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# Effects of a Brief Relaxation Intervention on Stress-Related Eating

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# Effects of a Brief Relaxation Intervention on Stress-Related Eating

by

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**ABSTRACT**

The experience of stress may contribute to increased food consumption and selection of unhealthy food options. Resource depletion theory suggests stress temporarily depletes resources needed to regulate behavior. Depletions of self-control may result in subsequent failure to regulate eating behaviors, which is particularly salient in restrained eaters. Restraint theory posits people high in dietary restraint require significant effort to control eating. Emotional eating theory further suggests palatable foods may be used to regulate emotional stress reactions. Relaxation exercises to mitigate stress reactions are recommended in eating and weight management programs, but lack quality scientific support. The current study examined the efficacy of a brief relaxation intervention on stress-related eating in a sample of at-risk women. Self-regulatory resources and affect were tested as mechanisms of action. A sample of 139 women high in dietary restraint completed a stress-task and were subsequently randomized to a relaxation intervention or control group. Participants were presented with foods varied on taste and fat content. Affect, subjective relaxation, and self-regulatory resources were measured at baseline, pre-, and post-intervention. Participation in a relaxation intervention resulted in significantly less food consumption ($p < .05$), with a trend toward lower consumption of sweet food ($p = .05$), compared to controls. Multiple mediator models examining proposed indirect effects of group on eating outcomes were not supported, with the exception of change in subjective relaxation as a significant indirect effect for high-fat food consumption. This study is the first to provide experimental evidence of the efficacy of relaxation in mitigating the effects of stress on eating. Limitations, implications, and future research directions are discussed.

## CHAPTER ONE:

## INTRODUCTION

Stress and eating behaviors are important controllable health-relevant factors that can affect quality and longevity of life. Stress may have a significant negative impact on overall health through direct and indirect pathways. It may directly affect health through changes in physiological functioning, and indirectly by impacting behaviors that influence health status. A great deal of evidence indicates that eating behaviors are amongst the health relevant behaviors that may be affected by stress (Adler & Ostrove, 1999; Ng, 2003; Wiebe & McCallum, 1986)

Unhealthy eating behavior is related to a variety of major health problems including eating disorders, obesity, cardiovascular disease (CVD), diabetes, and cancer. Unhealthy eating behavior, including binge eating, is a central feature of eating disorders including bulimia nervosa and binge-eating disorder (American Psychiatric Association, 2000). Binge eating may also be characteristic of a large percentage of the obese population and contribute to the obesity current epidemic (Yanovski, 1993, 2003). Greater than 35% of all U.S. adults 20 years old and above are obese (BMI $\geq$ 30), and more than 69% of adults are either overweight or obese ((BMI $\geq$ 25; Flegal, 2012). Obesity is linked to increased risk of a myriad of health conditions including heart disease, stroke, certain cancers, and type 2 diabetes (National Institutes of Health: National Heart, 1998). Unhealthy eating is a known contributor to the development of these conditions and may increase related mortality (Divisi, Di Tommaso, Salvemini, Garramone, & Crisci, 2006; Go et al., 2013; Li, Qi, Workalemahu, Hu, & Qi, 2012; World Health Organization, 2003). Modification of unhealthy dietary habits is not only a common recommendation for reduction of risk for these chronic diseases and health conditions; dietary changes are often central to their treatment and management. Consequently, people with these diagnoses must work to meet certain standards of eating to help manage their medical conditions (American Diabetes Association, 2012; Grundy et al., 2005; Lichtenstein et al., 2006).

**Stress and Eating Behavior**

Correlational studies clearly show a connection between the experience of stress and reported changes in eating behavior. Surveys show that people tend to experience an increased appetite and drive to eat when under stress, along with greater disinhibition and increases in binge eating (Groesz et al., 2012; Kandiah, Yake, Jones, & Meyer, 2006). Perceived stress is also related to an increase in consumption of sweet and highly palatable non-nutritive foods that are normally avoided for weight-control or health purposes, along with a decrease in the consumption of nutritious foods such as vegetables and whole grains (Arnow, Kenardy, & Agras, 1995; van Strien, Frijters, Bergers, & Defares, 1986; Wallis & Hetherington, 2009; Zellner et al., 2006). Longitudinal studies show similar findings, including a study that showed an association between highly-stressful work periods and increases in fat, sugar, and caloric intake (Wardle, Steptoe, Oliver, & Lipsey, 2000). Another study showed a positive association between increased cortisol secretion experienced during periods of chronic stress and weight, total food consumption, and intake of sweet and high-fat food over a 4-month period (Roberts, 2008).

Experimental studies improve upon correlational studies by providing evidence that stress can directly cause changes in eating behaviors. Experiments on stress and eating typically incorporate a laboratory-based stress-induction task followed by the presentation of a variety of foods, with measurement of amount and type of food consumed. These studies have demonstrated that stress can increase food consumption (Habhab, Sheldon, & Loeb, 2009;

Lemmens, Rutters, Born, & Westerterp-Plantenga, 2011; Roemmich, Lambiase, Lobarinas, & Balantekin, 2011; Royal & Kurtz, 2010) and also alter the types of food eaten, with a propensity towards choosing more sweet and fatty foods that are calorie dense and low-nutritive (Habhab, et al., 2009; Oliver, Wardle, & Gibson, 2000; Zellner, et al., 2006). Experimental research using non-human animals (rats) also shows that acute stressors contribute to increased consumption when highly palatable foods are present or changes in food preferences, with an increase in sweet food and sweet fluid consumption after stress exposure (Ely et al., 1997; Rowland & Antelman, 1976; Silveira, 2000; Wallach, Dawber, McMahon, & Rogers, 1977).

**Psychological Mechanisms of the Stress-Eating Relationship**

Psychological mechanisms that have been proposed to account for stress-induced changes in eating include depletion of self-regulatory resources and affect regulation. Resource depletion theory suggests that we have limited resources for self-control, which is required when a person actively attempts to change behavior or thinking, or inhibit competing urges (Baumeister, Bratslavsky, Muraven, & Tice, 1998; M. Muraven, Tice, & Baumeister, 1998). It is theorized that when these self-regulatory resources are depleted, self-control breaks down and efforts to control subsequent behavior fail. Exposure to stress can contribute to decrements in self-control, as adjusting to stressful situations consumes self-regulatory resources. These depletions are not permanent, as resources may be fully replenished and possibly strengthened over time with adequate rest periods (Muraven & Baumeister, 2000). Empirical support for this model is often demonstrated in studies that include two successive tasks, the first of which taxes self-regulatory resources in some manner, followed by poorer participant self-regulation in the second task. Numerous experimental studies, including studies of eating behavior, support the self-regulatory resource depletion model by demonstrating that exposure to stress and emotional distress disrupt self-control (e.g., T.F. Heatherton & Baumeister, 1991; T. F. Heatherton, Herman, & Polivy, 1991; Mark Muraven, Collins, & Nienhaus, 2002; M. Muraven, et al., 1998).

Emotional eating theory posits that stress-related eating may serve to regulate affective reactions to stress by both increasing positive affect and reducing negative affect (Wiser & Telch, 1999). When stressful situations and associated affective changes occur, eating may increase positive affect as the consumption of palatable foods provides automatic positive reinforcement (Macht, Haupt, & Ellgring, 2005; Macht & Mueller, 2007). Eating may also reduce negative affect, in part by providing a distraction from negative emotions (T.F. Heatherton & Baumeister, 1991; C. P. Herman & Polivy, 1988; Macht, 2008; Macht, et al., 2005; Macht & Mueller, 2007; Spitzer & Rodin, 1983). Experimental research supports the theory that consumption of sweets, highly palatable foods, and carbohydrate-rich foods can improve negative moods states. In one experiment, eating a highly palatable chocolate produced immediate improvements in negative mood in normal healthy adults, an effect not seen with water or unpalatable (bitter) chocolate was consumed (Macht & Mueller, 2007). Similar findings have been demonstrated in a variety of populations including people with seasonal affective disorder (Rosenthal et al., 1989), in obese people who prefer carbohydrate snack foods (Lieberman, Wurtman, & Chew, 1986), and even in newborns (Smith, Fillion, & Blass, 1990).

**Stress-Management Interventions for Eating and Weight**

The link between stress and eating has promoted wide use of stress reduction interventions as part of programs designed to improve eating behavior. Meta-analytic studies confirm that stress management programs are effective in improving general health, overall quality of life, and psychological, physiological, and immunological functioning in a variety of populations (e.g., Grossman, Niemann, Schmidt, & Walach, 2004; Kraag, Zeegers, Kok, Hosman, & Abu-Saad, 2006; Richardson & Rothstein, 2008; Shapiro & Schwartz, 2000). Stress management techniques are designed to help people learn to adaptively respond to stressors through the development of appropriate coping skills, typically categorized as either "problem focused" or "emotion-focused" (Lazarus & Folkman, 1984). The former refers to coping by directly making changes to the stressor, and the latter refers to coping through the regulation of emotional reactions to the stressor. The specific techniques to develop these stress reduction skills are varied and may include mindfulness, cognitive coping, problem solving, or relaxation exercises (Gramling & Auerbach, 1998; Kristeller & Hallett, 1999). Relaxation exercises, which will be utilized in this study, are designed to help people regulate the physiological and emotional responses to stressful events. Diaphragmatic breathing, visualization, and progressive muscle relaxation are commonly used relaxation techniques and are considered to be the most fundamental of coping strategies used to better manage stress (Gramling & Auerbach, 1998).

Relaxation may provide an important adaptive alternative to eating for people who eat to cope with stress or anticipate great difficulty dealing with stressful situations (Drapkin, Wing, & Shiffman, 1995; Macht, 2008). Relaxation exercises can be easily taught in a clinical or laboratory setting and can diminish the negative psychological and physiological effects of stress (Goldrosen & Straus, 2004; van Dixhoorn & Duivenvoorden, 1999), even after a single session (e.g., Emery, France, Harris, Norman, & Vanarsdalen, 2008; Pawlow, 2002; Rausch, Gramling, & Auerbach, 2006; Sherlin, Gevirtz, Wyckoff, & Muench, 2009; Vancampfort et al., 2013; Vancampfort et al., 2011). Experiments show that a single abbreviated 20-minute relaxation training session produce greater improvements in heart-rate, cortisol, state anxiety, and perceived stress compared to sitting quietly (Pawlow, 2002). Another experiment showed similar findings with single session relaxation contributing to greater improvements in cognitive, somatic, and general state anxiety, as well as quicker recovery after exposure to a stressor than in closed-eyes controls (Rausch, et al., 2006). That relaxation-based stress management techniques can be quickly learned and may produce immediate benefits is promising for use in stress-related eating.

Despite evidence linking stress and eating, and evidence of the immediate benefits of relaxation training, relatively few studies have investigated the impact of stress-management alone on eating or weight. Stress management techniques have been incorporated into popular mainstream weight management and eating programs (e.g., Beck, 2007; Brownell, 2004), yet their effectiveness as an intervention to modify eating or weight has not been empirically established. Because many studies incorporate stress reduction as one component of a multifaceted approach to eating and weight regulation (Kristeller & Hallett, 1999; Manzoni et al., 2008; Manzoni et al., 2009), it is unclear whether stress reduction is affecting outcomes. Other studies examining stress reduction alone have incorporated multiple forms of stress reduction, including physical-activity based relaxation such as yoga or meditative walking (Dalen et al., 2010; Daubenmier et al., 2011). Although these studies provide some evidence of the utility of stress management for weight and eating interventions, it is unknown if intervention effects were due specifically to stress management or other treatment components, such as social support or physical exercise, that may confer additional benefits for eating and weight.

Two studies have investigated the effect of relaxation training alone on eating or weight. Both studies had methodological flaws and examined unique populations, making it difficult to generalize results or draw strong conclusions. One study of intensive relaxation training resulted in significant reductions in weight, stress, and anxiety levels after a 12-week intervention for obese black women, but the study had major methodological issues including a nonrandomized design and lack of control group (Banks, 1981). Another study (Pawlow, O'Neil, & Malcolm, 2003) utilized an experimental design to examine the role of a relaxation intervention in improving mood and eating patterns in people with night eating syndrome (NES), which is related to stress and difficulties losing weight. NES is a disorder characterized by dysregulated hunger and eating patterns, resulting in persistent morning anorexia and consuming greater than 50% of daily calories in the evening (Gluck, Geliebter, & Satov, 2001; Stunkard, Grace, & Wolff, 1955). The initial experimental intervention consisted of a brief progressive muscle relaxation (PMR) exercise and was compared to a control condition in which participants sat quietly for the same amount of time (Pawlow, et al., 2003). Participants in the experimental group were also asked to practice the PMR nightly at home until follow-up. Relaxation in the lab resulted in immediate improvements in mood and cortisol levels, which were not observed in the control group. At one-week follow-up, weight loss and normalized patterns of hunger (i.e., increased morning and decreased night time hunger levels) and eating were observed in the relaxation participants, but not in the control group. However, control participants did not receive any placebo equivalent for the at-home relaxation practice in the experimental group. Group differences cannot confidently be attributed to relaxation alone, as other uncontrolled factors from the nightly relaxation ritual may have contributed to the observed effects, such as a change in evening activity, engaging in an incompatible behavior, placebo effects, or simple distraction. However, the results are promising and provide evidence that the use of relaxation in the regulation of eating may be a helpful intervention strategy.

**Risk Factors**

The impact of stress on eating behaviors does not appear to be uniform, as certain characteristics put people at greater risk for stress-induced eating. The individual differences model for stress-induced eating posits that stress does not universally increase eating, but, rather, individual differences in vulnerability to eating in response to stress exist (Greeno & Wing, 1994). Research suggests that certain characteristics such as being overweight (Lemmens, et al., 2011), female (Grunberg & Straub, 1992; Oliver, et al., 2000; Zellner, et al., 2006; Zellner, Saito, & Gonzalez, 2007), an emotional eater (Oliver, et al., 2000), and high in dietary restraint (Roemmich, Wright, & Epstein, 2002; Royal & Kurtz, 2010; Wardle, et al., 2000), are among these vulnerabilities that may moderate the effect of stress on eating behavior.

Several studies have shown gender differences in the stress-eating paradigm, with stress induced changes in eating behavior occurring more often in women than in men. One experiment showed that women subjected to a stress task consumed significantly more unhealthy, calorie-dense sweet food and less healthy sweet food than their no-stress controls (Zellner, et al., 2006), but the opposite results were observed male participants exposed to the same experimental conditions (Zellner, et al., 2007). These results are similar to an earlier study that showed that stress results in decreased consumption in men, but increased consumption in women (Grunberg & Straub, 1992) suggesting that the effects of stress on eating behavior may be gender specific. Some researchers have postulated that gender differences in stress-induced eating could be due to differences in dietary restraint (Zellner, et al., 2007), which tends to be higher among women than men (Wardle, 1987; Zellner, et al., 2006; Zellner, et al., 2007).

Research suggests that people high in dietary restraint may be at higher risk for stress induced changes in eating behaviors (Greeno & Wing, 1994) (Greeno & Wing, 1994). Several studies provide evidence of the moderating role of dietary restraint in the relationship between stress and eating (Lattimore & Caswell, 2004; Roemmich, et al., 2002; Wardle, et al., 2000). For example, in a longitudinal study showing an association between increased work-related stress and fat, sugar, and calorie consumption, dietary restraint moderated the effect. Restrained eaters had a hyperphagic response to increased work stress, whereas stress did not affect eating behavior in unrestrained eaters (Wardle, et al., 2000). Similarly, in an experiment on the effect of stress tasks on food intake, participants high in dietary restraint consumed significantly more food than unrestrained eaters when presented with a cognitively taxing stress task (Lattimore & Caswell, 2004). However, after a control task requiring participants to sit quietly while using relaxation imagery restrained eaters consumed significantly less than unrestrained eaters. Stress induced eating has even been demonstrated in children with high dietary restraint levels (Roemmich, et al., 2002). When children were exposed to an interpersonal stress-task, those high in dietary restraint ate significantly more snack foods than when they were not stressed, with the opposite findings occurred in children low in dietary restraint.

Restraint theory offers a potentially useful conceptual framework for understanding the relevance of the effect of stress on eating among people high in dietary restraint. Restrained eating refers to a self-initiated effort to restrict intake of food for the purpose of controlling weight (de Lauzon-Guillain et al., 2006; Greeno & Wing, 1994; Lowe & Kral, 2006). Restraint theory posits that eating patterns are balanced between physiological needs for food and cognitive efforts to resist the desire to eat, or restrain. Individual differences in restraint levels exist in that people low in dietary restraint eat freely when they desire food, whereas those high in dietary restraint struggle to resist the desire to eat and persistently worry about eating (C.P. Herman & Polivy, 1980). People with restrained eating patterns tend to waver between periods of restricted eating and temporary periods of overeating which occur when certain events, including stressful experiences and associated affective changes, lead to disinhibition over eating (Ruderman, 1986).

Self-regulatory resource depletion theory may help to further explain the significance of dietary restraint in the stress-eating relationship. Restriction of eating requires self-control to override competing urges to eat unhealthy or greater quantities of foods. Stress may deplete the limited self-regulatory resources required to control eating, resulting in overeating and poorer food choices (C. P. Herman & Polivy, 1984; Vohs & Heatherton, 2000). People high in dietary restraint cannot maintain the high level of cognitive control over their eating under stressful periods as attentional and self-control resources are directed towards the stressful situation. The stressor may decrease the amount of attention restrained eaters normally allocate to control eating, lowering self-awareness and awareness of eating behaviors in general, subsequently leading to increased eating or less healthy food choices. Experimental studies provide support for this theory in relation to eating behavior (Boon, Stroebe, Schut, & Ijntema, 2002; Boon, Stroebe, Schut, & Jansen, 1998; T. F. Heatherton, Polivy, Herman, & Baumeister, 1993; Hofmann, Rauch, & Gawronski, 2007; Lattimore & Caswell, 2004; Ward & Mann, 2000).

A relevant example of the application of resource depletion theory and dietary restraint is provided by a series of experiments demonstrating that initial exertions of self-control lead to decrements in self-regulation, making it more difficult for restrained eaters to later control eating (Vohs & Heatherton, 2000). In one experiment, participants were either told "help yourself" or "don't touch" a variety of tempting snacks sitting either close by (highly tempting) or far away (low temptation) in the laboratory while watching an emotionally neutral film. The "help yourself" condition ostensibly depleted self-regulatory resources by requiring exertion of self-control, and the "don't touch" condition did not affect self-regulatory resources as no option to consume the snacks was offered. Following the video, participants were asked to taste test ice cream flavors. The amount of ice cream consumed varied as a function of dietary restraint and temptation level. The eating behavior of non-restrained eaters was unaffected by the experimental manipulations. However, restrained eaters' ice cream consumption was significantly higher when they were required to exert self-control over initial eating behavior in a highly tempting situation.

The same researchers (Vohs & Heatherton, 2000) conducted another experiment with restrained eaters using a self-regulatory depletion manipulation unrelated to food. Participants in the depletion condition were asked to purposefully suppress their emotional reactions to a film and control participants were not asked to control their emotional reactions. An ice cream "taste test" followed the film, and participants who were asked to inhibit their emotional reactions ate significantly more than those who were not asked to control their reactions. This study provides further evidence that, among restrained eaters, depleting self-regulatory resources can impair later ability to exert self-control over eating behavior. Other experiments report similar findings; increased consumption in restrained eaters following depletions of self-regulation resources (e.g., Hofmann, et al., 2007; Kahan, Polivy, & Herman, 2003)

**Summary**

Unhealthy eating behavior is related to a variety of major health problems, and a great deal of evidence indicates that stress affects eating behavior, resulting in overeating and less healthy food choices. Eating in response to stress may occur because stress decreases self-regulatory resources needed to control eating behavior, or because stress helps regulate affect (increases positive affect, decreases negative affect). As a result of theory and research on stress and eating behavior, clinical interventions often incorporate some form of stress-management intervention. Yet, there is a dearth of research supporting the use of stress-management interventions as a way of altering eating behavior. Research also suggests that people high in dietary restraint are particularly vulnerable to the effects of stress on eating. The current proposed study seeks to improve upon limitations in available research by experimentally investigating the effects of a brief relaxation-based intervention on stress-induced eating in a population of women high in dietary-restraint. Proposed psychological mechanisms of action, including affect regulation and changes in self-regulatory resources, will also be formally investigated.

