulation was effective in changing participant's self-reported strategy used to guide their eating behaviors. This was true for multiple measures of resistance (e.g., state assessment of resistance; eating strategy questionnaire), which suggests participant's momentary cognitive restraint was strongly influenced by the manipulation. Thus, it could be that a restricted mindset was stronger than the immediate temptation and therefore food consumption did not increase when individuals were exposed to temptation. That is, the temptation may not have been salient or strong enough to conflict with the restrictive mindset that was created and lead to disinhibited eating as a result.

Importantly, literature typically uses individual difference measures to capture restraint, which consider it as a trait-level construct rather than a momentary process. Previous research has long suggested that people with restrained eating behaviors are highly susceptible to overeating when faced with temptation (Herman & Polivy, 1980), and it is likely that this pattern of behavior develops over time. Though it may require individuals who restrict their caloric intake (i.e., dieters) extensive effort to do so initially (van Koningsbruggen, Stroebe, & Aarts, 2013), research indicates this process becomes more habitual over time (Rideout & Barr, 2009). Given that habitual behavior is more prone to error-processing (Baumeister et al., 2000) and self-regulation failure (Wood & Neal, 2007), it could be that habitual restraint is more susceptible to self-regulation failure than less engrained and more effortful cognitive restraint. As such, exposing participants to a brief manipulation of restraint and temptation may not have been effective in altering immediate eating behavior; however, future work may wish to examine longer-term effects (e.g., eating behavior over the days following the laboratory study) which

might more accurately represent the pathway through which restrained eating culminates in disinhibited eating. Further, I purposefully recruited healthy, unrestrained eaters via the Revised Restraint Scale (Herman & Polivy, 1980), though there are a set of alternative scales (e.g., Three-Factor Eating Questionnaire; Stunkard, 1981) that similarly measure restrained eating. Interestingly, studies comparing the psychometric properties of these measures (e.g., Allison, Kalinsky, & Gorman, 1992) suggest that each measure taps into a variant of the same construct, and that alternative measures of restraint, such as the Eating Inventory, represents a more valid measure of the intent to cognitively manage food intake (Williamson et al., 2007). As such, while the intent was to recruit healthy, unrestrained eaters it is possible that the RRS may not have been the best measure to use for this purpose. In addition, previous research has long suggested that people with restrained eating behaviors are highly susceptible to overeating when faced with temptation (Herman & Polivy, 1980), and it is likely that this pattern of behavior develops over time. Exposing participants to a brief manipulation of restraint and temptation may not have been effective in altering immediate eating behavior; however, future work may wish to examine longer-term effects (e.g., eating behavior over the days following the laboratory study) which might more accurately represent the pathway through which restrained eating culminates in disinhibited eating.

Second, I predicted that those guided to think restrictively about food would report lower levels of positive and greater levels of negative affect compared to those guided to think intuitively about food, with the assumption that thinking in a restrictive way about food would be largely unpleasant. In line with this assumption, I predicted that negative mood would increase and positive mood would decrease over time for those guided to think restrictively about food, whereas negative mood should remain constant or decrease and positive affect should increase

for those guided to think intuitively about food. I also predicted positive affect would be higher following exposure to food temptation for those guided to think intuitively about food compared to those guided to think restrictively about food, which would suggest the interactive effect of temptation and a restricted mindset is negative in valence and therefore more likely to result in maladaptive downstream eating behaviors. This prediction was not directly supported (i.e., there were no significant interaction effects between restraint and temptation on positive affect or negative affect). It is worth noting that those in the intuitive eating condition reported greater levels of positive affect at each time point compared to baseline throughout the study, which suggests individuals felt more pleasant after reading about the benefits of intuitive eating, rating products (irrespective of temptation status), and completing a taste test. However, this relationship was not significant for those in the restriction condition. It could be that being asked to think in a particular way about food that differs from the "norm" for that individual counteracts the normative increases in positive mood individuals experience when trying tasty foods, which could have downstream implications on eating behavior. Alternatively, it could be that the specific restrictive nature of these thoughts is unpleasant and leads to such affective outcomes. Though past work has found an association between restrained eating and negative affect (McFarlane, Polivy, & Herman, 1998; Papies, Stroebe, & Aarts, 2009), no work has tested the causal mechanisms of a restrained mindset on negative (or positive) affect. In fact, the results of the current study indicated that a restrained mindset predicted marginally significant greater mixed affect, suggesting a possible explanation as to why separate levels of positive and negative affect did not alter as a function of restraint condition. Thus, this evidence provides preliminary evidence that a restricted mindset may have differential effects on affective