**Current Study**

The current study is designed as an extension of previous literature in the relationship between stress and eating behaviors. Specifically, the purpose of the current study is to examine the effects of a brief relaxation-based stress-reduction intervention on eating behaviors following a laboratory-based stress-induction paradigm, and to investigate and identify the psychological mechanisms of action involved in the stress-reduction intervention. That stress can impact eating behaviors has significant implications, and whether a brief intervention to modulate the effects of stress on eating behaviors is important from a clinical perspective. If the detrimental effects of stress on eating behaviors can be mitigated through brief relaxation training, it is important to know the underlying mechanistic processes that explain the effects. Participants were exposed to a stress-induction procedure and then randomly assigned to either a brief stress-reduction intervention or no intervention, followed by assessments of affect, self-regulatory resources, and eating behavior.

**Hypotheses.**

Five main hypotheses were proposed:

1. The stress induction procedure will result in an increase in negative affect (NA), a decrease in positive affect (PA), and decreased subjective feelings of calmness and relaxation.
2. Participation in a relaxation exercise intervention will result in affective improvements relative to no-treatment; i.e., increased PA and decreased NA.
3. Participation in a relaxation exercise intervention will result in better control of self-regulatory resources, relative to the control group.
4. Participation in a relaxation based intervention will contribute to lower overall food consumption and a lower proportion of consumption of sweet and high-fat to savory and low-fat food.
5. The relationship between group assignment (relaxation intervention vs. wait control) and eating behaviors will be mediated by affect and self-regulation resources. The hypothesized mediation models can be seen in Figure 1.

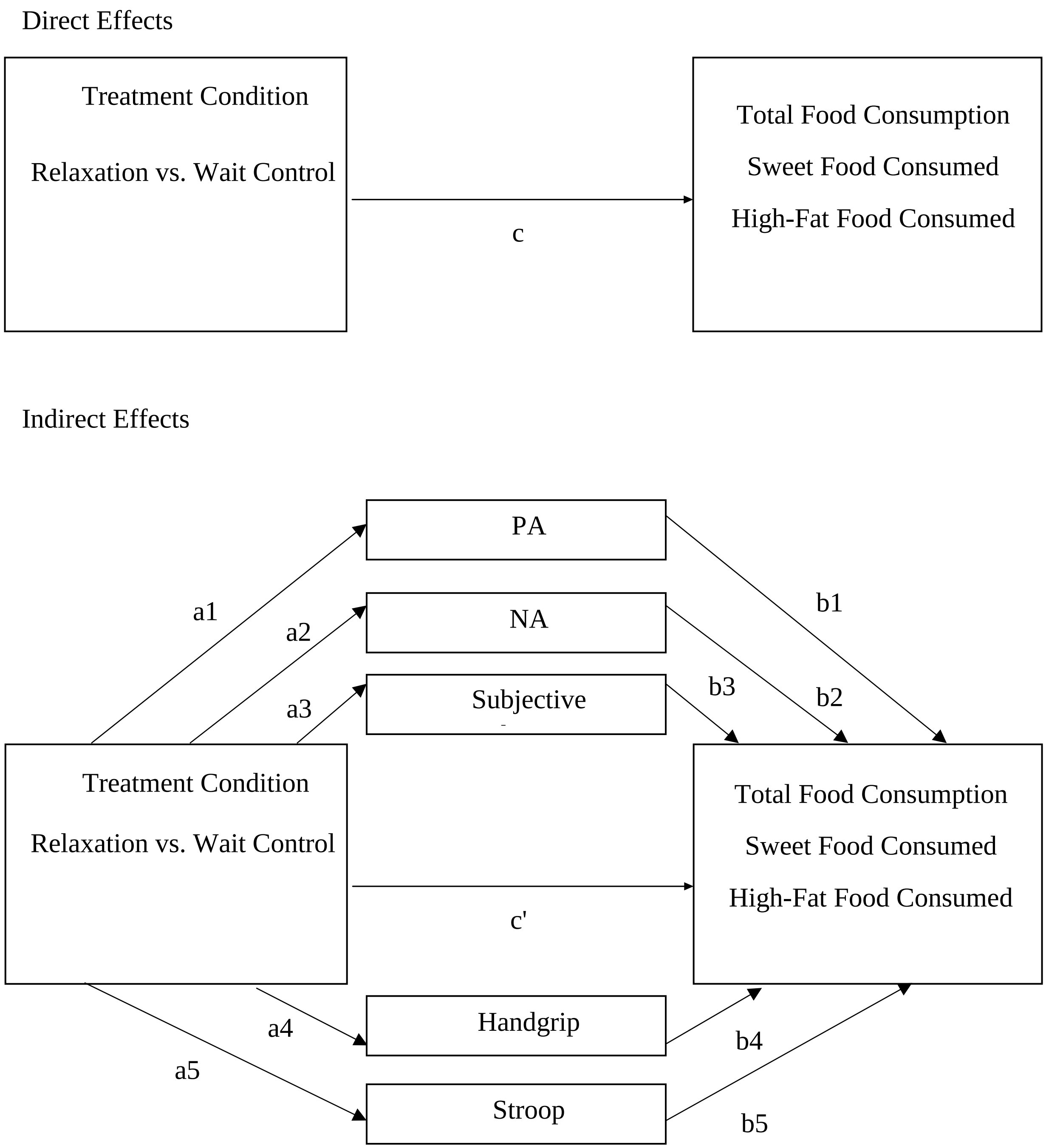


**Figure 1**. Model of the hypothesized mediators of the relaxation intervention on eating behaviors.

*Note.* Mediators are based on change scores from pre-to-post randomization and treatment intervention. Previous Stroop Task experience will be included as a covariate in the model.

# CHAPTER TWO:

# METHOD

## Participants

Participants included female undergraduate students, graduate students, and employees at the University of South Florida between of 18 and 30 years of age. Participants were recruited via the psychology department Sona research participant pool as well as through announcements posted on the university campus and university related organization web pages (See Figure 2 for participant flow chart). A total of 1006 participants completed the online eligibility questionnaire, 429 of whom met inclusion criteria based on self-reported dietary restraint scores of 3.0 or greater on the DEBQ-R scale. Of the 429 eligible, a total of 139 participants (experimental = 70, control = 69) completed the lab-based portion of the study. The 290 eligible participants who did not complete the lab-based portion of the study either declined, did not respond to repeated (i.e., up to 4) email invitations, or no-showed for appointments and failed to reschedule. A comparison of eligible participants who completed the lab-based study (n = 139) and those who did not (n = 290) was conducted to determine if group differences existed (see Table 1 for descriptive statistics). Chi-square tests of independence indicated no group differences in self-reported race ($\chi 2$ (5, $n$ = 427) = 6.63, $p$ = .25) or ethnicity ($\chi 2$ (1, $n$ = 429) = .32, $p$ = .58) between eligible participants who completed the lab portion of the study versus those who did not participate. Independent t-tests indicated that the groups did not differ on dietary restraint scores ($t$(427) = -.27, $p$ = .79) or weight ($t$(423) = 1.29, $p$ = .20). There were statistically significant differences in age ($t$(425) = -2.05, $p < .05$) and BMI ($t$(423) = 2.00, $p$ <

.05), such that eligible participants who did not complete the lab-based portion of the study were slightly younger and had slightly higher BMIs than those who did complete the lab-based portion of the study.

A total of 9 (4 from experimental, 5 from control) participants were removed from the final analyses due to food allergies that precluded them from being able to eat the food provided (outcome variable). Thus, a total of 130 participants were included in the final analyses. All following data are based on this sample. A series of independent samples t-tests and chi-square tests of independence were conducted to examine recruitment group (e.g., Sona versus advertisement) equivalency on demographic and trait variables for participants in the lab-based portion of the study. No significant differences were found between groups on age ($t(128) = -1.33$, $p = .19$), dietary restraint level ($t(128) = -1.13$, $p = .26$), self-reported weight ($t(128) = -1.59$, $p = .11$), or BMI ($t(128) = -1.59$, $p = .11$). Recruitment group differences on categorical demographic variables were examined via chi-squared tests of independence, and there were no significant group differences in self-reported race, $\chi2(4, n = 129) = 8.35$, $p = .08$. A significantly greater proportion of participants in the advertisement-based recruitment group self-identified as Hispanic than in the Sona recruitment group, $\chi2 (1, n = 130) = 4.16$, $p < .05$. However, this difference may be related to differences in recruitment group sample size, and no differences in self-reported ethnicity were present between randomization groups. To test for equivalency of proportions of participants from each recruitment group randomized to each of the two randomization groups (i.e., experimental and control), a chi-square test of independence was conducted. The chi-square test was not significant, indicating there was no difference in the proportion of participants from either recruitment group represented in either randomization group, $\chi2 (1, n = 130) = 3.04$, $p = .08$.

A series of independent t-tests and chi-square tests of independence were conducted to evaluate equivalency of randomization groups on traits and demographics. Groups were equivalent on all variables including age ($t(128) = .32$, $p = .75$), dietary restraint ($t(128) = -1.23$, $p = .22$), weight ($t(128) = 1.27$, $p = .21$), and BMI ($t(128) = 1.38$, $p = .17$). Groups were also equivalent on race ($\chi 2$ (4, $n = 129$) = 4.80, $p = .31$) and ethnicity ($\chi 2$ (1, $n = 130$) = .51, $p = .47$). A summary of participant characteristics for the total sample, and by recruitment and randomization group, can be seen in Table 2.

**Measures**

**Demographics.** Participants were asked to report age, race, ethnicity, year in school, height and weight.

**Anthropometrics.** Participants' height in inches and weight in pounds were measured to calculate body mass index (BMI). Height was be measured with a stadiometer and weight was measured with a digital scale to the nearest .10 pound. BMI was calculated using the English BMI formula of (Weight in Pounds/ (Height in Inches x Height in Inches)) x 703). Visceral, or central, obesity was determined by measuring waist circumference in inches. Waist to hip ratio (WHR) was also calculated by measuring hip circumference in inches, and dividing waist circumference in inches by hip circumference in inches.

**Food intake.** Food intake was determined by measuring the difference in bowl weight of the various food types (described in detail below) between participant arrival and study completion. Measurements were made on a digital food scale with accuracy to the .10 oz.

**Affect.** Affective reactivity was measured using the short form of the *Positive and Negative Affect Schedule* (PANAS-SF; Kercher, 1992; Mackinnon et al., 1999; Watson, Clark, & Tellegen, 1988), a 10-item self-report instrument designed to measure the extent to which an individual is high or low on Positive Affect (PA) and Negative Affect (NA) during a specified time period (e.g., in the moment, today, in general, etc.). According to *PANAS* developers, PA and NA are orthogonal dimensions that can be experienced simultaneously, and PA reflects the degree to which a person feels alert, active, and enthusiastic, whereas NA measures the degree to which an individual feels distressed and the degree of experience of aversive mood states (Watson, et al., 1988). The original *PANAS* consists of two internally consistent and largely uncorrelated10-item mood scales that independently measure PA and NA. It can be used to measure affect as either a dispositional trait or a situational state, which reflects moment to moment variability in affect related to situational fluctuations.

The PANAS-SF consists of a 5-item subset of the PA and NA mood scales, containing 10 of the original 20 adjectives on the PANAS. The PANAS-SF scales have good reliability including internal consistency, with alphas of .78 and .87 for PA and NA, respectively (Mackinnon, et al., 1999); however, they may be sensitive to mood fluctuations when used with short-term instructions (Watson, et al., 1988) which is useful for measuring changes in state affectivity. The PANAS-SF also has good factorial validity, with a good fit for the two-factor NA and PA structure (Mackinnon, et al., 1999) Respondents are asked to indicate the extent to which they have felt each mood within a specified time frame (e.g., “right now” for state affect, or “in general” for trait affect). Participants rate the degree to which they have felt each mood based on a 5-point Likert-type scale ranging from 1 (“very slightly or not at all”) to 5 (“extremely”). Scores for PA and NA for the PANAS-SF range from 5 to 25, with higher scores indicative of greater levels of PA and NA, respectively. The PANAS-SF was modified for the current study to include two additional items assessing the degree to which participants feel calm and relaxed, in order to assess changes in the degree of feelings of calmness and relaxation in the study. The 12-item modified trait and state versions of the PANAS-SF can be found in Appendices A and B, respectively.

**Dietary restraint and emotional eating.** Dietary restraint and emotional eating were measured using the restraint and emotional eating subscales of the *Dutch Eating Behavior Questionnaire (DEBQ; van Strien, et al., 1986;* See Appendix C for measure*)*. The DEBQ scales, including restrained, emotional, and external eating, are widely used and have been shown to be psychometrically sound with excellent reliability and validity (Allison, Kalinsky, & Gorman, 1992; van Strien, et al., 1986; Wardle, 1987). Exploratory and confirmatory factor analyses demonstrate high factorial validity for the three-factor structure of the measure (van Strien, et al., 1986; Wardle, 1987). The DEBQ showed high levels of internal consistency for all subscales, with Cronbach alpha scores of .95 for restrained eating, .80 for external eating, and a range from .86 to .94 for the three emotional eating subscales (described below; van Strien, et al., 1986). Response categories on the DEBQ are on a 5-point Likert-type scale that range from 1 ("never") to 5 ("very often"), although a "not relevant" response category is included on all items that are presented in a conditional format (e.g., "When you have put on weight, do you eat less than usual."). The score for each scale is determined by dividing the sum of the items scored by the total number of items on the scale answered with a 1 to 5 response, excluding "not relevant" responses.

The 10-item Restrained Eating (DEBQ-RS) subscale of the DEBQ measures dieting behaviors and will be used to assess how much each participant attempts to restrict eating in order to prevent weight gain. The DEBQ-RS has excellent psychometric properties including high convergent validity with other measures of restraint, excellent internal consistency and two-week test-retest reliability, and is a homogenous scale with a stable factor structure across various populations (Allison, et al., 1992; van Strien, et al., 1986).Examples of items on this subscale include "When you have put on weight, do you eat less than you usually do?," and "How often do you refuse food or drink offered because you are concerned about your weight?"

The 13-item Emotional Eating (DEBQ-ES) subscale of the DEBQ measures the extent to which people eat in response to both diffuse and clearly labeled emotions. The DEBQ-ES provides a general assessment of emotional eating, and is comprised of two dimensions measuring eating in response to diffuse (e.g., "feeling lonely" or "having nothing to do") and clearly labeled (e.g., "depressed" or "anxious") emotions. All three subscales have good internal consistency, with Cronbach alphas of .94 for the full scale, .93 for the 9-item clearly labeled emotion scale, and .86 for the 4-item diffuse emotion scale (van Strien, et al., 1986). The DEBQES will be used to assess the extent to which participants eat in response to emotional arousal, such as in response to stress and fear. Examples of items on this scale are, "Do you have the desire to eat when you are irritated?" (clearly labeled emotion) and, "Do you have a desire to eat when somebody lets you down?" (diffuse emotion).

**Self-regulatory resource depletion.** Depletion of self-regulatory resources was measured with both a cognitive and physical stamina measure of self-regulation. The Stroop color-naming task was used as a measure of cognitive resource depletion and a handgrip was used as a measure of physical persistence stamina.

***Stroop task***. The Stroop is a reaction-time task that requires people to state the color in which a word is printed (Stroop, 1935), overriding the automatic response to read the word itself, which requires self-regulation and executive attentional control. Stroop task performance provides a measure of the extent to which participants are able to engage in cognitively-based self-regulatory behaviors. The Stroop task is a commonly used measure of self-regulation and cognitive resource depletion (DeWall, Baumeister, & Vohs, 2008; Gailliot et al., 2007; Gailliot, Schmeichel, & Baumeister, 2006; Gino, Schweitzer, Mead, & Ariely, 2011; Johns, Inzlicht, & Schmader, 2008; Richeson et al., 2003).

For the Stroop task, participants were first be shown a string of #s (#####) one at a time in a series of practice control trails. As in previous studies (Gailliot, et al., 2006), participants first completed a series of control trials to allow them to become familiar with how to respond on the screen and acclimate to the computer program. Participants were presented with 10 trials in which a string of #s (#####) appeared on the computer screen in either a red, green, yellow, or blue font. Participants were be instructed to indicate the color of the target #s by clicking on the button that names the color of the target (#####) as quickly as possible. During these initial practice trials, participants were be provided with the following instructions on the screen: “Look at the COLOR of the word that comes up in the middle of the screen. As fast as possible, click on the button that names the color of the target word.” The participant was provided with three practice trials before the main test begins. The practice trials began when the participant clicks on the test to start, indicating she is ready to begin the test, and the main test began once the participant again clicks the start button indication readiness to begin. A string of #s in one of four font colors (red, blue, green, or yellow) were presented in the center of a black screen with four buttons below with the color words (i.e., “red,” “blue,”, “green,” or “yellow”) shown in black ink. Participants clicked one of four large buttons below the center word that matches the color of the string of #s. Following each response, the next string of #s appeared immediately. Response latencies and errors were be automatically recorded for the 10 control trials using the English Stroop Test software program (Xavier Educational Software Ltd, 2006).

Immediately following the Stroop task control trials, participants completed the main Stroop task test with color naming of incongruent color-word presentations. As in previous studies (e.g., Gailliot, et al., 2007; Gino, et al., 2011), participants were be presented with one of four color words (i.e., red, blue, green, or yellow) one at a time on a screen in a series of 40 color-incongruent trials, where the word appears in a font color that diverges from the meaning of the word (e.g., *red* appears in green ink). Participants were be presented with the following instructions on the computer screen: "Look at the COLOR of the word that comes up in the middle of the screen. As fast as possible, click on the button that names the color of the target word." Participants were again be provided with three practice trials before the main test begins. The practice trials began when the participant clicks on the test to start, indicating that she is ready to begin the test and the main test began once the participant again clicks the start button indication readiness to begin. The setup for this task was be the same as that for the Stroop task control trials, except instead of a string of #s, incongruent color words (e.g., the word "yellow" shown in blue ink, or the word "red" shown in green ink) was presented in the center of a black screen. Participants clicked one of four large buttons with the color words (i.e., "red," "blue,", "green," or "yellow") displayed in black ink that matches the color of the word shown on the center of the screen. Participants were presented with a total of 40 color-word incongruent trials. Total response latencies and number of errors in the incongruent color-word trials were be automatically recorded and used as the outcome measure for resource depletion.

***Handgrip stamina***. Handgrip stamina is considered a measure of self-control in that it measure physical stamina. Stamina requires resisting fatigue and overriding the urge to quit (Baumeister, Vohs, & Tice, 2007) and self-control must be exerted to resist the impulse to quit squeezing the handgrip device as the hand grows increasingly fatigued (Tice, Baumeister, Shmueli, & Muraven, 2007). The ability to persist in squeezing the handgrip in spite of increasing fatigue is an indicator of self-regulation, with decreases in handgrip stamina indicative of self-regulatory resource depletion (Vohs, Baumeister, & Ciarocco, 2005). Handgrip stamina was measured using a commercially available handgrip exerciser consisting of a metal spring and two handles. Participants were asked to squeeze the handles together and maintain the grip for as long as possible. As done in previous research (M. Muraven, et al., 1998; e.g., Tice, et al., 2007; Vohs, et al., 2005), a pliable ball was inserted between the ends of the handles so that the ball fell once the grip is relaxed and signal for timing of handle squeezing to stop. Handgrip stamina ability was measured by the number of seconds that participants can exert enough pressure to hold the paper between the handles. An experimenter timed participants with a stopwatch to measure how long participants were able to maintain the grip before releasing enough to allow the ball to fall out. Once the ball fell from between the handles, the experimenter stopped timing. Shorter duration of and greater decreases in handgrip stamina are indicative of self-regulatory resource depletion.

**Post-experimental questionnaire.** Additional eating behavior variables were measured and participants were probed for suspicion of the study purpose with a final questionnaire**.** Participants were asked to indicate how long ago they had last eaten prior to coming in to the laboratory and whether what they ate was a meal or a snack. Current dieting behaviors were assessed. Additionally, participants were asked to indicate what they believe the purpose of the study was to check to see if anyone guessed the actual purpose of the study. See Appendix D for the full post-experimental questionnaire.

**Additional measures.** Additional measures were included in the web-based portion of the study to distract participants from the true purpose of the study. The study was presented as an investigation of personality, health behaviors, and task performance. The following measures were included in the online portion of the study to represent the stated purpose of the study and obscure the true study purpose: the *Pittsburgh Sleep Quality Index (PSQI; Buysse, Reynolds Iii, Monk, Berman, & Kupfer, 1989)*; the *Perceived Stress Scale-10 (PSS; S. Cohen & Williamson, 1988);* the *International Physical Activity Questionnaire* (IPAQ; Booth, 2000; Craig et al., 2003); the *Behavioral Regulation in Exercise Questionnaire-2* (*BREQ-2*; Markland & Tobin, 2004); the *Disinhibition* subscale of the *Three Factor Eating Questionnaire* (TFEQ-D; Stunkard & Messick, 1985) the *Ten-Item Personality Inventory (*TIPI; Gosling, Rentfrow, & Swann Jr., 2003). These measures can be found in Appendices E-J, respectively.

**Procedure**

Participants were recruited via the undergraduate research pool SONA system and via flyers posted around the USF campus. Figure 3 provides details of the study procedure. Before participation in laboratory based procedures, participants completed the following questionnaires to determine eligibility for the lab-based study via an online survey site: demographic information, PANAS-SF-Trait, DBEQ-ES and –RS, and the distracter measures including the PSQI, PSS, TFEQ-D, IPAQ, BREQ-2, and the TIPI. After completion of the online baseline questionnaire, eligibility was determined based on DEBQ-RS scores (i.e., participants high in dietary restraint, as indicated by scores at or above the mean DEBQ-RS score of 3.00, met inclusion criteria for continuation in the study). Sona and non-Sona participants completed identical online surveys distributed through different links to allow for differentiation of recruitment source and compensation type, as well as group analyses post data collection to ensure there were no group differences based on recruitment source. Eligible participants were invited to participate in the laboratory-based portion of the experiment via email alert. Sona participants were sent an invitation code (password) to register and non-Sona participants were sent a schedule of available times to sign up directly with the researcher. Participants were contacted up to four times for scheduling lab-based study participation. Participants were not randomized to either the intervention or control group until immediately prior to the intervention. Upon entering the lab, all participants completed the modified PANAS-SF (state affect) to determine baseline state affect. They then participated in the stress-induction speech task.

**Stressful speech task.** To induce stress, participants completed an interpersonal speech task, similar to methods used in previous studies (e.g., Koo-Loeb, Costello, Light, & Girdler, 2000; Levine & Marcus, 1997; Roemmich, et al., 2011). Speech tasks have been demonstrated to reliably induce both physiological and emotional stress responses (Feldman et al., 1999) and a stress task with multiple components (e.g., public speaking, an audience, anticipatory period, anticipation of negative consequences) may contribute to more consistent stress effects than stress tasks with only a single component (Kirschbaum, Pirke, & Hellhammer, 1993). For the stressful speech task, participants were instructed to prepare and deliver a 3 minute speech about their strengths and weaknesses as a friend. Participants were instructed that they had 2 minutes for speech preparation and they were subsequently asked to give their 3-minute speech in front of the present researcher as well as a video recorder. Participants were informed that their speech was required to last for the entire duration of the allotted 3 minutes, and participants were prompted to continue speaking if they stopped before the time was up. Participants were instructed that their video recording would be subsequently be reviewed by three other laboratory staff to be judged for poise, articulation, style, and likability as a speaker; however, unbeknownst to the participants, no such ratings were actually completed, and the video recording was immediately deleted upon completion of the speech. Upon completion of the speech task, the researcher stopped the video recording, provided the participants with instructions for follow-up questionnaires, and informed the participant that she was going to provide the recorded speech to the panel of laboratory staff for evaluation, and that feedback will be provided later in the session. See Appendix K for the full instructions for the speech task.

Immediately following the stress-induction speech task, the PANAS-SF-State was administered again. This data was analyzed as a manipulation check to determine if the stress task increased negative affectivity. Baseline levels of self-regulatory resources were measured with initial Stroop and handgrip task measurement. Randomization to treatment or control was then determined by a random number generator, and participants were instructed to either wait quietly or to follow the audio instructions for relaxation based on group assignment. Participants randomized to the intervention group were set up for completion of the relaxation task administered through audio recording, and those randomized to the control group were instructed to sit and wait quietly for 20 minutes. All participants were informed that their speech performance videos were being evaluated and rated by multiple research assistants during the 20-minute relaxation or control period.

**Relaxation exercise.** Participants randomized to the relaxation-intervention condition were instructed that the next part of the study involved participation in a relaxation exercise. They were provided with verbal instructions, instructing them to listen to a 20 minute audio recording guiding them through a relaxation exercise, similar to single-session relaxation exercises previously used (Royal & Kurtz, 2010). The recording began with a brief overview of the relaxation exercise with instructions designed to maximize relaxation (e.g., sit comfortably, close eyes). The relaxation exercise combined both active and passive relaxation components, including progressive muscle relaxation (PMR), and autogenic training (AT). The script for the relaxation exercise intervention in this study is an adaptation of previously published PMR, and AT scripts (Benson, 1993; Gramling & Auerbach, 1998) and can be seen in Appendix L. PMR is an active form of relaxation that involves methodological tensing and relaxing of major muscle groups in the body, with tensing of muscles for approximately 15 s followed by release of tension and a focus on the difference between tension and relaxation. AT involves a passive focus on breathing and a focus on feeling of heaviness and sense of warmth in the limbs (Benson, 1993), and involves a systematic scan of the body, similar to PMR, but with a passive, rather than active, relaxation component. These relaxation techniques have been shown to modulate a variety of stress-related reactions and conditions including reducing physiological stress responses, anxiety, hostility, and pain and improving mood, subjective relaxation, and well-being (Beary & Benson, 1974; Benson, Beary, & Carol, 1974; Carrington et al., 1980; Pawlow, 2002), even after a single session (Pawlow, 2002; Rausch, et al., 2006). Participants randomized to the control condition were instructed to sit quietly for 20 minutes. It was expected that control participants will continue to experience the stress response during their 20-minute waiting period. Previous experiments have demonstrated that indicators of physiological stress responses continued to increase even 30 minutes after exposure to a stressor for participants who waited in silence, whereas the stress reaction ceased to increase after the stressor for participants who listened to music (Khalfa, Bella, Roy, Peretz, & Lupien, 2003).

After completion of the relaxation intervention or wait time-control, the modified PANAS-SF-State was administered to measure affective state and subjective relaxation levels. The computerized Stroop task and handgrip stamina tests were then administered in a randomized order to control for order effects. Participants were instructed that the scoring of the speech performance was still in progress. Participants were presented with food and water and informed that the snacks are provided to say “thank you” for their study participation and patience during the scoring process. A sign on the food tray told the participant that she can enjoy as much of the food as she would like.

**Food presentation.** Participants were provided with four different types of snack foods to eat. Food items varied on taste (either salty or sweet) and level of fat (either high or low level of fat). The current study used similar types of food items used in previous research on stress and eating behaviors that includes nonperishable food items with similarly textures (crunchy and non-moist) to improve standardization across foods (Habhab, et al., 2009). The four food items presented included mini chocolate chip cookies (sweet, high fat), caramel flavored mini rice cakes (sweet, low fat), plain potato chips (salty, high fat), and hard mini pretzels (salty, low fat). All foods were presented unwrapped in individual bowls and placed on the table in front of the participant. Participants were presented with single-size servings of each food (ranging from 28-56 grams), weighed for accuracy prior to presentation. Of note, the mini-cookies were denser than the other foods and could be easily counted, so a greater weight (i.e., the entire 2 oz. single-serve bag) was provided so as to match the visual effect of the other food items and obscure the total number of cookies present. Participants were informed that the snacks are provided as a token of appreciation for their participation. A sign on the tray instructed them to eat as much as they would like, and the researcher indicated it would be just a few more minutes until their speech performance feedback was finalized. Participants were provided 10 minutes to eat the food to allow ample time for participants to consume as much food as they wish, as done in previous studies (Royal & Kurtz, 2010). Participants were also presented with 8 oz. of water.

The researcher then left the participant alone in the lab, informing her that she will be back in a few minutes for the remaining portion of the study. After 10 minutes, the researcher returned, removing any remaining food from the participant's view. The amount of food consumed was determined by measuring the difference in weight from the initial weight of each type of food after the participant has left the lab using a digital scale. The participant was informed that the study is almost complete and that some anthropometric measurements and a final questionnaire needed to be completed. Then the participant's anthropometrics were measured, including height, weight, and waist circumference. A post-experimental questionnaire was administered (see Appendix D) to determine time since last meal, current diet status, and as a check to see if participants guessed the study purpose. The participants were debriefed, informed that their speeches were not actually evaluated and that the video recording was already destroyed. Participants were asked to keep the purpose of the study confidential and thanked for their participation.

**Table 1.** Characteristics of eligible participants who completed lab-based portion of study and those who did not complete lab-based portion of study.

| | Lab Participants | Lab Non-Participants |
|---|---|---|
| | *n* = 139 | *n* = 290 |
| | *M (SD)* | *M (SD)* |
| Age | 21.48 (2.97) | 20.88 (2.82)* |
| Restraint | 3.50 (0.50) | 3.48 (0.53) |
| Weight | 145.64 (29.48) | 150.11 (35.18) |
| BMI | 24.48 (4.83) | 26.19 (9.46)* |
| | | |
| Race | *n (%)* | *n (%)* |
| White | 87 (62.6%) | 208 (71.7%) |
| Black | 16 (11.5%) | 25 (8.6%) |
| Asian | 17 (12.2%) | 18 (6.2%) |
| Pac. Isl. | 1 (0.7%) | 2 (0.7%) |
| Other | 17 (12.2%) | 36 (12.4%) |
| | | |
| Hispanic | 32 (23.0%) | 74 (25.5%) |
| Non-Hispanic | 107 (77.0%) | 216 (74.5%) |

Note. * $p < .05$. Significant group differences based on independent t-test results are notated. Lab participant group includes all participants who completed lab-based portion of study, regardless of whether data was utilized for final analyses. BMI is based on self-reported height and weight. Race was not reported by 1 participant in each group.

**Table 2.** Participant characteristics by total sample, recruitment group, and randomization group.

| | Total Sample | Sona Pool | Advertisement | Experimental | Control |
|---|---|---|---|---|---|
| | *n* = 130 | *n* = 59 | *n* = 71 | *n* = 66 | *n* = 64 |
| | *M (SD)* | *M (SD)* | *M (SD)* | *M (SD)* | *M (SD)* |
| Age | 21.51 (3.05) | 21.12 (3.04) | 21.83 (3.04) | 21.59 (2.90) | 21.42 (3.21) |
| Restraint | 3.48 (0.50) | 3.43 (0.51) | 3.53 (0.48) | 3.43 (0.44) | 3.54 (0.55) |
| Weight | 145.48 (29.59) | 140.97 (21.96) | 149.23 (34.39) | 148.71 (37.29) | 142.14 (18.34) |
| BMI | 24.71 (5.25) | 24.20 (4.24) | 25.14 (5.96) | 25.00 (6.33) | 24.42 (3.85) |
| Race | *n (%)* | *n (%)* | *n (%)* | *n (%)* | *n (%)* |
| White | 81 (62.3%) | 40 (69%) | 41 (58%) | 41 (62.1%) | 40 (63.5%) |
| Black | 16 (12.3%) | 7 (12.1%) | 9 (12.7%) | 10 (15.2%) | 6 (9.5%) |
| Asian | 15 (11.5%) | 2 (3.4%) | 13 (18.3%) | 9 (13.6%) | 6 (9.5%) |
| Pac. Isl. | 1 (0.8%) | 0 (0%) | 1 (1.4%) | 1 (1.5%) | 0 (0%) |
| Other | 16 (12.3%) | 9 (15.5%) | 7 (9.9%) | 5 (7.6%) | 11 (17.5%) |
| Hispanic | 31 (23.8%) | 19 (32.2%)* | 12 (16.9%) | 14 (21.2%) | 17 (26.6%) |
| Non-Hispanic | 99 (76.2%) | 40 (67.8%) | 59 (83.1%) | 52 (78.8%) | 47 (73.4%) |

Note. * $p < .05$. Notation indicates significant difference between recruitment groups on self-reported ethnicity. Race was not reported by 1 person.

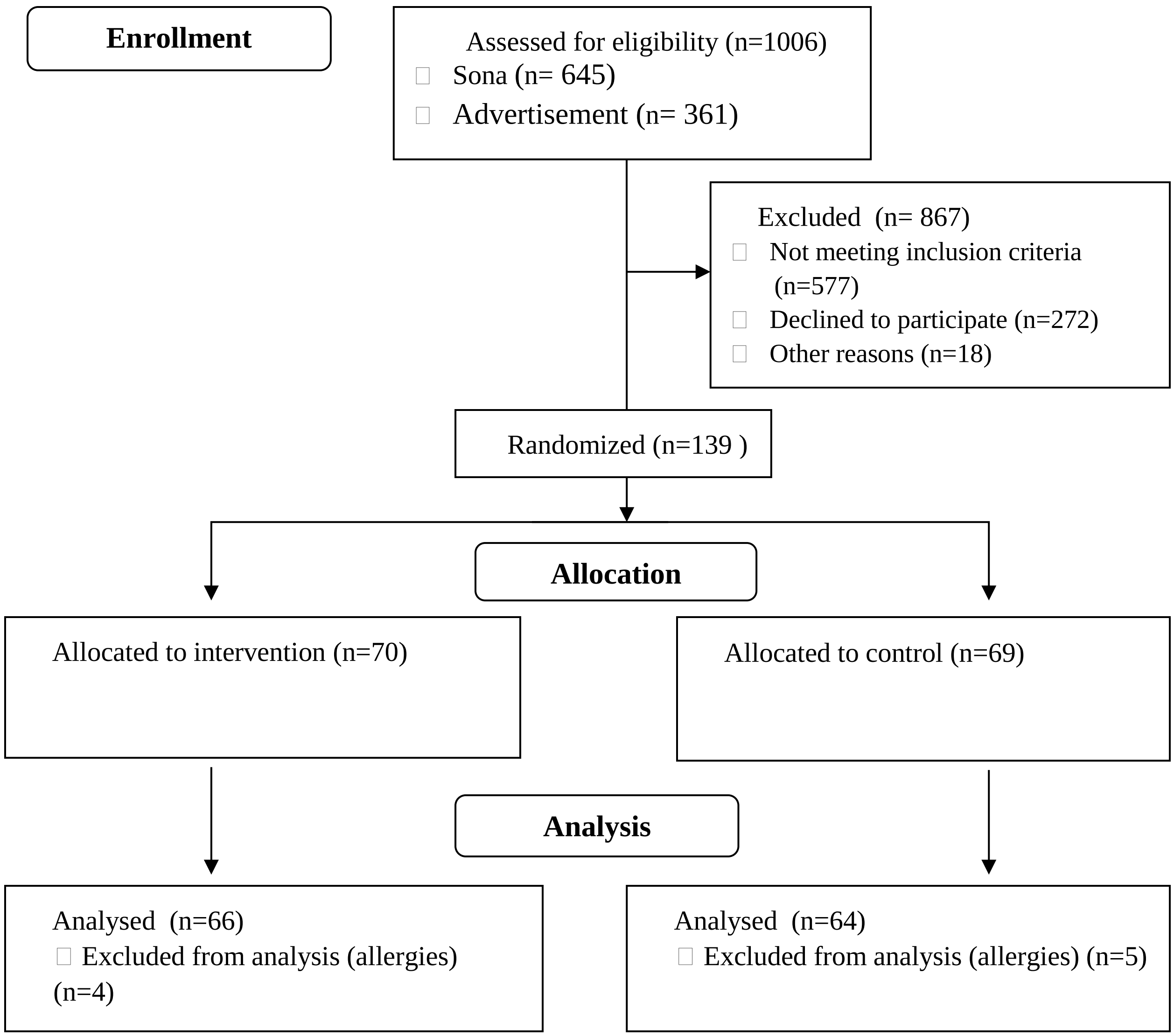


**Figure 2.** Participant flow diagram

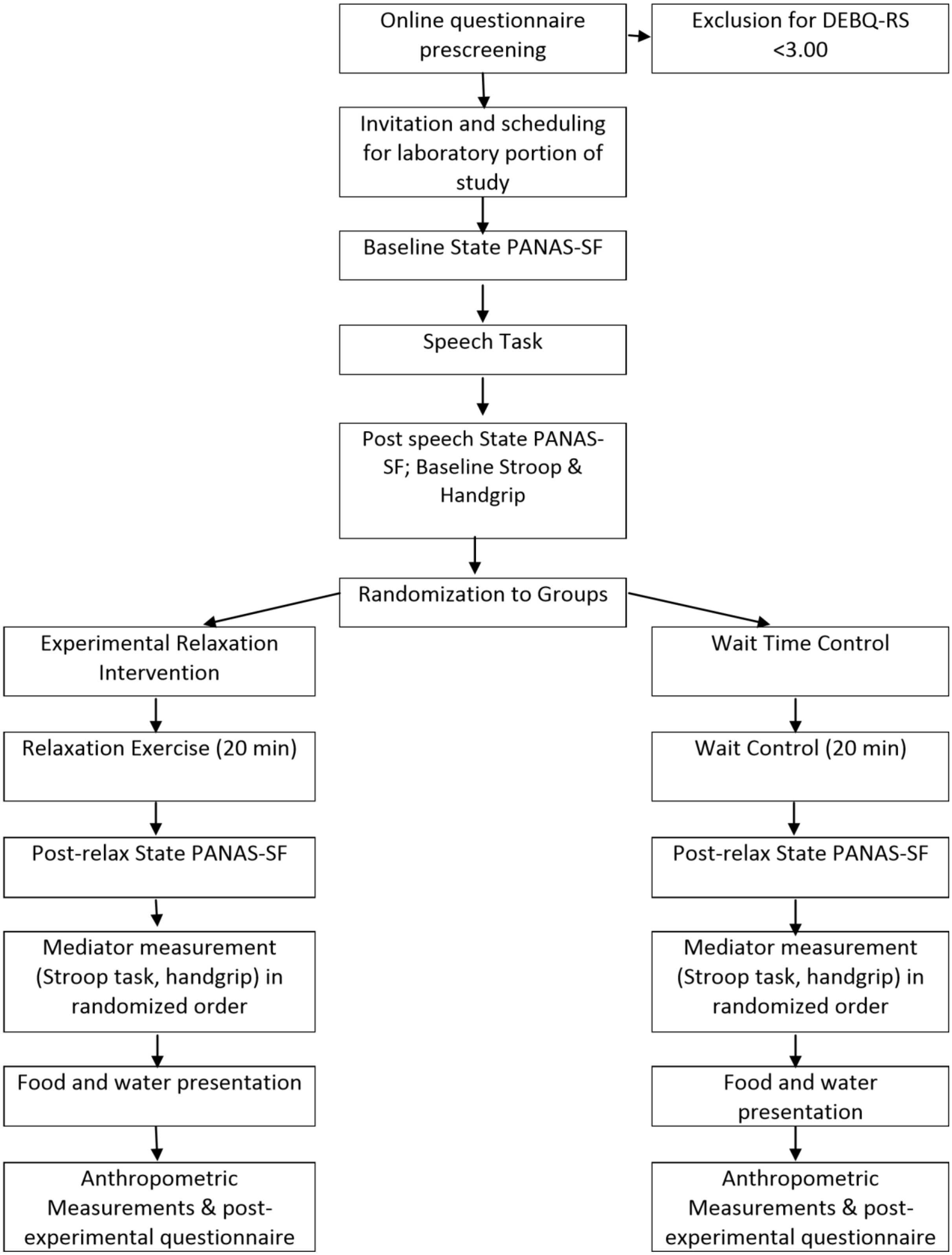


**Figure 3.** Study procedure flow.

# CHAPTER THREE:

# RESULTS

## Preliminary Analyses

Prior to analysis, variables were examined for accuracy of data entry and missing values. Data were screened for patterns of missing values. Missing values occurred infrequently ($< 1\%$) and in a random pattern. Two participants were missing data from a computer-based VAS PANAS administration and one participant was missing data from one Stroop task administration, due to computer program error. The fully conditional specification maximum likelihood multiple imputation procedure in IBM SPSS statistical software was used to impute the missing data. All variables used in the preliminary, primary, and mediational analyses were included in the imputation models. Five imputed datasets were created with a total run length of 100 iterations. Complete case analysis did not result in altered outcomes.