outcomes than an unrestrained mindset, and further work investigating these phenomena is clearly warranted.

Third, I predicted that levels of craving and resistance would be higher among those guided to think restrictively about food compared to those guided to think intuitively about food during exposure to food temptations, with the assumption being that attempting to restrict eating behavior may backfire and result in *higher* craving, despite the heightened attempted resistance, when in the face of palatable food. However, after being exposed to neutral objects, I anticipated only resistance would be significantly higher for those guided to think restrictively about food compared to those guided to think intuitively about food, as the palatable food temptation would not be present to interact with a restrictive mindset. Findings indicated resistance was greater for those in the restriction condition when exposed to food temptation compared to those in the intuitive eating condition, which was expected; however, there were no significant differences in self-reported resistance based on temptation condition for those guided to think restrictively about food. Similarly, there were no significant differences in craving based on restraint condition. As previously stated, it could be that the trajectory through which restricted cognitive focus contributes to disinhibited eating is developed over a longer period of time than was allowed in the 90 minute laboratory session. In fact, the time length between the restraint manipulation, temptation manipulation, and taste test was less than 30 minutes in total, and the temptation task only lasted for 7 minutes. It is unrealistic to believe the longstanding and deep-rooted restrained mindset that theoretically occurs in restrained eaters can be modeled in this amount of time. While restrained eaters do, at times, overeat when faced with temptation, they are often able to successfully restrict their eating behaviors (Ouwehand & Papies, 2010). Similar to dieters who embark on their dieting journey with the best of intentions and experience initial

success, individuals in the current study may not have experienced the downstream effects of restricted cognitive focus (e.g., disinhibited eating when exposed to temptation) due to the novelty of this mindset and their subsequent initial heightened motivation to restrict food intake, which may help explain why temptation did not influence resistance or craving for people guided to think restrictively about food intake. In line with this reasoning, our results suggest that post-taste test craving was significantly higher for those in the restriction condition; thus, lengthening the study and/or adding additional temptation exposures and assessments may result in interactive effects on eating behavior based on temptation and restraint conditions.

The results of the current study did indicate that after controlling for gender and RRS restrained eating scores, a restrained mindset toward food and eating predicted greater levels of goal-conflict following the taste test, while restrained eating scores on their own did *not* predict goal-conflict. This finding is particularly important, as it further supports the prediction that there may be differential effects of restricted cognitive focus toward eating and restrained eating as an individual difference factor. While the goal-conflict model of eating (Stroebe et al., 2013) posits that eating behavior of individuals attempting to control their food intake is controlled by two conflicting goals that are cognitive in nature (i.e., the goal of eating for pleasure vs. the goal of controlling one's weight), this phenomenon has strictly been examined in restrained and unrestrained eaters. This is problematic, as considering restraint to be a grouping implies individuals either possess restraint-like tendencies or they do not and does not allow for the examination of restrained eating on a spectrum, varying in degree of severity. Extant research has indicated that restrained individuals do experience cognitive processing deficits when faced with tempting food (Green at al., 1994; Mann & Ward, 2004) but whether such deficits manifest as a function of restrained eaters as a trait group, or whether it is cognitive restraint that

influences the behaviors often exhibited by restrained eaters, has yet to be tested. The results of the present study provide preliminary evidence that: (1) restrained eating may reflect momentary cognitive processing, rather than a general and stylistic approach toward eating, and (2) that cognitive restraint may be a better predictor of goal-conflict compared to restrained eating as a taxonomy. Future work examining the mediational effects of goal-conflict in the relationship between cognitive restraint and both eating and non-eating outcomes is clearly warranted.

Several limitations to the present work are noteworthy. As mentioned, the timeframe through which the study was conducted may have been too short for the manipulations to work as intended. Results from both the pilot and laboratory based studies indeed suggest I was able to manipulate restraint among healthy, unrestrained eating individuals; however, the theoretical goal-conflict experienced as an effect of restricted cognitive focus (i.e., co-occurring craving and resistance) may unfold over a longer period of time. Future work may wish to incorporate ambulatory assessment methodology, which allows for an examination of individuals in their daily lives, to assess the downstream effects of cognitive restriction. Additionally, while the temptation task did result in increased craving overall, individual difference factors (e.g., liking of the food items) may have influenced the manipulation. I did not ask participants how tempting they found the food they were exposed to, and I therefore could not exclude people who did not experience the situation as a temptation. Future research may seek to create temptation situations that are personally relevant to each individual to ensure true temptation is experienced. A particularly important limitation worth noting is the significant shift in restrained eating scores from the pre-screening measures to the laboratory study, which suggests I may not have obtained a true sample of unrestrained eaters who are consistent in their non-restrictive eating behaviors. Future work could use a lower cut-off score on the Revised Restraint Scale

(e.g., 12 or below, compared to the score of 15 used in the present study) to increase the likelihood that a clean sample of unrestrained eaters is chosen. An additional limitation includes the food items chosen for the taste-test. The chosen foods met my aim to use low-fat, high-fat, sweet, and salty foods in the taste-test to increase the likelihood participants would be exposed to at least one type they enjoyed; however, there are hundreds of foods that meet those criteria and could have been viewed as more (or less) favorable than the foods chosen for the study. Furthermore, it should be noted that the generalizability and interpretability of the current study were limited in that the ethnic majority of the sample was White and individuals were predominantly female college seeking, emerging adults. Future work recruiting a community sample that is not course-credit seeking, college-aged would increase the generalizability and strengthen the conclusions presented here.

To my knowledge, this is the only known study to date to manipulate restricted cognitive focus and examine its causal effects on disinhibited eating behavior. Extant research overwhelmingly investigates restrained eating through individual difference factors and it is unclear whether engaging in effortful cognition to control dietary restraint behavior actually causes disinhibited eating behavior. Though the results of the present study suggest cognitive restraint may not influence immediate eating behavior, work investigating the real-world applicability and contextual influences may help in our understanding of how cognitive restraint influences eating patterns over time. Overall, understanding how restraint operates on a cognitive level is critical to developing targeted interventions and preventing maladaptive behavioral outcomes. Future work assessing other forms of self-regulation failure outside the context of eating behavior may be crucial in disentangling the cognitive restraint processes that underlie regulation and goal-directed behavior.