**Pilot data analysis.** Data from the initial 35 randomized participants were analyzed to ensure efficacy of stress-induction and relaxation intervention manipulations. A series of within-subjects paired-samples t-tests was conducted to evaluate the change in baseline to post-stress task affect (PA, NA, and subjective relaxation). It was expected that there would be an increase in NA and a decrease in PA and Subjective Relaxation from baseline to post-stress task. Results supported the hypotheses for NA and subjective relaxation, indicating there was a significant increase in NA from baseline ($M$ = 19.94, $SD$ = 17.36) to post-stress task ($M$ = 32.73, $SD$ = 23.76), $t(34) = -3.84$, $p < .001$, as well as a significant decrease in subjective relaxation from baseline ($M$ = 58.56, $SD$ = 21.73) to post-stress task ($M$ = 39.21, $SD$ = 25.61), $t(34) = 3.84$, $p <$

.001. There was no significant change in PA from baseline ($M = 46.24$, $SD = 21.74$) to post-stress task ($M = 44.58$, $SD = 22.87$), $t(34) = .61$, $p = .55$. Based on the significant increase in NA and decrease in subjective relaxation from baseline to post-stress task, the speech task was considered to be an effective manipulation.

A series of independent samples t-tests was conducted to evaluate the efficacy of the relaxation intervention compared to wait-control on affect outcomes. Unequal variances were assumed given the unequal distribution of participants randomized to the control group ($n = 21$) versus the experimental group ($n = 13$) at the time of this analyses. As anticipated, results indicated that participants in the experimental condition who participated in a relaxation exercise experienced significantly lower levels of NA post-intervention ($M = 9.31$, $SD = 8.33$) compared to control group participants ($M = 17.95$, $SD = 14.92$), $t(31.78) = -2.16$, $p < .05$. Differences in subjective relaxation between experimental ($M = 77.81$, $SD = 15.33$) compared to control group participants ($M = 63.61$, $SD = 25.79$), approached significance, $t(31.98) = 2.01$, $p = .053$. There was no significant difference between the experimental ($M = 38.02$, $SD = 25.74$) and control ($M = 29.05$, $SD = 22.34$) groups on PA, $t(22.82) = 1.04$, $p = .29$. Given the small sample size and disparity in group sizes, the significant group differences in NA and near-significant group differences in subjective relaxation in the anticipated directions were considered evidence of efficacy of the relaxation intervention. Thus, the study was continued as originally designed.

**Pre-randomization group affect equivalency check.** A series of independent samples t-tests was conducted to ensure no baseline or post-stress task differences in PA, NA, or subjective relaxation existed prior to randomization. Summary results for all group scores can be seen in Table 3. No affect-related group differences were observed at baseline or post-stress task prior to randomization (See Figures 4, 5, and 6 for graphical depiction of data), indicating that randomization was successful and the stress task was equally effective between groups. Specifically, there were no significant differences between the experimental and control group at baseline on PA ($t(128) = -0.15$, $p = .88$), NA ($t(128) = -0.79$, $p = .43$), or subjective relaxation ($t(128) = -1.71$, $p = .09$). After the stress (speech) task there were also no differences on PA ($t(128) = 0.58$, $p = .56$), NA ($t(128) = 0.44$, $p = .66$), or subjective relaxation ($t(128) = -1.18$, $p = .24$).

**Stress task manipulation check**. A within-subjects repeated measures MANOVA was conducted to test the hypothesis that participation in the self-relevant, evaluative, speech-task would increase stress levels. It was expected that there would be an increase in NA and a decrease in PA and subjective relaxation as measured by the modified PANAS-SF. A MANOVA evaluated the effect of stress task participation on affective outcomes (PA, NA, and subjective relaxation) by comparing baseline to post-stress task measurements of affect (See Table 3 for descriptive statistics; see Table 4 for change scores by group). The overall model was significant, indicating a statistically significant difference in affect from baseline to post-stress task completion, $F$ (3, 127), = 26.80, $p < .001$; Wilk's $\Lambda = .61$, Partial $\eta^2 = 0.39$. Specifically, the stress-task produced a significant change from baseline levels of NA ($F$ (1, 129), = 39.13, $p < .001$; Partial $\eta^2 = 0.23$) and subjective relaxation ($F$ (1,129), = 80.29, $p < .001$; Partial $\eta^2 = 0.38$), but not PA ($F$ (1, 129), = 0.008, $p = .93$ (n.s.); Partial $\eta^2 = 0.00$). Thus, the stress-task was successful in that it produced significant increases in NA and decreases in subjective relaxation from baseline to post-stress task.

**Evaluation of relaxation task efficacy.** A mixed-factorial repeated measures MANOVA was conducted to test the effect of the intervention on measures of affect (PA, NA, and subjective relaxation). Overall, the model was significant, with a significant interaction between randomization group (control vs. experimental) and time (pre- and post-intervention), $F$ (3, 126) = 4.34, $p < .01$; Wilk's $\Lambda = .91$, Partial $\eta^2 = .09$. The within-subjects factor of time was significant, $F$ (3, 126) = 93.42, $p < .001$, Wilk's $\Lambda = .31$, Partial $\eta^2 = .69$, but there was no main effect for group, $F$ (3, 126) = .343, $p = .79$ (*n.s.)*, Wilk's $\Lambda = .99$, Partial $\eta^2 = .01$. Univariate analyses show (see Figures 4, 5, and 6) there was a significant effect of time on PA ($F$ (1,128) = 76.80, $p < .001$; Partial $\eta^2 = .38$), NA ($F$ (1,128) = 112.26, $p < .001$; Partial $\eta^2 = .47$), and subjective relaxation ($F$ (1,128) = 183.54, $p < .001$; Partial $\eta^2 = .59$). Both PA and NA decreased and subjective relaxation increased from post-stress task to post-intervention for both groups.

Further inspection of univariate analyses indicate that the interaction between group assignment and time was significant for NA ($F$ (1,128) = 4.04, $p < .05$; Partial $\eta^2 = .03$) and subjective relaxation ($F$ (1,128) = 11.58, $p < .01$; Partial $\eta^2 = .08$), but not for PA ($F$ (1,128) = 1.36, $p = .25$ (*n.s.*); Partial $\eta^2$= .01). As shown in Figure 5, although both groups experienced decreases in NA from pre- to post-intervention, the experimental group experienced a greater decrease in NA. Similarly, as shown in Figure 6, there were significant overall increases in subjective relaxation levels after the intervention, but participants in the experimental group had significantly higher subjective relaxation levels post-intervention compared to the control group. Overall, these results demonstrate that engagement in the relaxation intervention resulted in significantly greater decreases in NA and increases in subjective relaxation than a wait-time control, providing evidence that the intervention was effective.

**Evaluation of self-regulatory resource depletion by group.** It was hypothesized that participation in the relaxation exercise intervention would result in greater self-regulatory resources, relative to the control group. A between-subjects MANOVA examining randomization group differences in in self-regulatory resources as measured by post-intervention

Stroop task mean response time, total Stroop items correct, and handgrip task persistence duration was conducted to test this hypothesis. Results indicated no significant group differences in self-regulatory task performance, $F$ (3, 126) = 1.50, $p$ = 2.17 (n.s.); Wilk's Λ = .97, Partial $\eta^2$ = 0.04. Descriptive statistics for these variables can be seen in Table 5.

**Effect of Relaxation on Eating Behaviors**

A series of independent samples t-tests was conducted to evaluate the effect of relaxation vs. time-control on eating behaviors. Descriptive statistics for food consumption by group and for the total sample are shown in Table 5. It was hypothesized that participants randomized into the experimental relaxation exercise intervention condition would eat significantly less total food, less sweet foods, and more high-fat food than participants randomized into the control condition. Independent samples t-tests supported the hypothesis for total food consumed ($t(128) = -2.01$, $p < 0.05$). Participants in the experimental group consumed significantly less food overall than their control group counterparts. Effect size analysis indicates a small to medium effect (d = .35). The effect of the relaxation intervention on the total amount of sweet foods consumed approached significance ($t(128) = -1.98$, $p = 0.05$), with a small to medium effect (d = .35). There was no significant difference in the amount of high-fat food consumed between the relaxation and control group ($t(128) = -1.18$, $p = .24$).

**Multiple Mediation Analyses**

SPSS macros for multiple mediation effects (Preacher & Hayes, 2008) were used to test the direct and indirect effects of group assignment on food outcome variables (i.e., total food consumed, total sweet foods, total high fat foods) with the pre-to-post intervention change in affect (i.e., PA, NA, and relaxation) and self-regulatory resource measures (i.e., Stroop task and handgrip performance) as mediating variables (See Tables 3 and 4 for descriptive statistics for proposed affect mediators and Table 5 for descriptive statistics for proposed self-regulatory resource mediating variables). Although group assignment was significantly related only to the total amount food consumed, Hayes (2009) indicates the IV-DV total effect criteria is no longer necessary to test for indirect effects of a mediator variable (or set of mediator variables) between the two IV-DV variables, unlike as required in the causal steps approach (Baron and Kenny, 1986)., Therefore, the multiple mediator model was tested to evaluate the indirect effects of proposed mediators on the relationship between group assignment and sweet-food and high-fat food consumption outcomes as well. Significance tests for each of the mediated effects were obtained using estimation methods described by Preacher and Hayes (2004, 2008) including 5000 bootstrap samples which produce estimates for bias corrected confidence intervals. The full proposed model, tested for each of the three outcome variables, is shown in Figure 1. Raw score (unstandardized) coefficient estimates for all of the paths in the models appear in Table 6. The point estimates, standard errors (SEs), and confidence intervals (CIs) for the models derived from the bootstrap distributions are reported in Table 7.

For the total food consumption mediator model, the total (path c) and the direct effects (path c') of group assignment on total food consumed were $B = 9.53$, $p < .05$ and $B = 6.68$, $p = .19$, respectively. Although the inclusion of the mediators in the model reduced the direct effect of group on total food consumed to non-significance, none of the specific indirect effects nor the total indirect effects were significant, as CIs for all of these effects contained 0. Further, the $R^2$ for prediction of total food consumed from group assignment with the three affect and two self-regulatory mediators was only 0.06. The total (path c) and the direct effects (path c') of group assignment on sweet food consumed were $B = 6.62$, $p = .05$ and $B = 4.24$, $p = .23$, respectively. None of the specific indirect effects, nor the total indirect effects, were significant based on CI values. The $R^2$ for the model was 0.07. Neither the direct (path c) nor indirect effects (path c') of group assignment on total high-fat food consumed were significant ($B$ = 4.24, $p$ = .24, and $B$ = 1.87, $p$ = .62, respectively). The total indirect effects and the specific indirect effects of change in PA, NA, handgrip, and Stroop task performance were all non-significant. The indirect effect of change in subjective relaxation on high-fat food consumption was significant. The $R^2$ for prediction of high-fat food consumption from group assignment with affect and self-regulatory resource change mediators was 0.06.

**Table 3.** Baseline, post-speech, and post-intervention affect by randomization group

| | Experimental | Control |
|---|---|---|
| | *n* = 66 | *n* = 64 |
| | *M (SD)* | *M (SD)* |
| Baseline PA (T1) | 51.49 (18.53) | 51.97 (18.68) |
| Baseline NA (T1) | 18.83 (15.10) | 21.17 (18.62) |
| Baseline Relaxation (T1) | 58.44 (22.92) | 65.17 (22.07) |
| | | |
| Post-speech PA (T2) | 52.84 (20.00) | 50.80 (20.15) |
| Post-speech NA (T2) | 31.80 (22.70) | 30.13 (20.04) |
| Post-speech Relaxation (T2) | 38.81 (22.09) | 43.72 (25.46) |
| | | |
| Post-intervention PA (T3) | 38.68 (19.88) | 39.96 (20.94) |
| Post-intervention NA (T3) | 10.20 (9.97) | 15.67 (13.24)* |
| Post-intervention Relaxation (T3) | 78.69 (19.01) | 67.59 (24.51)** |

Note. * $p < .05$. ** $p < .01$.

**Table 4.** Change in affect for total sample and randomization group

| | Total Sample | Experimental | Control |
|---|---|---|---|
| | *N* = 130 | *n* = 66 | *n* = 64 |
| | *M (SD)* | *M (SD)* | *M (SD)* |
| T1 to T2 PA Change | 0.11 (14.65) | 1.35 (14.70) | -1.17 (14.61) |
| T1 to T2 NA Change | 10.99 (20.04)*** | 12.96 (23.35) | 8.96 (15.85) |
| T1 to T2 Relaxation Change | -20.53 (26.11)*** | -19.63 (27.91) | -21.45 (24.31) |
| | | | |
| T2 to T3 PA Change | -12.52 (16.28)*** | -14.16 (17.32) | -10.84 (15.08) |
| T2 to T3 NA Change | -18.08 (19.65)*** | -21.60 (21.08) | -14.45 (17.49)* |
| T2 to T3 Relaxation Change | 31.99 (27.90)*** | 39.87 (27.55) | 23.87 (26.05)** |

Note. * $p < .05$. ** $p < .01$. *** $p < .001$. Significant affect changes in overall sample are indicated in Total Sample column. Significant differences in affect change by group are notated in Control column. T1 = Time 1 (Baseline). T2 = Time 2 (Post-Speech). T3 = Time 3 (Post-Intervention).

**Table 5.** Descriptive statistics for self-regulatory resource measures and food variables

| | Total | Experimental | Control |
|---|---|---|---|
| | *n* = 130 | *n* = 66 | *n* = 64 |
| | *M (SD)* | *M (SD)* | *M (SD)* |
| Stroop items correct (T1) | 46.38 (6.06) | 47.26 (2.44) | 45.48 (8.22) |
| Stroop mean response time (T1) | 1194.07 (287.97) | 1180.33 (268.02) | 1208.25 (308.68) |
| Handgrip duration (T1) | 20.54 (29.59) | 16.93 (14.96) | 24.26 (39.17) |
| | | | |
| Stroop items correct (T2) | 46.82 (4.97) | 47.43 (1.55) | 46.19 (6.87) |
| Stroop mean response time (T2) | 1122.08 (239.35) | 1117.67 (218.02) | 1126.62 (261.19) |
| Handgrip duration (T2) | 20.20 (30.40) | 16.30 (15.23) | 24.22 (40.26) |
| | | | |
| Pretzels consumed | 6.32 (8.49) | 5.33 (7.79) | 7.33 (9.10) |
| Chips consumed | 6.53 (8.49) | 6.08 (8.43) | 7.00 (8.59) |
| Cookies consumed | 14.77 (15.35) | 13.14 (14.73) | 16.45 (15.91) |
| Rice cakes consumed | 7.81 (8.98) | 6.18 (7.80) | 9.48 (9.70) |
| | | | |
| Total food consumed | 35.42 (27.36) | 30.73 (23.85) | 40.27 (29.97)* |
| Total sweet food consumed | 22.58 (19.26) | 19.32 (16.42) | 25.94 (21.42) |
| Total high-fat food consumed | 21.30 (20.45) | 19.21 (19.70) | 23.45 (21.38) |

Note. * $p < .05$. Stroop mean response time presented in milliseconds. Handgrip time presented in seconds. Food consumed measured by weight in grams. T1 = Time 1, pre-randomization. T2 = Time 2, post-intervention.

**Table 6.** Results (unstandardized coefficient (*SE)*) of mediation analyses for intervention group as predictor of eating outcome variables with change in affect and self-regulatory resources as mediators of the relationship.

| | Total Food | Sweet Food | High-Fat Food |
|---|---|---|---|
| | *B* (*SE*) | *B* (*SE*) | *B* (*SE*) |
| Total Effect (c) | 9.53 (4.75)* | 6.62 (3.35) | 4.24 (3.59) |
| Direct Effect (c') | 6.68 (5.06) | 4.54 (3.55) | 1.87 (3.79) |
| a1 path (PA) | 16.59 (14.29) | 16.59 (14.29) | 16.59 (14.29) |
| b1 path (PA) | 0.007 (0.03) | 0.01 (0.02) | 0.01 (0.02) |
| a2 path (NA) | 35.66 (17.00)* | 35.66 (17.00)* | 35.66 (17.00)* |
| b2 path (NA) | -0.003 (0.03) | 0.01 (0.02) | -0.01 (0.02) |
| a3 path (Relax) | -32.00 (9.42)*** | -32.00 (9.42)*** | -32.00 (9.42)*** |
| b3 path (Relax) | -0.08 (0.05) | -0.06 (0.04) | -0.08 (0.04)* |
| a4 path (Handgrip) | 0.59 (2.31) | 0.59 (2.31) | 0.59 (2.31) |
| b4 path (Handgrip) | 0.06 (0.18) | 0.01 (0.13) | 0.09 (0.14) |
| a5 path (Stroop) | 0.51 (0.37) | 0.51 (0.37) | 0.51 (0.37) |
| b5 path (Stroop) | 0.34 (1.15) | -0.15 (0.80) | -0.25 (0.86) |
| Total $R^2$ | 0.06 | 0.07 | 0.06 |

Note. *$p < .05$. ** $p < .01$. ***$p < .001$. N = 130. Mediator models included previous Stroop experience as a covariate.

**Table 7.** Bootstrapping multiple mediation estimates for mediation of the effect of group assignment on eating behaviors through change in affect and self-regulatory resources (path ab).

| | Total Food Consumed | | | | Sweet Food Consumed | | | | High Fat Food Consumed | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Bootstrapping BC 95% CI | | | | Bootstrapping BC 95% CI | | | | Bootstrapping BC 95% CI | |
| | Point Est. | SE | Lower | Upper | Point Est. | SE | Lower | Upper | Point Est. | SE | Lower | Upper |
| PA | 0.12 | 0.60 | -0.75 | 2.01 | 0.23 | 0.47 | -0.28 | 1.97 | 0.13 | 0.46 | -0.46 | 1.65 |
| NA | -0.11 | 1.05 | -2.45 | 1.88 | 0.35 | 0.76 | -0.83 | 2.40 | -0.31 | 0.77 | -2.25 | 1.00 |
| Relax | 2.63 | 2.37 | -0.61 | 9.52 | 1.87 | 1.57 | -0.21 | 6.32 | 2.62* | 1.74 | 0.21 | 7.37 |
| Handgrip | 0.04 | 0.44 | -0.56 | 1.35 | 0.01 | 0.27 | -0.49 | 0.63 | 0.05 | 0.36 | -0.42 | 1.34 |
| Stroop | 0.17 | 0.48 | -0.55 | 1.53 | -0.08 | 0.36 | -1.05 | 0.49 | -0.13 | 0.56 | -1.61 | 0.75 |
| Total | 2.85 | 2.54 | -0.76 | 9.58 | 2.38 | 1.69 | -0.08 | 6.65 | 2.36 | 1.89 | -0.56 | 70.4 |

Note. *$p < .05$ as determined by the 95% bias corrected bootstrapping confidence interval (BC 95% CI). All mediator variables are measures of change from pre-to-post randomization and intervention. Previous Stroop experience included as covariate in all models. PA = positive affect, NA = negative affect, Relax = subjective relaxation, Stroop = change in number of correct items on Stroop task, Total = total indirect effects. N = 130. 5000 bootstrap samples.

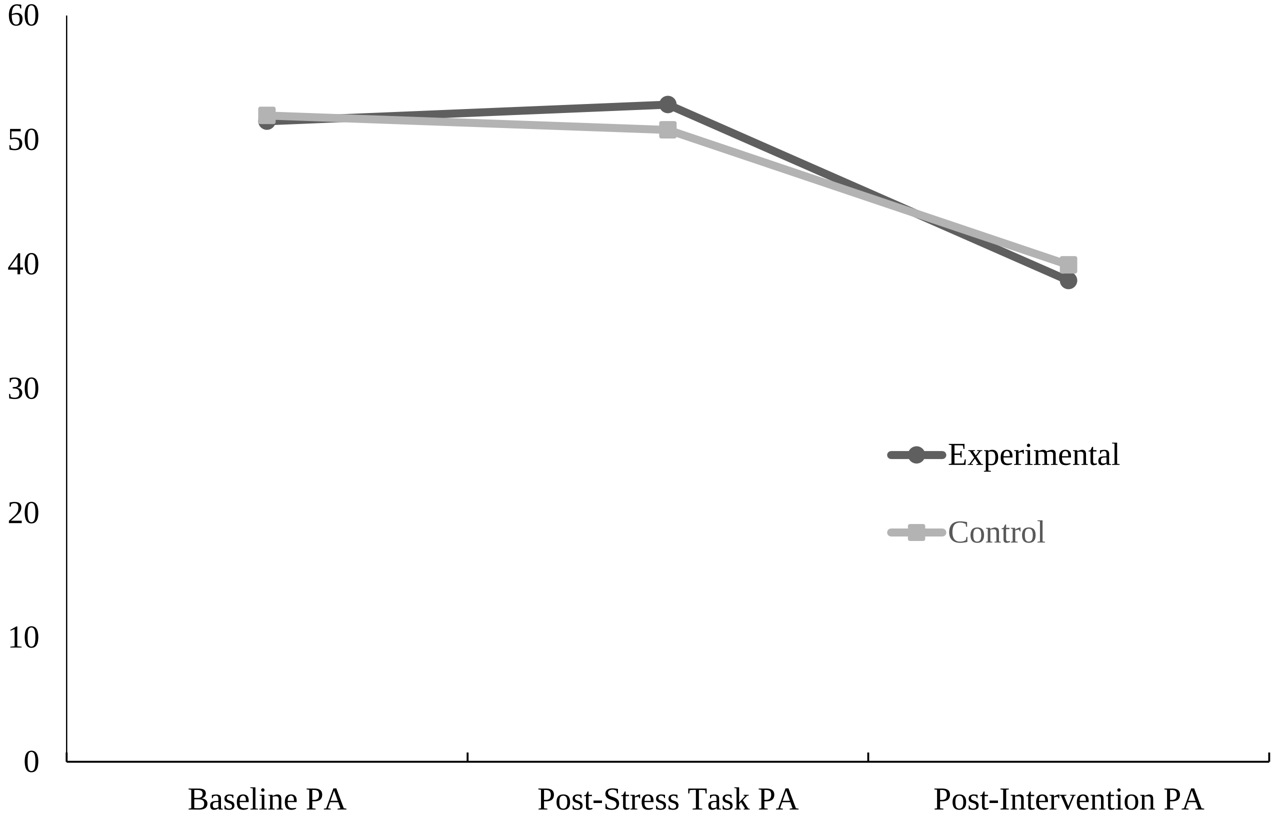


**Figure 4.** Positive affect by randomization group at baseline, post-stress task, and post-intervention.

*Note*. PA = positive affect.

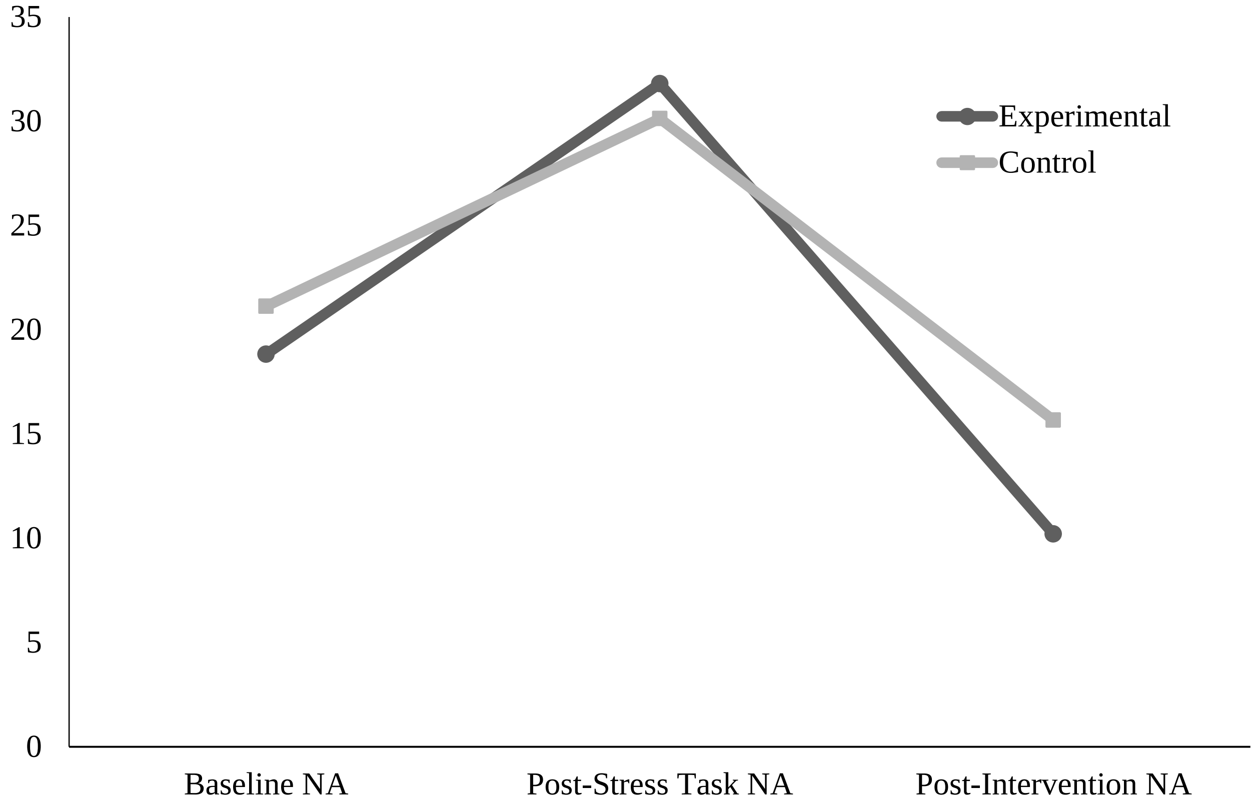


**Figure 5.** Negative affect by randomization group at baseline, post-stress task, and post-intervention.

*Note*. NA = Negative affect

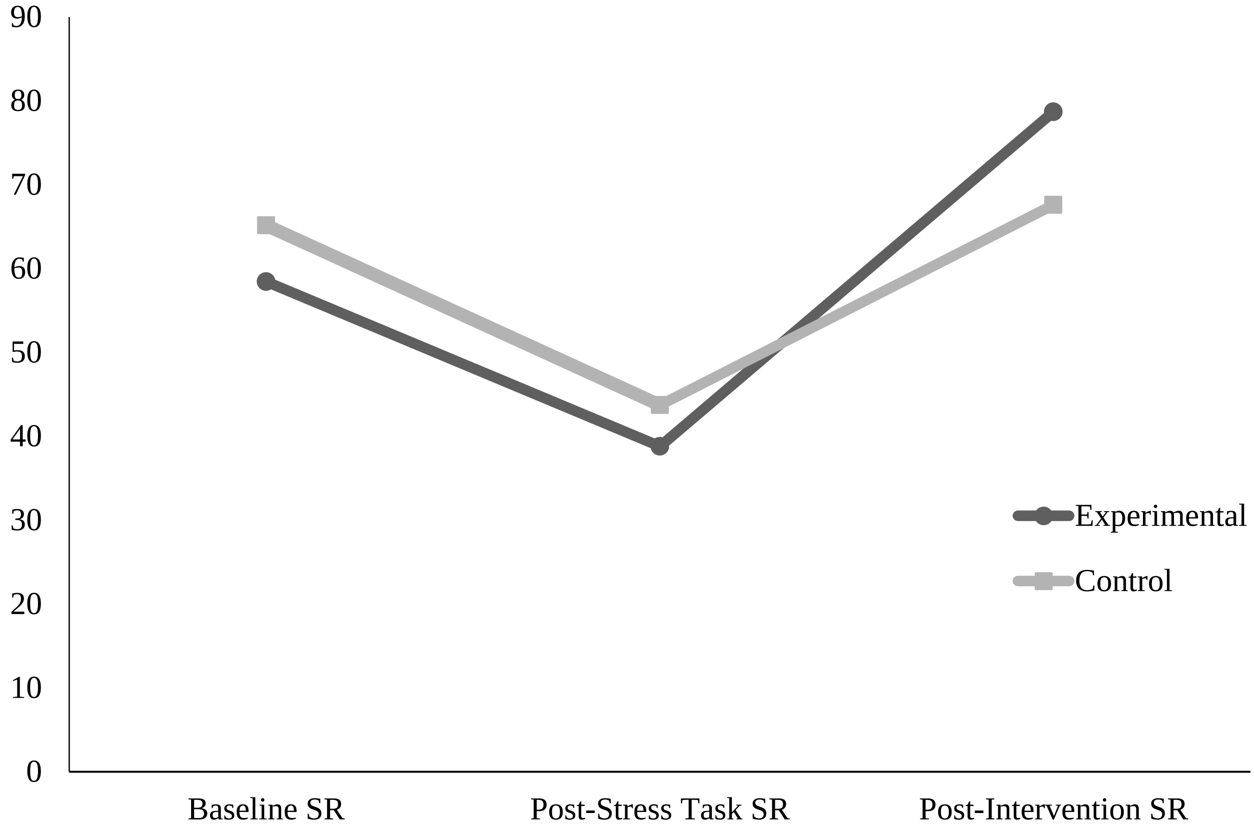


**Figure 6.** Subjective relaxation by randomization group at baseline, post-stress task, and post-intervention.

*Note*. SR = Subjective relaxation

## CHAPTER FOUR:

## DISCUSSION

The purpose of the current study was to evaluate the efficacy of a brief relaxation-based intervention in women with high levels of dietary restraint, a population at high-risk for stress-related eating (Greeno & Wing, 1994; Lattimore & Caswell, 2004; Roemmich, et al., 2002; Wardle, et al., 2000). In addition, the study examined change in affect and self-regulatory resources as potential psychological mechanisms of action based on extant theoretical models of emotional eating, self-regulatory resource-depletion, and restraint theories. Although previous research has examined the effectiveness of stress-reduction and relaxation in eating behaviors (e.g., Dalen et al., 2010; Daubenmier et al., 2011; Pawlow, et al., 2003), this is the first study using an experimental design to examine the efficacy of a single-session brief relaxation intervention on eating behaviors in a sample of women at-risk for stress-related eating.

Preliminary analyses were conducted to confirm the stress-induction task and relaxation interventions were effective. The first hypothesis, that the stress induction procedure would result in an increase in NA and decreased subjective feelings of calmness and relaxation, was supported. There was a significant increase in NA and decrease in subjective relaxation from baseline following completion of the stressful speech. The hypothesis that the stress task would decrease PA was not supported, as there was no significant change in PA levels. The anomalous PA data is discussed below, as PA performed inconsistently with hypothesized changes throughout the study. Overall, results indicate that the speech task was effective as a stress-

Inducing task and successfully increased levels of NA and decreased levels of subjective relaxation.

The second hypothesis, that participation in a relaxation exercise intervention would improve affect relative to no-treatment (i.e., increase PA and subjective relaxation and decrease), was partially supported. While both groups experienced improved NA and subjective relaxation from post-speech task levels, intervention group participants experienced greater improvement in NA and subjective relaxation than the control group. PA decreased for both groups from pre- to post-randomization with no significant group differences in PA levels.

The unanticipated results that PA did not decrease after completing the stress-task and that it decreased for both groups with no group differences post-intervention, might be explained by the nature of the items on the positive affect scale of the PANAS-SF. The intention was to measure PA in terms of pleasant mood state, but the PANAS-SF items seem to reflect more high-activation and energized states (e.g., excited, enthusiastic), rather than non-activated pleasant facets (Lucas & Fujita, 2000) of affect. While the PANAS is one of the most frequently researched and used measures of positive and negative affect, it has been suggested that that global PA scale of the PANAS may more accurately measure three distinct dimensions of PA (joy, interest, and activation), rather than the core positive emotion of happiness. These dimensions of PA may result in differential changes to various stimuli (Egloff, Schmukle, Burns, Kohlmann, & Hock, 2003). For example, in a series of experiments, Egloff et al. (2003) showed an increase in “activation” with a simultaneous decrease in “joy” from baseline to completion of a stressful speech task; however, no change was observed in total PA due to the opposite courses of the PA subscales. The same may be true for the current study, and given that a modified, abbreviated form of the PANAS (PANAS-SF) was utilized, it would be difficult to accurately ascertain whether specific facets (e.g., joy, interest, or activation) of PA changed as a function of engaging in the speech task.

That the PA scale may have been measuring activation and interest more so than simply "pleasant" affect can help to explain the observed pattern of results. It is possible that participants may have been experiencing high amounts of activation, interest, and/or joy when first presenting to the research study, a novel situation. This novel situation may have elicited this highly activated affective state, as reflected by the relatively high baseline levels of self-reported PA. Although the stress-task seemed to effectively elicit NA and reduce relaxation levels, there was no change in PA levels post-stress task, and PA dropped for both groups after the intervention or time-controlled waiting period. The possibility of a ceiling effect on PA from baseline to post-stress task must be considered. If participants entered the novel situation with high levels of activation indicated by elevated PA, their PA would not have much room for upward movement after engaging in a stressful task. The PA levels dropped for both groups post-randomization, which may reflect lower levels of activation due to habituation to what was initially a novel situation, or due to participation in the relaxation exercise or waiting in a quiet room. Thus, the lack of group differences and the unexpected direction of change in PA post-intervention may be due to the possibility that the PA subscale measuring multiple facets of PA (e.g., activation, joy, and interest), as opposed to a more general global pleasant facet of PA. Or, the lack of group differences may be explained by the more activated nature, rather than generally pleasant affective states, of the items on the scale which are inconsistent with the low-activation nature of relaxation states.

The primary aim of the study was to determine if participation in a relaxation intervention after a stressful experience would affect food consumption and food choices compared to a control group who waited alone silently in a small room for an equivalent amount of time. The results partially supported the primary hypothesis. The brief relaxation-based exercise resulted in less total food consumption. The size of the treatment effect was small to moderate and translates to a 25-30 kilocalorie difference in consumption between groups. Because previous research has suggested a trend towards making unhealthier food choices (e.g., higher fat and high sugar foods) as a result of stress (e.g., Habhab, Sheldon, & Loeb, 2009; Roberts, 2008; Royal & Kurtz, 2010), it was expected that the relaxation exercise would result in lower consumption of high-fat and high-sugar foods compared to the control condition. The results did not support this hypothesis, although there was a trend towards significantly lower consumption of sweet foods for the relaxation group compared to their control-group counterparts.

The findings of the current study extends upon previous studies that demonstrated increases in total food consumption or consumption of highly palatable "comfort foods" after stress (e.g., Oliver, Wardle, & Gibson, 2000; Zellner, et al., 2006). It also improves upon prior research demonstrating the utility of regularly practiced relaxation to regulate hunger and eating behaviors in persons with disordered eating patterns (Pawlow, O'Neil, & Malcolm, 2003). The current findings are unique, as this is the first study to experimentally examine the efficacy of a single-session relaxation intervention on eating behaviors. Previous studies have been methodologically flawed due to use of nonexperimental designs (Banks, 1981), confounded multifaceted relaxation programs (Dalen et al., 2010; Daubenmier et al., 2011), or unique clinical samples that preclude generalization of results to the broader population (Pawlow et al., 2003) Results from the current study demonstrate a reduction in total food consumption and trend towards less sweet foods consumed compared to a control group after a single-session relaxation intervention. This provides evidence of the utility of incorporating relaxation exercises as one adaptive and effective coping mechanism to mitigate the effects of stress within the context of programs aimed for weight management and alteration of maladaptive eating behaviors. This is particularly important for individuals who struggle with eating in response to stress, likely those high in dietary restraint who put forth significant effort to control their eating, or those who use food as a means to manage their emotions. Additionally, the modest difference in calorie consumption between groups occurred within a 10-minute period in the context of a tightly controlled laboratory setting. It is reasonable to suspect that the total-calorie difference may be more substantial without the experimentally mandated time constraints or within a more naturalistic setting. Furthermore, brief periods of stress-related eating could occur multiple times throughout a single day and small excesses in caloric consumption can add up over time. An excess of just 25 to 30 calories daily could add up to 3 pounds over a year, or 30 pounds over a 10-year period. Thus, even modest changes as a result of engaging in a relaxation exercise could reap significant benefits over time.

Affect and self-regulatory resources were investigated as potential psychological mechanisms to explain the relationship between engaging in a brief relaxation exercise and eating outcomes. It was hypothesized that participation in the relaxation intervention would result in improved self-regulatory resources and affective state (e.g., increased PA and subjective relaxation and decreased NA), which would mediate the relationship between group assignment and eating outcomes. The hypothesis that participation in a relaxation exercise intervention would result in better control of self-regulatory resources, relative to the control group, was not supported. No group differences were observed on measures of response latency or number of correct responses on a computerized Stroop task, nor on physical stamina measures of self-regulatory resources utilizing a handgrip tool. Although groups differed only on total food consumed, the proposed mediators of self-regulatory resources and affect change were tested for all eating outcomes, as Hayes (2009) suggests a significant IV to DV relationship is not necessary to test for indirect effects of mediator variables. He argues that the total effect is "the sum of many different paths of influence, direct and indirect, not all of which may be a part of the formal model." However, the proposed mechanisms of changes in affective state and self-regulatory resources did not explain the relationship between group assignment and eating outcomes. Only one significant indirect effect between group assignment and eating outcomes, the change in level of subjective relaxation on consumption of high-fat food items, was detected in this study. This suggests that participants who were most successful in increasing their sense of calmness and relaxation tended to consume less high-fat "comfort" foods (i.e., cookies and potato chips). While this is the only indirect effect supported in the current analysis, it provides additional evidence of the utility of engaging in relaxation exercises to modulate stress-related eating. However, although this finding is interesting and suggestive, because it was the only significant indirect effect, it should be interpreted with caution.

There are several possible explanations for these findings regarding proposed psychological mechanisms that should be considered. First, the measurement of affect change must be considered. As mentioned previously, the PA subscale of the PANAS-SF may not have adequately detected changes in pleasant affect and may have measured changes in other facets of PA. Further, PA, as it was measured, unexpectedly decreased after the intervention. Had the intervention resulted in increases in PA compared to the control group as hypothesized, group differences in self-regulatory resources may have been detected. Studies have shown that positive mood can counteract self-regulatory resource depletion, more so than engaging in a brief resting period (Tice, Baumeister, Shmueli, & Muraven, 2007). However, the active relaxation intervention in the current did not result in the anticipated PA benefits, and in fact, resulted in a decrease in PA as it was measured. Additionally, subjective relaxation level was measured by only 2-items added to the PANAS-SF (i.e., "calm" and "relaxed"), and the items were terms used in the relaxation exercise recording. It is possible that individuals in the relaxation intervention may have overestimated their level of subjective relaxation post-intervention as a result of priming or demand characteristics, with the assumption that the exercise was intended to induce a sense of calm and relaxation based on the language used.

Further, other possible mechanisms of the relaxation-eating behavior relationship, not examined in this study, should be considered. There is a significant amount of research implicating physiological mechanisms in the relationship between stress, eating behavior, and obesity. The hypothalamic-pituitary-adrenal (HPA), the major neuroendocrine system involved in stress responses, is the part of the stress system that releases cortisol, a hormone that plays a central role in the body's response to stress and illness (Foss & Dyrstad, 2011), into the bloodstream. Corticosteroids have significant stimulatory effects on energy intake and food preferences in both humans and rats (Dallman et al., 2004) and cortisol released during stress stimulates appetite (Takeda et al., 2004). Exogenous administration of cortisol has been shown to significantly increase food intake (Tataranni et al., 1996), so it logically follows that the natural increase in response to stressors elicits the same behavioral response. Further, as stress increases release of adrenal corticosteroids, this may enable recruitment of a chronic stress-response network that increases the salience of pleasurable or compulsive activities, in turn motivating the consumption of comfort foods. Eating "comfort foods" may regulate HPA responses and normalize effects of stress (Maniam & Morris, 2010). Research suggests eating comfort foods may alter HPA-axis activity in both humans as well as rats (Dallman et al., 2003 & 2010), providing evidence for a direct neuroendocrinological relationship between stress and eating. This physiological response may be independent of any subjective evaluation of relaxation, as measured in the current study. It is possible that these physiologic mechanisms may better explain the relationship between relaxation and eating behaviors than the proposed psychological mechanisms resulting from self-regulatory resource depletion theory, restraint theory, or emotional eating theory.