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Appendix A

Pilot Study Figures

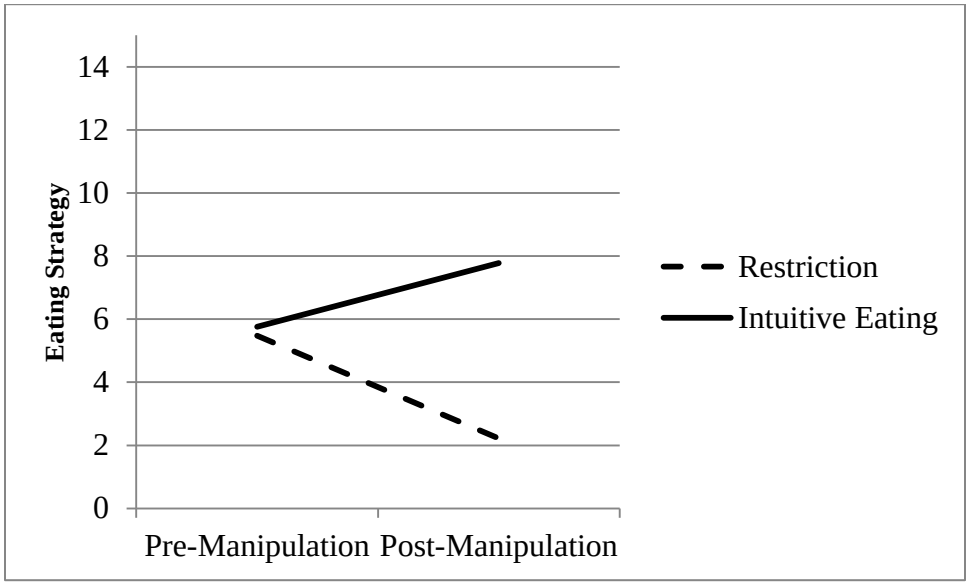

Figure 1. *Pilot-study eating strategy change as a function of restraint manipulation*

***Higher scores reflect greater intuitive eating; lower scores represent stronger reporting of mentally planning/managing food intake*

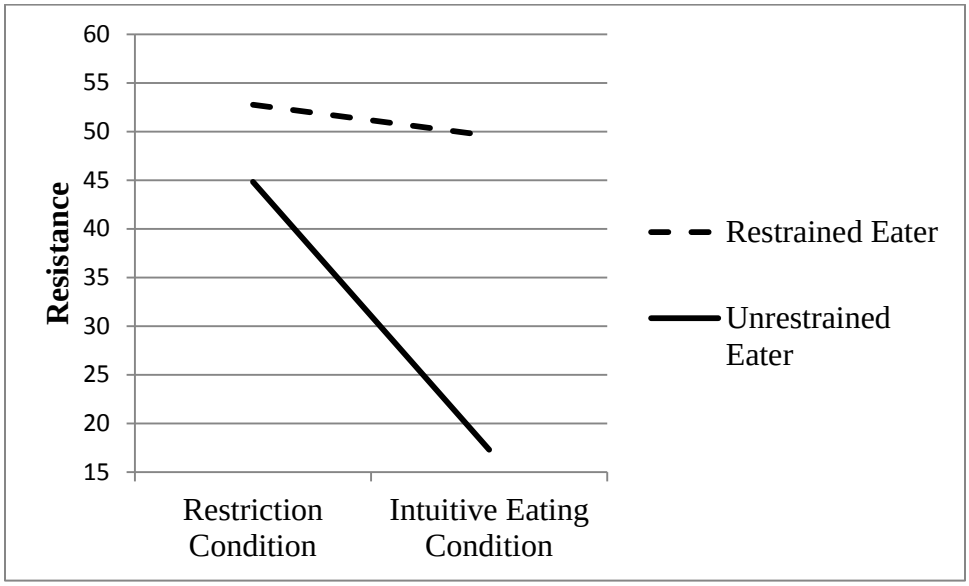

Figure 2. *Pilot-study state-level resistance based on restrained eating status and restraint condition*

Appendix B

Experimental Study Tables and Figures

Table 1. *Timeline of experimental procedures*

Time	Event	Measures
0-5	Participant arrives, signs consent form	
5-10	Initial taste-rating	ESG, GCG, Baseline hunger and satiety
10-20	Restraint manipulation	Content quiz, article reflection free-write, ESG and GCG directly after
20-30	Temptation manipulation	Product rating forms, thoughts about products form, ESG and GCG
30-40	Taste-test	Taste rating forms, ESG and GCG
40-60	Online questionnaire(s)	Individual difference measures assessing restrained eating, self-control, and personality
60-65	Debriefing	

GCG = Goal-Conflict Grid
ESG = Evaluative Space Grid

Table 2. *A comparison of demographic variables across temptation and restraint conditions*