## Limitations and Future Directions

While this study uniquely contributes to the extant body of literature on the relationship between stress, relaxation, and eating behaviors, several limitations exist that should be addressed in future research. First, consideration should be given to the characteristics of the control group in potentially influencing study outcomes. The moderately small effect sizes for eating outcome variables, the absence of group differences on levels of self-regulatory resources, and lack of detection of indirect effects may be attributable in part to the nature of the control condition. Control group participants were instructed to wait in a room without distractions (e.g., no cell phones, reading material, etc.) for an equivalent amount of time as the relaxation intervention participants. Ostensibly, control group participants were assumed to have been ruminating about the stress task or focusing on the upcoming performance feedback, which would, among other things potentially maintain subjective stress levels. However, results indicate that simply waiting in the room was somewhat "relaxing," albeit not as relaxing as engaging in a relaxation intervention. This respite could possibly have conferred similar restorative benefits to self-regulatory resources theorized to occur after actively engaging in a relaxation exercise. Given that decreases in NA and PA and increases in subjective relaxation occurred in both groups post-intervention (although changes in NA and subjective relaxation were significantly greater for the intervention group), the relative effect of the relaxation intervention on eating outcomes could have been attenuated. Because the intervention did not differentiate the groups as much as anticipated (e.g., the control group experienced similar benefits as the experimental group, at a lower level), this may have made it more difficult to detect theorized differences in self-regulatory resources as a function of engagement in a relaxation exercise and reduced the size of the effect in eating behavior outcomes.

The control condition used in the current study may not have been as divergent from the intervention group as would likely be observed in "real world" situations. Specifically, sitting quietly for 20 minutes after a stressful situation may have provided a reprieve more similar to the experimental relaxation exercise than needing to address additional stressors that typically occurs in day-to-day life. Had a control condition more analogous to what happens in "real life" situations been utilized, eating outcomes might have been more robust allowing for a better test of theorized mechanisms. Thus, a control group that is more similar to real-life situations in which other stressors, or at least less relaxing conditions, are presented may provide a better comparison for the relaxation intervention group. Attempts should be made to utilize more ecologically valid control groups in future studies.

Second, the proposed psychological mediators for the relaxation-eating relationship were not supported in this study, so the mechanisms explaining the relationship between engagement in a relaxation intervention participation and reduced food consumption remain unclear. Thus, additional investigation of both the potential psychological and physiological mechanisms involved in the relationship between relaxation exercise participation and eating behavior outcomes warrants further investigation. Expansion of mediators studied and improved procedures related to overall group design and measurement of potential psychological mechanisms should be considered.

Third, the generalizability of the results is limited due to the nature of the sample, a relatively young sample of women high in dietary restraint from a large university campus. Participant self-selection bias should also be considered as analysis of eligible individuals (based on dietary restraint scores) who participated in the lab-study versus those who did not participate revealed that lab-study participants were slightly older and had slightly lower BMIs than their non-participant counterparts. Given that eligibility surveys focused on broad health-related behaviors, this may have had some influence on participants who were younger with higher BMIs deciding to opt out of experimental participation. Future studies should target a sample with greater variability in age to investigate the effectiveness of relaxation exercises on stress-related eating across the lifespan. Further, any eligibility screening should obscure the health-behavior related nature of future studies.

Lastly, given that this was a tightly controlled lab-based experiment, future studies examining the utility of brief relaxation interventions on eating behaviors in at-risk populations in more natural settings are necessary to determine the applicability of these results in "real-world" situations. The current study only provided a 10-minute period for eating, which may not be analogous to real-world settings in which time available to engage in stress-related eating is less tightly constrained. Further, participants' exposure to and/or experience in relaxation exercises should be considered and manipulated in future studies. Research suggests that greater amounts of relaxation and meditation practice results in greater efficiency and effectiveness of the exercises in engendering desired outcomes (Carlson & Hoyle, 1993; Manzoni, Pagnini, Castelnuovo, & Molinari, 2008). Thus, future studies should look at longer-term multi-session relaxation interventions to determine what dosage of relaxation exercise participation will result in the greatest improvements in eating behavior outcomes.

**Conclusions and Implications**

Relaxation interventions are often suggested as one means of helping to regulate stress induced eating behaviors not driven by physiological hunger (e.g., Pawlow, et al., 2003), yet there has been a lack of rigorous scientific evidence supporting this recommendation. This study is the first to provide experimental evidence of the efficacy of engaging in a brief relaxation exercise as a means to reduce food consumption in response to stress. Despite its limitations, the current study makes a timely contribution to existing literature on the relationship between stress and eating. Results suggest that engaging in a relaxation-based exercise after a stressful interpersonal task may result in decreases in food consumption in populations at-risk for stress-related eating. Further, even modest changes in eating and other lifestyle-related behaviors, can result in positive long-term health-related beneficial outcomes and this “small-change” approach is the recommended method for creating sustainable behavioral changes (Damschroder, et al., 2010; Gokee, LaRose, Tate, & Wing, 2010; Hill, 2009; Stroebele et al., 2009). While this study provides evidence of the utility of relaxation exercises in modulating stress-related eating, mechanisms of action remain unclear. Both psychological and physiological mechanisms theorized in the relaxation-eating relationship warrant further investigation. Nevertheless, the current study provides empirical clarity on the usefulness of the practice of relaxation as part of a multi-method approach to managing unhealthy eating behaviors influenced by stress levels, by reducing total post-stress calorie consumption.

## REFERENCES


Adler, N. E., & Ostrove, J. M. (1999). Socioeconomic Status and Health: What We Know and What We Don't. *Annals of the New York Academy of Sciences, 896*(1), 3-15. doi: 10.1111/j.1749-6632.1999.tb08101.x

Allison, D. B., Kalinsky, L. B., & Gorman, B. S. (1992). A comparison of the psychometric properties of three measures of dietary restraint. *Psychological Assessment, 4*(3), 391-398. doi: 10.1037/1040-3590.4.3.391

American Diabetes Association. (2012). Standards of medical care in diabetes--2012. *Diabetes Care, 35 Suppl 1*, S11-63. doi: 10.2337/dc12-s011

American Psychiatric Association. (2000). *Diagnostic and Statistical Manual of Mental Disorders, 4th ed., text revision*. Washington D. C.: American Psychiatric Association

Arnow, B., Kenardy, J., & Agras, W. S. (1995). The emotional eating scale: The development of a measure to assess coping with negative affect by eating. *International Journal of Eating Disorders, 18*(1), 79-90. doi: 10.1002/1098108x(199507)18:1<79::aideat2260180109>3.0.co;2-v

Banks, J. (1981). The effects of relaxation training and biofeedback on the weight of black obese clients. *Dissertation Abstracts International. B. The sciences and engineering, 42*, 965.

Baron, R. M., & Kenny, D. A. (1986). The moderator-mediator variable distinction in social psychological research: Conceptual, strategic, and statistical considerations. *Journal of Personality and Social Psychology, 51*, 1173-1182.

Baumeister, R. F., Bratslavsky, E., Muraven, M., & Tice, D. M. (1998). Ego depletion: is the active self a limited resource? *Journal of Personality and Social Psychology, 74*(5), 1252-1265.

Baumeister, R. F., Vohs, K. D., & Tice, D. M. (2007). The strength model of self-control. *Current Directions in Psychological Science 16*(6), 351-355. doi: 10.1111/j.1467-8721.2007.00534.x

Beary, J. F., & Benson, H. (1974). A simple psychophysiologic technique which elicits the hypometabolic changes of the relaxation response. *Psychosomatic Medieine, 36*(2), 115-120.

Beck, J. (2007). *The Beck Diet Solution: Train Your Brain to Think Like a Thin Person*. Birmingham, AL: Oxmoor House.

Benson, H. (1993). The Relaxation Response. In D. Goleman & J. Gurin (Eds.), *Mind Body Medicine: How to Use Your Mind for Better Health*. Yonkers, N.Y.: Consumer Reports Books.

Benson, H., Beary, J. F., & Carol, M. P. (1974). The relaxation response. *Psychiatry, 37*(1), 37-46.

Boon, B., Stroebe, W., Schut, H., & Ijntema, R. (2002). Ironic processes in the eating behavior of restrained eaters. *British Journal of Health Psychology, 7*(1), 1-10. doi: 10.1348/135910702169303

Boon, B., Stroebe, W., Schut, H., & Jansen, A. (1998). Food for thought: Cognitive regulation of food intake. *British Journal of Health Psychology, 3*(1), 27-40. doi: 10.1111/j.2044-8287.1998.tb00553.x

Booth, M. (2000). Assessment of Physical Activity: An International Perspective. *Research Quarterly for Exercise and Sport, 71*, 114.

Brownell, K. B. (2004). *The LEARN Program for Weight Management* (10th ed.). Dallas: American Health Publishing Company.

Buysse, D. J., Reynolds Iii, C. F., Monk, T. H., Berman, S. R., & Kupfer, D. J. (1989). The Pittsburgh sleep quality index: A new instrument for psychiatric practice and research. *Psychiatry Research*, *28*(2), 193-213. doi: http://dx.doi.org/10.1016/0165-1781(89)90047-4

Carrington, P., Collings, G. H., Benson, H., Robinson, H., Wood, L. W., Lehrer, P. M. (1980). The use of meditation--relaxation techniques for the management of stress in a working population. *Journal of Occupational Medicine: Official Publication of the Industrial Medical Association, 22*(4), 221-231.

Cohen, J. (1992). A power primer. *Psychological Bulletin, 112*(1), 155-159.

Cohen, S., & Williamson, G. (1988). *Perceived Stress in a Probability Sample of the United States*. Newbury Park, CA: Sage.

Craig, C. L., Marshall, A. L., Sjostrom, M., Bauman, A. E., booth, M. L., Ainsworth, B. E. (2003). International Physical Activity Questionnaire: 12-Country reliability and validity. *Medicine and Sciences in Sports and Exercise*, *35*(8), 1381-1395. doi: 10.1249/01.MSS.0000078924.61453.FB

Dalen, J., Smith, B. W., Shelley, B. M., Sloan, A. L., Leahigh, L., & Begay, D. (2010). Pilot study: Mindful Eating and Living (MEAL): weight, eating behavior, and psychological outcomes associated with a mindfulness-based intervention for people with obesity. *Complementary Therapies in Medicine, 18*(6), 260-264. doi: S0965-2299(10)00104-4

Dallman, M. F. (2010). Stress-induced obesity and the emotional nervous system. *Trends in Endocrinology and Metabolism, 21*(3), 159-165. doi: S1043-2760(09)00176-3 [pii] 10.1016/j.tem.2009.10.004

Dallman, M. F., la Fleur, S. E., Pecoraro, N. C., Gomez, F., Houshyar, H., & Akana, S. F. (2004). Minireview: glucocorticoids--food intake, abdominal obesity, and wealthy nations in 2004. *Endocrinology, 145*(6), 2633-2638. doi: 10.1210/en.2004-0037 en.2004-0037 [pii]

Dallman, M. F., Pecoraro, N., Akana, S. F., La Fleur, S. E., Gomez, F., Houshyar, H. (2003). Chronic stress and obesity: a new view of "comfort food". *Proceedings of the National Academy of Sciences of the United States of America, 100*(20), 11696-11701. doi: 10.1073/pnas.1934666100 1934666100 [pii]

Damschroder, L. J., Lutes, L.D., Goodrich, D.E., Gillon, L, Lowery, J. C. (2010). A small-change approach delivered via telephone promotes weight loss in veterans: Results from the ASPIRE-VA pilot study. *Patient Education Counseling, 79*, 262–266.

Daubenmier, J., Kristeller, J., Hecht, F. M., Maninger, N., Kuwata, M., Jhaveri, K. (2011). Mindfulness Intervention for Stress Eating to Reduce Cortisol and Abdominal Fat among Overweight and Obese Women: An Exploratory Randomized Controlled Study. *Journal of Obesity 2011*, 1-13. doi: 10.1155/2011/651936

de Lauzon-Guillain, B., Basdevant, A., Romon, M., Karlsson, J., Borys, J.-M., Charles, M. A. (2006). Is restrained eating a risk factor for weight gain in a general population? *The American Journal of Clinical Nutrition, 83*(1), 132-138.

DeWall, C. N., Baumeister, R. F., & Vohs, K. D. (2008). Satiated with belongingness? Effects of acceptance, rejection, and task framing on self-regulatory performance. *Journal of Personality and Social Psychology, 95*(6), 1367-1382. doi: 10.1037/a0012632

Divisi, D., Di Tommaso, S., Salvemini, S., Garramone, M., & Crisci, R. (2006). Diet and cancer. *Acta Biomedica-Ateneo Parmense, 77*(2), 118.

Drapkin, R. G., Wing, R. R., & Shiffman, S. (1995). Responses to hypothetical high risk situations: do they predict weight loss in a behavioral treatment program or the context of dietary lapses? *Health Psychology, 14*(5), 427-434.

Egloff, B., Schmukle, S. C., Burns, L. R., Kohlmann, C. W., & Hock, M. (2003). Facets of dynamic positive affect: differentiating joy, interest, and activation in the positive and negative affect schedule (PANAS). *Journal of Personality and Social Psychology, 85*(3), 528. DOI: 10.1037/0022-3514.85.3.528

Ely, D. R., Dapper, V., Marasca, J., CorrÃªa, J. B., Gamaro, G. D., Xavier, M. H. (1997). Effect of Restraint Stress on Feeding Behavior of Rats. *Physiology and Behavior, 61*(3), 395-398.

Emery, C. F., France, C. R., Harris, J., Norman, G., & Vanarsdalen, C. (2008). Effects of progressive muscle relaxation training on nociceptive flexion reflex threshold in healthy young adults: a randomized trial. *Pain, 138*(2), 375-379. doi: S0304-3959(08)00024-9

Feldman, P., Cohen, S., Lepore, S., Matthews, K., Kamarck, T., & Marsland, A. (1999). Negative emotions and acute physiological responses to stress. *Annals of Behavioral Medicine, 21*(3), 216-222. doi: 10.1007/bf02884836

Flegal, K. M., Carroll, M. D., Kit, B. K, Ogden, C. L. (2012). Prevalence of obesity and trends in the distribution of body mass index among us adults, 1999-2010. *Journal of the American Medical Association, 307*(5), 491-497.

Foss, B., & Dyrstad, S. M. (2011). Stress in obesity: cause or consequence? *Medical Hypotheses, 77*(1), 7-10. doi: S0306-9877(11)00113-7 [pii] 10.1016/j.mehy.2011.03.011

Fritz, M. S., & MacKinnon, D. P. (2007). Required Sample Size to Detect the Mediated Effect. *Psychological Science, 18*(3), 233-239. doi: 10.1111/j.1467-9280.2007.01882.x

Gailliot, M. T., Baumeister, R. F., DeWall, C. N., Maner, J. K., Plant, E. A., Tice, D. M. (2007). Self-control relies on glucose as a limited energy source: willpower is more than a metaphor. *Journal of Personality and Social Psychology, 92*(2), 325-336. doi: 2007-00654-010

Gailliot, M. T., Schmeichel, B. J., & Baumeister, R. F. (2006). Self-regulatory processes defend against the threat of death: Effects of self-control depletion and trait self-control on thoughts and fears of dying. *Journal of Personality and Social Psychology, 91*(1), 49-62. doi: 2006-08705-004

Gino, F., Schweitzer, M. E., Mead, N. L., & Ariely, D. (2011). Unable to resist temptation: How self-control depletion promotes unethical behavior. *Organizational Behavior and Human Decision Processes, 115,* 191 - 203. doi: 10.1016/j.obhdp.201 1.03.001

Gluck, M. E., Geliebter, A., & Satov, T. (2001). Night eating syndrome is associated with depression, low self-esteem, reduced daytime hunger, and less weight loss in obese outpatients. *Obesity Research, 9*(4), 264-267. doi: 10.1038/oby.2001.31

Go, A. S., Mozaffarian, D., Roger, V. r. L., Benjamin, E. J., Berry, J. D., Borden, W. B. (2013). Executive Summary: Heart Disease and Stroke Statisticsâ€"2013 Update: A Report From the American Heart Association. *Circulation, 127*(1), 143-152. doi: 10.1161/CIR.0b013e318282ab8f

Gokee LaRose, J, Tate, D.F., Gorin, A.A., & Wing, R.R. (2010). Preventing weight gain in young adults: A randomized controlled pilot study. *American Journal of Preventive Medicine, 39,*63–68.

Goldrosen, M. H., & Straus, S. E. (2004). Complementary and alternative medicine: assessing the evidence for immunological benefits. *Nature Reviews Immunology, 4*(11), 912-921.

Gosling, S. D., Rentfrow, P. J., & Swann, Jr. W. B. (2003). A very brief measure of the Big-Five personality domains. *Journal of Research in Personality, 37,* 504-528. doi:10.1016/S0092-6566(03)00046-1

Gramling, S. E., & Auerbach, S. M. (1998). *Stress Management Workbook: Techniques and Self-Assessment Procedures*. Upper Saddle River, NJ: Prentice Hall

Greeno, C. G., & Wing, R. R. (1994). Stress-induced eating. *Psycholoigcal Bulletin, 115*(3), 444-464.

Groesz, L. M., McCoy, S., Carl, J., Saslow, L., Stewart, J., Adler, N. (2012). What is eating you? Stress and the drive to eat. *Appetite, 58*(2), 717-721. doi: S0195-6663(11)00657-X

Grossman, P., Niemann, L., Schmidt, S., & Walach, H. (2004). Mindfulness-based stress reduction and health benefits. A meta-analysis. *Journal of Psychosomatic Research,, 57*(1), 35-43. doi: 10.1016/S0022-3999(03)00573-7

Grunberg, N. E., & Straub, R. O. (1992). The role of gender and taste class in the effects of stress on eating. *Health Psychology, 11*(2), 97-100.

Grundy, S. M., Cleeman, J. I., Daniels, S. R., Donato, K. A., Eckel, R. H., Franklin, B. A. (2005). Diagnosis and Management of the Metabolic Syndrome: An American Heart Association/National Heart, Lung, and Blood Institute Scientific Statement. *Circulation, 112*(17), 2735-2752. doi: 10.1161/circulationaha.105.169404

Habhab, S., Sheldon, J. P., & Loeb, R. C. (2009). The relationship between stress, dietary restraint, and food preferences in women. *Appetite, 52*(2), 437-444. doi: S0195-6663(08)00627-2

Hayes, A. F. (2009). Beyond Baron and Kenny: Statistical mediation analysis in the new millennium. *Communication Monographs*, *76*(4), 408-420.

Heatherton, T. F., & Baumeister, R. F. (1991). Binge eating as escape from self-awareness. *Psychological Bulletin, 110*(1), 86.

Heatherton, T. F., Herman, C. P., & Polivy, J. (1991). Effects of physical threat and ego threat on eating behavior. *Journal of Personality and Social Psychology, 60*(1), 138-143.

Heatherton, T. F., Polivy, J., Herman, C. P., & Baumeister, R. F. (1993). Self-awareness, task failure, and disinhibition: how attentional focus affects eating. *J Pers, 61*(1), 49-61.

Herman, C. P., & Polivy, J. (1980). *Restrained Eating*. Philadelphia: Saunders.

Herman, C. P., & Polivy, J. (1984). A boundary model for the regulation of eating. In Stunkard, A.J., & Stellar, E. (Eds.), *Eating and Its Disorders*, 141-156. New York: Raven Press

Herman, C. P., & Polivy, J. (1988). *Studies of eating in normal dieters*. Washington, DC: American Psychiatric Association Press.

Hill, J. O. (2009). Can a small-changes approach help address the obesity epidemic? A report of the Joint Task Force of the American Society for Nutrition, Institute of Food Technologists, and International Food Information Council. *The American Journal of Clinical Nutrition*, *89*(2), 477-484.

Hofmann, W., Rauch, W., & Gawronski, B. (2007). And deplete us not into temptation: Automatic attitudes, dietary restraint, and self-regulatory resources as determinants of eating behavior. *Journal of Experimental Social Psychology, 43*(3), 497-504.

Johns, M., Inzlicht, M., & Schmader, T. (2008). Stereotype threat and executive resource depletion: examining the influence of emotion regulation. *Journal of Experimental Ppsychology, General, 137*(4), 691. doi: 10.1037/a0013834

Kahan, D., Polivy, J., & Herman, C. P. (2003). Conformity and dietary disinhibition: A test of the ego-strength model of self-regulation. *International Journal of Eating Disorders, 33*(2), 165-171.

Kandiah, J., Yake, M., Jones, J., & Meyer, M. (2006). Stress influences appetiet and comfort food preferences in college women. *Nutrition Research, 26,* 118-123.

Kercher, K. (1992). Assessing Subjective Well-Being in the Old-Old: The PANAS as a Measure of Orthogonal Dimensions of Positive and Negative Affect. *Research on Aging, 14*(2), 131-168. doi: 10.1177/0164027592142001

Khalfa, S., Bella, S. D., Roy, M., Peretz, I., & Lupien, S. J. (2003). Effects of relaxing music on salivary cortisol level after psychological stress. *Annals of the New York Academy of Sciences,* 999, 374-376. DOI: 10.1196/annals.1284.045

Kirschbaum, C., Pirke, K. M., & Hellhammer, D. H. (1993). The ‘Trier Social Stress Test’– A tool for investigating psychobiological stress responses in a laboratory setting. *Neuropsychobiology*, *28*, 76-81.

Koo-Loeb, J. H., Costello, N., Light, K. C., & Girdler, S. S. (2000). Women with eating disorder tendencies display altered cardiovascular, neuroendocrine, and psychosocial profiles. *Psychosomatic Medicine, 62*(4), 539-548.

Kraag, G., Zeegers, M. P., Kok, G., Hosman, C., & Abu-Saad, H. H. (2006). School programs targeting stress management in children and adolescents: A meta-analysis. *Journal of School Psychology, 44*(6), 449-472.

Kristeller, J. L., & Hallett, C. B. (1999). An Exploratory Study of a Meditation-based Intervention for Binge Eating Disorder. *Journal of Health Psychology, 4*(3), 357-363. doi: 4/3/357

Lattimore, P., & Caswell, N. (2004). Differential effects of active and passive stress on food intake in restrained and unrestrained eaters. *Appetite, 42*(2), 167-173. doi: 10.1016/j.appet.2003.09.002

Lazarus, R. S., & Folkman, S. (1984). *Stress, Appraisal, and Coping*. New York, NY: Springer.

Lemmens, S. G., Rutters, F., Born, J. M., & Westerterp-Plantenga, M. S. (2011). Stress augments food 'wanting' and energy intake in visceral overweight subjects in the absence of hunger. *Physiology and Behavior, 103*(2), 157-163. doi: S0031-9384(11)00024-2 10.1016/j.physbeh.2011.01.009

Levine, M., & Marcus, M. (1997). Eating behavior following stress in women with and without bulimic symptoms. *Annals of Behavioral Medicine, 19*(2), 132-138. doi: 10.1007/bf02883330

Li, Y., Qi, Q., Workalemahu, T., Hu, F. B., & Qi, L. (2012). Birth weight, genetic susceptibility, and adulthood risk of type 2 diabetes. *Diabetes Care*. doi: 10.2337/dc12-0168

Lichtenstein, A. H., Appel, L. J., Brands, M., Carnethon, M., Daniels, S., Franch, H. A. (2006). Diet and Lifestyle Recommendations Revision 2006: A Scientific Statement From the American Heart Association Nutrition Committee. *Circulation, 114*(1), 82-96. doi: 10.1161/circulationaha.106.176158

Lieberman, H. R., Wurtman, J. J., & Chew, B. (1986). Changes in mood after carbohydrate consumption among obese individuals. *The American Journal of Clinical Nutrition, 44*(6), 772-778.

Lowe, M. R., & Kral, T. V. (2006). Stress-induced eating in restrained eaters may not be caused by stress or restraint. *Appetite, 46*(1), 16-21. doi: S0195-6663(05)00111-X

Lucas, R. E., & Fujita, F. (2000). Factors influencing the relation between extraversion and pleasant affect. *Journal of Personality and Social Psychology, 79*(6), 1039.

Macht, M. (2008). How emotions affect eating: a five-way model. *Appetite, 50*(1), 1-11. doi: S0195-6663(07)00323-6

Macht, M., Haupt, C., & Ellgring, H. (2005). The perceived function of eating is changed during examination stress: a field study. *Eating Behavior, 6*(2), 109-112. doi: S1471-0153(04)00065-0

Macht, M., & Mueller, J. (2007). Immediate effects of chocolate on experimentally induced mood states. *Appetite, 49*(3), 667-674. doi: S0195-6663(07)00298-X

Mackinnon, A., Jorm, A. F., Christensen, H., Korten, A. E., Jacomb, P. A., & Rodgers, B. (1999). A short form of the Positive and Negative Affect Schedule: evaluation of factorial validity and invariance across demographic variables in a community sample. *Personality and Individual Differences, 27*(3), 405-416. doi: 10.1016/S0191-8869(98)00251-7

Maniam, J., & Morris, M. J. (2010). Long-term postpartum anxiety and depression-like behavior in mother rats subjected to maternal separation are ameliorated by palatable high fat diet. *Behavioural Brain Research, 208,* 72-79. doi: 10.1016/j.bbr.2009.11.005

Manzoni, G. M., Gorini, A., Preziosa, A., Pagnini, F., Castelnuovo, G., Molinari, E. (2008). New technologies and relaxation: An explorative study on obese patients with emotional eating. *Journal of CyberTherapy and Rehabilitation, 1*(2), 182-191.

Manzoni, G. M., Pagnini, F., Castelnuovo, G., & Molinari, E. (2008). Relaxation training for anxiety: A ten-years systematic review with meta-analysis. *BMC Psychiatry, 8,* 41. doi: 10.1186/1471-244X-8-41.

Manzoni, G. M., Pagnini, F., Gorini, A., Preziosa, A., Castelnuovo, G., Molinari, E. (2009). Can relaxation training reduce emotional eating in women with obesity? An exploratory study with 3 months of follow-up. *Journal of the American Dietetic Association, 109*(8), 1427-1432. doi: S0002-8223(09)00626-9 [pii]10.1016/j.jada.2009.05.004

Markland, D., & Tobin, V. (2004). A modification to the Behavioural Regulation in Exercise Questionnaire to include an assessment of amotivation. *Journal of Sport & Exercise Psychology*, *26*(2), 191.

Muraven, M., & Baumeister, R. F. (2000). Self-regulation and depletion of limited resources: does self-control resemble a muscle? *Psychological Bulletin, 126*(2), 247-259.

Muraven, M., Collins, R. L., & Nienhaus, K. (2002). Self-control and alcohol restraint: an initial application of the self-control strength model. *Psychology of Addictive Behaviors: Journal of the Society of Psychologists in Addictive Behaviors, 16*(2), 113.

Muraven, M., Tice, D. M., & Baumeister, R. F. (1998). Self-control as limited resource: regulatory depletion patterns. *Journal of Personality and Social Psychology, 74*(3), 774-789.

National Institutes of Health: National Heart, L., and Blood Institute. (1998). *Clinical guidelines on the identification, evaluation, and treatment of overweight and obesity in adults: The evidence report*.

Ng, D. M. (2003). Relationships between perceived stress and health behaviors in a sample of working adults. *Health Psychology, 22*(6), 638.

Oliver, G., Wardle, J., & Gibson, E. L. (2000). Stress and food choice: a laboratory study. *Psychosomatic Medicine, 62*(6), 853-865.

Pawlow, L. A. (2002). The impact of abbreviated progressive muscle relaxation on salivary cortisol. *Biological psychology, 60*(1), 1.

Pawlow, L. A., O'Neil, P. M., & Malcolm, R. J. (2003). Night eating syndrome: effects of brief relaxation training on stress, mood, hunger, and eating patterns. *International Journal of Obesity and Related Metabolic Disorders, 27*(8), 970-978. doi: 10.1038/sj.ijo.0802320 0802320 [pii]

Preacher, K. J., & Hayes, A. F. (2004). SPSS and SAS procedures for estimating indirect effects in simple mediation models. *Behavior Research Methods, Instruments, and Computers, 36*(4), 717-731.

Preacher, K. J., & Hayes, A. F. (2008). Asymptotic and resampling strategies for assessing and comparing indirect effects in multiple mediator models. *Behavior Research Methods, 40*(3), 879891.

Rausch, S. M., Gramling, S. E., & Auerbach, S. M. (2006). Effects of a single session of largegroup meditation and progressive muscle relaxation training on stress reduction, reactivity, and recovery. *International Journal of Stress Management, 13*(3), 273-290. doi: 10.1037/1072-5245.13.3.273

Richardson, K. M., & Rothstein, H. R. (2008). Effects of occupational stress management intervention programs: A meta-analysis. *Journal of occupational health psychology, 13*(1), 69.

Richeson, J. A., Baird, A. A., Gordon, H. L., Heatherton, T. F., Wyland, C. L., Trawalter, S. (2003). An fMRI investigation of the impact of interracial contact on executive function. *Nature Neuroscience*, *6*(12), 1323-1328. doi: 10.1038/nn1156nn1156 [pii]

Roberts, C. J. (2008). The effects of stress on food choice, mood and bodyweight in healthy women. *Nutrition Bulletin* (33), 33-39.

Roemmich, J. N., Lambiase, M. J., Lobarinas, C. L., & Balantekin, K. N. (2011). Interactive effects of dietary restraint and adiposity on stress-induced eating and the food choice of children. *Eating Behaviors, 12*(4), 309-312. doi: S1471-0153(11)00064-X [pii]10.1016/j.eatbeh.2011.07.003

Roemmich, J. N., Wright, S. M., & Epstein, L. H. (2002). Dietary Restraint and Stress-Induced Snacking in Youth. *Obesity Research, 10*(11), 1120-1126. doi: 10.1038/oby.2002.152

Rosenthal, N. E., Genhart, M. J., Caballero, B., Jacobsen, F. M., Skwerer, R. G., Coursey, R. D. (1989). Psychobiological effects of carbohydrate-and protein-rich meals in patients with seasonal affective disorder and normal controls. *Biological Psychiatry, 25*(8), 1029-1040. doi: 10.1016/0006-3223(89)90291-6

Rowland, N. E., & Antelman, S. M. (1976). Stress-induced hyperphagia and obesity in rats: a possible model for understanding human obesity. *Science, 191*(4224), 310-312.

Royal, J. D., & Kurtz, J. L. (2010). I ate what?! The effect of stress and dispositional eating style on food intake and behavioral awareness. *Personality and Individual Differences, 49*, 565-569. doi: 10.1016/j.paid.2010.04.022

Ruderman, A. J. (1986). Dietary restraint: A theoretical and empirical review. *Psychological Bulletin, 99*(2), 247.

Shapiro, S. L., & Schwartz, G. E. (2000). Intentional systemic mindfulness: An integrative model for self-regulation and health. *Advances in Mind-Body Medicine, 16*(2), 128-134. doi: 10.1054/ambm.1999.0118ambm.1999.0118 [pii]

Sherlin, L., Gevirtz, R., Wyckoff, S., & Muench, F. (2009). Effects of respiratory sinus arrhythmia biofeedback versus passive biofeedback control. *International Journal of Stress Management, 16*(3), 233-248. doi: 10.1037/a0016047

Silveira, P. P. (2000). Interaction between repeated restraint stress and concomitant midazolam administration on sweet food ingestion in rats. *Brazilian Journal of Medical and Biological Research, 33*(11), 1343.

Smith, B. A., Fillion, T. J., & Blass, E. M. (1990). Orally mediated sources of calming in 1- to 3day-old human infants. *Developmental Psychology, 26*(5), 731-737.

Spitzer, L., & Rodin, J. (1983). Arousal-induced eating: Conventional wisdom or empirical findings? In J. Capiocco & R. Petty (Eds.), *Social Psychophysiology* (pp. 565-591). New York: Guilford Press.

Stroebele, N., de Castro, J. M., Stuht, J., Catenacci, V., Wyatt, H. R., & Hill, J. O. (2009). A small-changes approach reduces energy intake in free-living humans. *Journal of the American College of Nutrition*, *28*(1), 63-68.

Stroop, J. R. (1935). Studies of interference in serial verbal reactions. *Journal of Experimental Psychology, 18*(6), 643-662. doi: 10.1037/h0054651

Stunkard, A. J., Grace, W. J., & Wolff, H. G. (1955). The night-eating syndrome: A pattern of food intake among certain obese patients. *The American Journal of Medicine, 19*(1), 78-86. doi: 0002-9343(55)90276-X [pii]

Stunkard, A. J., & Messick, S. (1985). The three-factor eating questionnaire to measure dietary restraint, disinhibition and hunger. *Journal of Psychosomatic Research, 29*(1), 71-83.

Takeda, E., Terao, J., Nakaya, Y., Miyamoto, K., Baba, Y., Chuman, H. (2004). Stress control and human nutrition. *The Journal of Medical Investigation*, *51*, 139-145.

Tataranni, P. A., Larson, D. E., Snitker, S., Young, J. B., Flatt, J. P., & Ravussin, E. (1996). Effects of glucocorticoids on energy metabolism and food intake in humans. *American Journal of Physiology, 271*(2 Pt 1), E317-325.

Tice, D. M., Baumeister, R. F., Shmueli, D., & Muraven, M. (2007). Restoring the self: Positive affect helps improve self-regulation following ego depletion. *Journal of Experimental Social Psychology, 43*(3), 379-384.

van Dixhoorn, J. J., & Duivenvoorden, H. J. (1999). Effect of relaxation therapy on cardiac events after myocardial infarction: a 5-year follow-up study. *Journal of Cardiopulmonary Rehabilitation and Prevention, 19*(3), 178-185.

van Strien, T., Frijters, J. E. R., Bergers, G. P. A., & Defares, P. B. (1986). The Dutch Eating Behavior Questionnaire (DEBQ) for assessment of restrained, emotional, and external eating behavior. *International Journal of Eating Disorders, 5*(2), 295-315. doi: 10.1002/1098-108x(198602)5:2<295::aid-eat2260050209>3.0.co;2-t

Vancampfort, D., Correll, C. U., Scheewe, T. W., Probst, M., De Herdt, A., Knapen, J. (2013). Progressive muscle relaxation in persons with schizophrenia: a systematic review of randomized controlled trials. *Clinical Rehabilitation, 27(4),* 291-298. doi: 0269215512455531 [pii]10.1177/0269215512455531

Vancampfort, D., De Hert, M., Knapen, J., Maurissen, K., Raepsaet, J., Deckx, S. (2011). Effects of progressive muscle relaxation on state anxiety and subjective well-being in people with schizophrenia: a randomized controlled trial. *Clinical Rehabilitation, 25*(6), 567-575. doi: 0269215510395633 [pii]10.1177/0269215510395633

Vohs, K. D., Baumeister, R. F., & Ciarocco, N. J. (2005). Self-regulation and self-presentation: regulatory resource depletion impairs impression management and effortful selfpresentation depletes regulatory resources. *J Pers Soc Psychol, 88*(4), 632-657. doi: 2005-02948-004 [pii]10.1037/0022-3514.88.4.632

Vohs, K. D., & Heatherton, T. F. (2000). Self-regulatory failure: a resource-depletion approach. *Psychological Science, 11*(3), 249-254.

Wallach, M. B., Dawber, M., McMahon, M., & Rogers, C. (1977). A new anorexigen assay: Stress-induced hyperphagia in rats. *Pharmacology Biochemistry and Behavior, 6*(5), 529-531.

Wallis, D. J., & Hetherington, M. M. (2009). Emotions and eating. Self-reported and experimentally induced changes in food intake under stress. *Appetite, 52*(2), 355-362. doi: S0195-6663(08)00605-3 [pii]10.1016/j.appet.2008.11.007

Ward, A., & Mann, T. (2000). Don't mind if I do: disinhibited eating under cognitive load. *Journal of Personality and Social Psychology, 78*(4), 753.

Wardle, J. (1987). Eating style: a validation study of the Dutch Eating Behaviour Questionnaire in normal subjects and women with eating disorders. *Journal of Psychosomatic Resesarch, 31*(2), 161-169.

Wardle, J., Steptoe, A., Oliver, G., & Lipsey, Z. (2000). Stress, dietary restraint and food intake. *Journal of Psychosomatic Research, 48*(2), 195-202. doi: S0022-3999(00)00076-3 [pii]

Watson, D., Clark, L. A., & Tellegen, A. (1988). Development and validation of brief measures of positive and negative affect: the PANAS scales. *Journal of Personality and Social Psychology, 54*(6), 1063-1070.

Wiebe, D. J., & McCallum, D. M. (1986). Health practices and hardiness as mediators in the stress-illness relationship. *Health Psychology, 5*(5), 425-438. doi: 10.1037/0278-6133.5.5.425

Wiser, S., & Telch, C. F. (1999). Dialectical behavior therapy for Binge-Eating Disorder. *Journal of Clinical Psychology 55*(6), 755-768. doi: 10.1002/(SICI)1097-4679(199906)55:6<755::AID-JCLP8>3.0.CO;2-R [pii]

World Health Organization. (2003). *Diet, nutrition, and the prevention of chronic diseases. Report of a Joint WHO/FAO Expert Consultation* (1990/01/01 ed. Vol. 916). Geneva, Switzerland: World Health Organization

Xavier Educational Software Ltd. (2006). English Stroop Test [Software]. Retrieved from http://www.xavier-educationalsoftware.co.uk/swgal/English_Stroop_Test/EnglishStroop.html

Yanovski, S. Z. (1993). Binge eating disorder: current knowledge and future directions. *Obesity Research, 1*(4), 306-324.