		Temptation (*n* = 31)	**No Temptation (*n* = 30)**
Intuitive Eating (*n* = 61)	Gender	51.6% Female	70.0% Female
	Age	19.23 (1.09)	19.50 (1.76)
	Ethnicity	83.9% White	63.3% White
	Total RRS	9.61 (*SD* = 3.24)	10.60 (*SD* = 3.05)
		Temptation (*n* = 32)	**No Temptation (*n* = 30)**
Restriction (*n* = 62)	Gender	59.4% Female	66.7% Female
	Age	19.65 (2.81)	19.43 (1.52)
	Ethnicity	62.5% White	83.3% White
	Total RRS	9.69 (*SD* = 3.42)	9.47 (*SD* = 3.38)

Table 3. *Food consumption totals (in grams) based on restraint and temptation conditions*

		Restriction Condition		Intuitive Eating Condition	
		Temptation	No temptation	Temptation	No temptation
Food Items	Teddy Grahams	12.19 (12.73)	12.00 (10.20)	7.48 (8.67)	9.07 (7.17)
	Chips	10.22 (10.46)	10.33 (10.01)	7.65 (6.31)	10.00 (9.19)
	Pretzels	7.06 (6.12)	6.60 (7.68)	8.10 (7.17)	5.50 (6.01)
	M&Ms	8.97 (9.28)	8.97 (10.39)	10.71 (8.83)	8.93 (7.33)
	Total Consumption	38.44 (27.09)	37.90 (30.06)	33.94 (21.34)	33.52 (19.17)

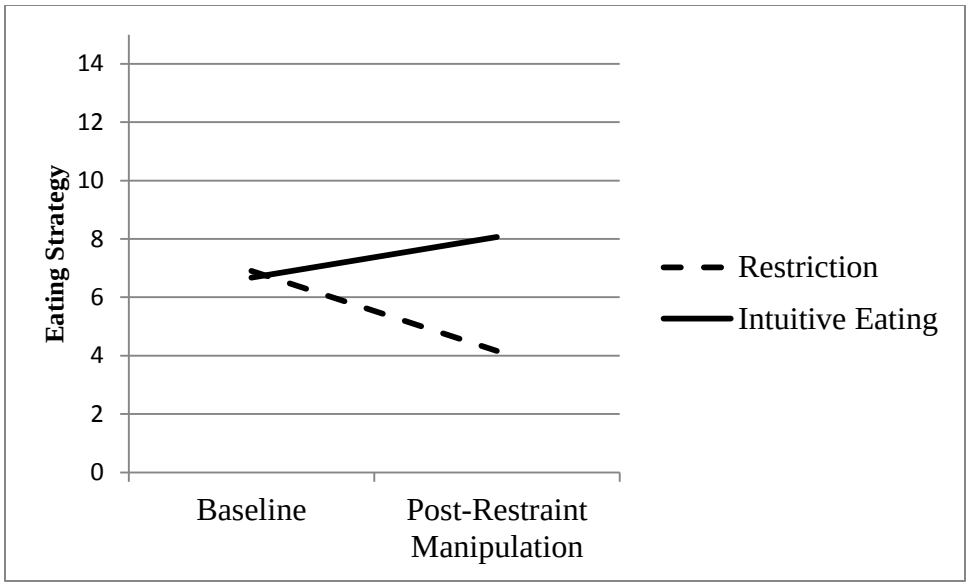

Figure 3. *Eating strategy scores based on restraint condition*

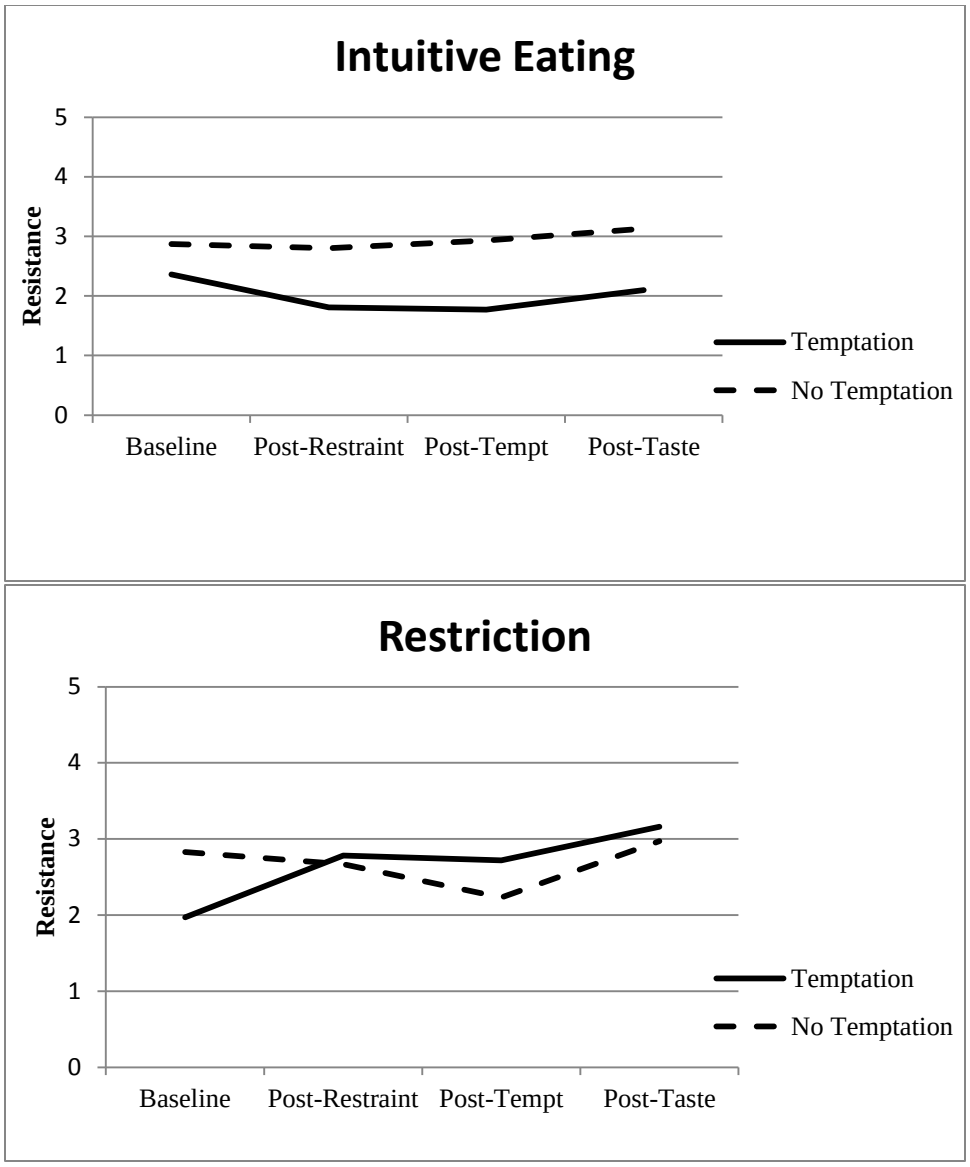

Figure 4. *Resistance scores over time for as a function of restraint and temptation conditions*

UNIVERSITY OF ARKANSAS

Office of Research Compliance
Institutional Review Board

February 13, 2015

MEMORANDUM

TO:	Kayla Skinner Desmond Webb Hanna Sprute Jennifer Veilleux
FROM:	Ro Windwalker IRB Coordinator
RE:	New Protocol Approval
IRB Protocol #:	15-02-477
Protocol Title:	*Mechanisms Underlying Eating Behavior: The Study of Goal-Conflict*
Review Type:	☐ EXEMPT ☐ EXPEDITED ☒ FULL IRB
Approved Project Period:	Start Date: 02/13/2015 Expiration Date: 02/12/2016

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 (https://vpred.uark.edu/units/rscp/index.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 400 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.

The IRB determined and documented that the risk is no greater than minimal and this protocol may be reviewed under expedited review procedure for future continuing reviews.

If you have questions or need any assistance from the IRB, please contact me at 109 MLKG Building, 5-2208, or irb@uark.edu.

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