Yanovski, S. Z. (2003). Binge eating disorder and obesity in 2003: could treating an eating disorder have a positive effect on the obesity epidemic? *International Journal of Eating Disorders, 34 Suppl*, S117-120. doi: 10.1002/eat.10211

Zellner, D. A., Loaiza, S., Gonzalez, Z., Pita, J., Morales, J., Pecora, D. (2006). Food selection changes under stress. *Physiology and Behavior, 87*(4), 789-793. doi: S0031-9384(06)00042-4 [pii]10.1016/j.physbeh.2006.01.014

Zellner, D. A., Saito, S., & Gonzalez, J. (2007). The effect of stress on men's food selection. *Appetite, 49*(3), 696-699. doi: S0195-6663(07)00321-2 [pii]10.1016/j.appet.2007.06.013

# APPENDICES

**Appendix A: Positive and Negative Affect Schedule Short Form – Trait**

**POSITIVE AND NEGATIVE AFFECT SCHEDULE SHORT FORM – TRAIT (PANAS- SF-TRAIT)**

This scale consists of a number of words that describe different feelings and emotions. Read each item and then mark the appropriate answer in the space next to that word. **Indicate to what extent you feel this way GENERALLY, that is, how you feel MOST OF THE TIME.** Use the following scale:

| Very Slightly or Not at all<br>1 | A little<br>2 | Moderately<br>3 | Quite a bit<br>4 | Extremely<br>5 |
|---|---|---|---|---|

| | | | | | |
|---|---|---|---|---|---|
| **Distressed** | 1 | 2 | 3 | 4 | 5 |
| **Excited** | 1 | 2 | 3 | 4 | 5 |
| **Upset** | 1 | 2 | 3 | 4 | 5 |
| **Scared** | 1 | 2 | 3 | 4 | 5 |
| **Enthusiastic** | 1 | 2 | 3 | 4 | 5 |
| **Relaxed** | 1 | 2 | 3 | 4 | 5 |
| **Alert** | 1 | 2 | 3 | 4 | 5 |
| **Inspired** | 1 | 2 | 3 | 4 | 5 |
| **Nervous** | 1 | 2 | 3 | 4 | 5 |
| **Determined** | 1 | 2 | 3 | 4 | 5 |
| **Afraid** | 1 | 2 | 3 | 4 | 5 |
| **Calm** | 1 | 2 | 3 | 4 | 5 |

**Appendix B: Positive and Negative Affect Schedule Short Form – State**

**POSITIVE AND NEGATIVE AFFECT SCHEDULE – STATE (PANAS-SF-STATE)**

This scale consists of a number of words that describe different feelings and emotions. Read each item and then mark the appropriate answer in the space next to that word. **Indicate to what extent you feel this way RIGHT NOW, that is, AT THIS PRESENT MOMENT:**

| Very Slightly or Not at all 1 | A little 2 | Moderately 3 | Quite a bit 4 | Extremely 5 |
|---|---|---|---|---|

| | | | | | |
|---|---|---|---|---|---|
| **Distressed** | 1 | 2 | 3 | 4 | 5 |
| **Excited** | 1 | 2 | 3 | 4 | 5 |
| **Upset** | 1 | 2 | 3 | 4 | 5 |
| **Scared** | 1 | 2 | 3 | 4 | 5 |
| **Enthusiastic** | 1 | 2 | 3 | 4 | 5 |
| **Relaxed** | 1 | 2 | 3 | 4 | 5 |
| **Alert** | 1 | 2 | 3 | 4 | 5 |
| **Inspired** | 1 | 2 | 3 | 4 | 5 |
| **Nervous** | 1 | 2 | 3 | 4 | 5 |
| **Determined** | 1 | 2 | 3 | 4 | 5 |
| **Afraid** | 1 | 2 | 3 | 4 | 5 |
| **Calm** | 1 | 2 | 3 | 4 | 5 |

**Appendix C: Dutch Eating Behavior Questionnaire – Restraint and Emotional Eating**

Please use the following scoring key to answering the following questions:

**Never (1) Seldom (2) Sometimes (3) Often (4) Very Often (5) Not Relevant (NA)**

| | | | | | | |
|---|---|---|---|---|---|---|
| 1. If you have put on weight, do you eat less than you usually do? | 1 | 2 | 3 | 4 | 5 | NA |
| 2. Do you try to eat less at mealtimes than you would like to eat? | 1 | 2 | 3 | 4 | 5 | |
| 3. How often do you refuse food or drink offered because you are concerned about your weight? | 1 | 2 | 3 | 4 | 5 | |
| 4. Do you watch exactly what you eat? | 1 | 2 | 3 | 4 | 5 | |
| 5. Do you deliberately eat foods that are slimming? | 1 | 2 | 3 | 4 | 5 | |
| 6. When you have eaten too much, do you eat less than usual the following days? | 1 | 2 | 3 | 4 | 5 | NA |
| 7. Do you deliberately eat less in order not to become heavier? | 1 | 2 | 3 | 4 | 5 | |
| 8. How often do you try not to eat between meals because you are watching your weight? | 1 | 2 | 3 | 4 | 5 | |
| 9. How often in the evening do you try not to eat because you are watching your weight? | 1 | 2 | 3 | 4 | 5 | |
| 10. Do you take into account your weight with what you eat? | 1 | 2 | 3 | 4 | 5 | |
| 11. Do you have the desire to eat when you are irritated? | 1 | 2 | 3 | 4 | 5 | NA |
| 12. Do you have a desire to eat when you have nothing to do? | 1 | 2 | 3 | 4 | 5 | NA |
| 13. Do you have a desire to eat when you are depressed or discouraged? | 1 | 2 | 3 | 4 | 5 | NA |
| 14. Do you have a desire to eat when you are feeling lonely? | 1 | 2 | 3 | 4 | 5 | NA |
| 15. Do you have a desire to eat when somebody lets you down? | 1 | 2 | 3 | 4 | 5 | NA |
| 16. Do you have a desire to eat when you are cross? | 1 | 2 | 3 | 4 | 5 | NA |
| 17. Do you have a desire to eat when you are anticipating something unpleasant to happen? | 1 | 2 | 3 | 4 | 5 | |
| 18. Do you get the desire to eat when you are anxious, worried or tense? | 1 | 2 | 3 | 4 | 5 | |
| 19. Do you have a desire to eat when things are going against you or when things have gone wrong? | 1 | 2 | 3 | 4 | 5 | |
| 20. Do you have a desire to eat when you are frightened? | 1 | 2 | 3 | 4 | 5 | NA |
| 21. Do you have a desire to eat when you are disappointed? | 1 | 2 | 3 | 4 | 5 | NA |
| 22. Do you have a desire to eat when you are emotionally upset? | 1 | 2 | 3 | 4 | 5 | NA |
| 23. Do you have a desire to eat when you are bored or restless? | 1 | 2 | 3 | 4 | 5 | NA |

**Appendix D: Post-Experimental Questionnaire**

Post-Experimental Questionnaire

Please answer the following questions as accurately as possible.

1. How many hours and/or minutes before the start of this study (which began approximately 45 minutes ago) did you last eat?

_______ **Hours** _______ **Minutes** before beginning of study

Was this a: (Please check one) ☐ Meal ☐ Snack

2. Are you currently dieting in an effort to reduce or control your body weight or shape?

(Please check one) ☐ Yes ☐ No

3. Please briefly describe what you believe the purpose of this study was:

______________________________________________________________

______________________________________________________________

______________________________________________________________

______________________________________________________________

## Appendix E: The Pittsburgh Sleep Quality Index

Instructions: The following questions relate to your usual sleep habits during the past month only. Your answers should indicate the most accurate reply for the majority of days and nights in the past month. Please answer all questions. During the past month,

1. When have you usually gone to bed? ________________________________
2. How long (in minutes) has it taken you to fall asleep each night? _________________________
3. When have you usually gotten up in the morning? ________________________________
4. 4. How many hours of actual sleep do you get at night? (This may be different than the number of hours you spend in bed) ___________________________________

5. During the past month, how often have you had trouble sleeping because you…

| | Not during the past month (0) | Less than once a week (1) | Once or twice a week (2) | Three or more times a week (3) |
|---|---|---|---|---|
| a. Cannot get to sleep within 30 minutes | | | | |
| b. Wake up in the middle of the night or early morning | | | | |
| c. Have to get up to use the bathroom | | | | |
| d. Cannot breathe comfortably | | | | |
| e. Cough or snore loudly | | | | |
| f. Feel too cold | | | | |
| g. Feel too hot | | | | |
| h. Have bad dreams | | | | |
| i. Have pain | | | | |
| j. Other reason(s), please describe, including how often you have had trouble sleeping because of this reason(s) | | | | |
| 6. During the past month, how often have you taken medicine (prescribed or "over the counter)" to help you sleep? | | | | |
| 7. During the past month, how often have you had trouble staying awake while driving, eating meals, or engaging in social activity? | | | | |
| 8. During the past month, how much of a problem has it been for you to keep up enthusiasm to get things done? | | | | |
| 9. During the past month, how would you rate your sleep quality overall? | Very good (0) | Fairly good (1) | Fairly bad (2) | Very bad (3) |

**Appendix F: Perceived Stress Scale**

The questions in this scale ask you about your feelings and thoughts **during the last month**. In each case, you will be asked to indicate by circling *how often* you felt or thought a certain way.

**0 = Never 1 = Almost Never 2 = Sometimes 3 = Fairly Often 4 = Very Often**

| | | | | | |
|---|---|---|---|---|---|
| 1. In the last month, how often have you been upset because of something that happened unexpectedly? .……... | **0** | **1** | **2** | **3** | **4** |
| 2. In the last month, how often have you felt that you were unable to control important things in your life? ………………. | **0** | **1** | **2** | **3** | **4** |
| 3. In the last month, how often have you felt nervous and "stressed"? ……...………………...………………...………… | **0** | **1** | **2** | **3** | **4** |
| 4. In the last month, how often have you felt confident about your ability to handle your personal problems? …….………… | **0** | **1** | **2** | **3** | **4** |
| 5. In the last month, how often have you felt that things were going your way? ……...………………...……………….. | **0** | **1** | **2** | **3** | **4** |
| 6. In the last month, how often have you found that you could not cope with all the things that you had to do? ….….……… | **0** | **1** | **2** | **3** | **4** |
| 7. In the last month, how often have you been able to control irritations in your life? ……...………………...………………... | **0** | **1** | **2** | **3** | **4** |
| 8. In the last month, how often have you felt that you were on top of things? ………………...………………...…………………. | **0** | **1** | **2** | **3** | **4** |
| 9. In the last month, how often have you been angered because of things that were outside of your control? ………..... | **0** | **1** | **2** | **3** | **4** |
| 10. In the last month, how often have you felt difficulties were piling up so high that you could not overcome them? … | **0** | **1** | **2** | **3** | **4** |

## Appendix G: International Physical Activity Questionnaire – Usual Week Self-Administered Format

We are interested in finding out about the kinds of physical activities that people do as part of their everyday lives. The questions will ask you about the time you spend being physically active in **a usual week** (if the last week was usual, think about the last 7 days). Please answer each question even if you do not consider yourself to be an active person. Please think about the activities you do at work/school, as part of your house and yard work, to get from place to place, and in your spare time for recreation, exercise or sport.

Think about all the **vigorous** activities that you do in **a usual week**. **Vigorous** physical activities refer to activities that take hard physical effort and make you breathe much harder than normal. Think *only* about those physical activities that you do for at least 10 minutes at a time.

1. During **a usual week**, on how many days do you do **vigorous** physical activities like heavy lifting, digging, aerobics, or fast bicycling?

    _____ **days per week**

    ☐ No vigorous physical activities → ***Skip to question 3***

2. How much time do you usually spend doing **vigorous** physical activities on one of those days?

    _____ **hours per day**

    _____ **minutes per day**

    ☐ Don't know/Not sure

Think about all the **moderate** activities that you do in **a usual week**. **Moderate** activities refer to activities that take moderate physical effort and make you breathe somewhat harder than normal. Think only about those physical activities that you do for at least 10 minutes at a time.

3. During **a usual week**, on how many days do you do **moderate** physical activities like carrying light loads, bicycling at a regular pace, or doubles tennis? Do not include walking.

    _____ **days per week**

    ☐ No moderate physical activities → ***Skip to question 5***

4. How much time do you usually spend doing **moderate** physical activities on one of those days?

_____ **hours per day**

_____ **minutes per day**

☐ Don't know/Not sure

Think about the time you spend **walking** in **a usual week**. This includes at work and at home, walking to travel from place to place, and any other walking that you have done solely for recreation, sport, exercise, or leisure.

5. During **a usual week**, on how many days do you **walk** for at least 10 minutes at a time?

_____ **days per week**

☐ No walking → ***Skip to question 7***

6. How much time do you usually spend **walking** on one of those days?

_____ **hours per day**

_____ **minutes per day**

☐ Don't know/Not sure

The last question is about the time you spend **sitting** on weekdays during **a usual week**. Include time spent at work, at home, while doing course work and during leisure time. This may include time spent sitting at a desk, visiting friends, reading, or sitting or lying down to watch television.

7. During **a usual week**, how much time do you spend **sitting** on a **week day**?

_____ **hours per day**

_____ **minutes per day**

☐ Don't know/Not sure

**This is the end of the questionnaire, thank you for participating.**

## Appendix H: Behavioral Regulations in Exercise Questionnaire-2

***WHY DO YOU ENGAGE IN EXERCISE?***

**We are interested in the reasons underlying peoples' decisions to engage, or not engage in physical exercise. Using the scale below, please indicate to what extent each of the following items is true for you. Please note that there are no right or wrong answers and no trick questions. We simply want to know how you personally feel about exercise. Your responses will be held in confidence and only used for our research purposes.**

| | | **Not true for me** | | **Sometimes true for me** | | **Very true for me** |
|---|---|---|---|---|---|---|
| 1 | I exercise because other people say I should | 0 | 1 | 2 | 3 | 4 |
| 2 | I feel guilty when I don't exercise | 0 | 1 | 2 | 3 | 4 |
| 3 | I value the benefits of exercise | 0 | 1 | 2 | 3 | 4 |
| 4 | I exercise because it's fun | 0 | 1 | 2 | 3 | 4 |
| 5 | I don't see why I should have to exercise | 0 | 1 | 2 | 3 | 4 |
| 6 | I take part in exercise because my friends/family/partner say I should | 0 | 1 | 2 | 3 | 4 |
| 7 | I feel ashamed when I miss an exercise session | 0 | 1 | 2 | 3 | 4 |
| 8 | It's important to me to exercise regularly | 0 | 1 | 2 | 3 | 4 |
| 9 | I can't see why I should bother exercising | 0 | 1 | 2 | 3 | 4 |
| 10 | I enjoy my exercise sessions | 0 | 1 | 2 | 3 | 4 |
| 11 | I exercise because others will not be pleased with me if I don't | 0 | 1 | 2 | 3 | 4 |
| 12 | I don't see the point in exercising | 0 | 1 | 2 | 3 | 4 |
| 13 | I feel like a failure when I haven't exercised in a while | 0 | 1 | 2 | 3 | 4 |
| 14 | I think it is important to make the effort to exercise regularly | 0 | 1 | 2 | 3 | 4 |
| 15 | I find exercise a pleasurable activity | 0 | 1 | 2 | 3 | 4 |
| 16 | I feel under pressure from my friends/family to exercise | 0 | 1 | 2 | 3 | 4 |
| 17 | I get restless if I don't exercise regularly | 0 | 1 | 2 | 3 | 4 |
| 18 | I get pleasure and satisfaction from participating in exercise | 0 | 1 | 2 | 3 | 4 |
| 19 | I think exercising is a waste of time | 0 | 1 | 2 | 3 | 4 |

## Appendix I: Three Factor Eating Questionnaire – Disinhibition

Part I: For items 1-13, please respond using the scale: **T = TRUE F = FALSE**

| | | |
|---|---|---|
| 1. When I smell a sizzling steak or see a juicy piece of meat, I find it very difficult to keep from eating, even if I have just finished a meal. | T | F |
| 2. I usually eat too much at social occasions, like parties and picnics. | T | F |
| 3. Sometimes things just taste so good that I keep on eating even when I am no longer hungry. | T | F |
| 4. When I feel anxious, I find myself eating. | T | F |
| 5. Since my weight goes up and down, I have gone on reducing diets more than once. | T | F |
| 6. When I am with someone who is overeating, I usually overeat too. | T | F |
| 7. Sometimes when I start eating, I just can't seem to stop. | T | F |
| 8. It is not difficult for me to leave something on my plate. | T | F |
| 9. When I feel blue, I often overeat. | T | F |
| 10. My weight has hardly changed at all in the last ten years. | T | F |
| 11. When I feel lonely, I console myself by eating. | T | F |
| 12. Without even thinking about it, I take a long time to eat. | T | F |
| 13. While on a diet, if I eat a food that is not allowed, I often then splurge and eat other high calorie foods. | T | F |

Part II: For items 14-16, please answer the following questions by indicating which number above the response is appropriate to you.

| | | | |
|---|---|---|---|
| 14. Do you eat sensibly in front of others and splurge alone? | | | |
| 1<br>Never | 2<br>Rarely | 3<br>Often | 4<br>Always |
| 15. Do you go on eating binges though you are not hungry? | | | |
| 1 Never | 2<br>Rarely | 3 Sometimes | 4<br>At least once a week |
| 16. To what extent does this statement describe your eating behavior? "I start dieting in the morning, but because of any number of things that happen during the day, by evening I have given up and eat what I want, promising myself to start dieting again tomorrow? | | | |
| 1<br>Not like me | 2<br>Little like me | 3<br>Pretty good description of me | 4<br>Describes me perfectly |

**Appendix J: Ten-Item Personality Inventory**

**Instructions:** Here are a number of personality traits that may or may not apply to you. Please circle a number next to each statement to indicate the extent to which *you agree or disagree with that statement.* You should rate the extent to which the pair of traits applies to you, even if one characteristic applies more strongly than the other.

| 1<br>Disagree strongly | 2<br>Disagree moderately | 3<br>Disagree a little | 4<br>Neither agree nor disagree | 5<br>Agree a little | 6<br>Agree moderately | 7<br>Agree strongly |
|---|---|---|---|---|---|---|

*I see myself as…*

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 1. Extraverted, enthusiastic. | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| 2. Critical, quarrelsome. | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| 3. Dependable, self-disciplined. | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| 4. Anxious, easily upset. | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| 5. Open to new experiences, complex | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| 6. Reserved, quiet. | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| 7. Sympathetic, warm. | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| 8. Disorganized, careless. | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| 9. Calm, emotionally stable. | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| 10. Conventional, uncreative. | 1 | 2 | 3 | 4 | 5 | 6 | 7 |

**Appendix K: Speech Task Instructions Script**

[*Researcher speaking to participant.*] You have been assigned to the personal speech condition. Your task is to prepare and deliver a 3-minute speech about your strengths and weaknesses as a friend. You should focus on both the positive and negative aspects about yourself as a friend, and consider how these characteristics affect your friendships. You will present the speech in front of me and I will be videotaping it. Immediately after your speech, it will be rated by a panel of laboratory staff who have been trained to evaluate how effectively you can deliver a speech. They will be judging your speech on a variety of qualities, including, poise, articulation, style, openness, organization, and likability as a speaker. You will receive feedback on your performance at the end of the study. You will have 2-minutes to prepare your speech, then you will have 3 minutes to deliver your speech. If you stop speaking before the 3-minutes is up, I will ask you to continue speaking until the full 3 minute period is finished. Do you have any questions? [PAUSE AND WAIT FOR RESPONSE] Your 2-minute preparatory period begins now. [*The researcher begins 2 minute timer for speech preparation and prepares video recorder.*]

[*When 2-minute time period is complete, researcher stops participant.]* Now we are ready for the speech, I am going to turn on the video recorder

[*Researcher starts recording.]*. When I say "begin," please begin your 3-minute speech about your strengths and weaknesses as a friend. Be sure to focus on both the positive and negative qualities, and keep in mind the evaluation criteria for your speech. Begin. [*Start timer. If the participant stops speaking before 3 minutes have elapsed, probe her to elaborate by saying any* *of the following*]: Tell me more about that. Please continue. What are your other strengths and weaknesses as a friend?

[*Alarm sounds*.] Thank you. Your speech time has elapsed. Please direct your attention to the computer monitor, sit quietly, and complete these measures. I am going to send your speech recording to the panel for evaluation.

## Appendix L: Relaxation Audio Script

The relaxation script includes portions of eliciting the relaxation response, progressive muscle relaxation, and autogenic training derived from the work of Benson and colleagues (1974, 1993) and Gramling & Auerbach (1998).

**Instructions**: This recording will guide you through a series of relaxation exercises to help relax your mind and body. The exercises include clearing and relaxing the mind as well as the body through progressive muscle relaxation in which you will methodically sweep through your body, tensing then relaxing each major muscle group. This attunes you to the difference in feeling when your muscles are tensed or relaxed. The relaxation exercise will take approximately 20 minutes to complete. Please get as comfortable as you can in the chair and feel free to remove your shoes or loosen any clothing to help you get as comfortable as possible.

**Relaxation audio recording script:**

First, settle back as comfortably as you can and close your eyes. Start by taking in a few deep natural breaths. Tell yourself that breathing and relaxation are the only things you need to think about right now. Clear your mind. Everything else you're worried about or have to do today can wait until you are done. Let this be your time. Give yourself permission to take this time to relax and enjoy the sensations of relaxation you create.

Pick a focus word or short phrase that's firmly rooted in your personal belief system. For example, you might choose a neutral word like "one" or "peace" or "love." Sit quietly in your comfortable position.

Relax your muscles.

Breathe slowly and naturally, repeating your focus word or phrase silently as you exhale.

Throughout, assume a passive attitude. Don't worry about how well you're doing. When other thoughts come to mind, simply say to yourself, "Oh, well," and gently return to the repetitions.

Now continue relaxing your mind and body and bring your attention to the muscles in your body. You will methodically sweep through the muscles in your body, tensing then relaxing each major muscle group.

First, tense the muscles throughout your body, from head to toe. Tighten your feet and legs, tense your arms and hands, clench your jaw, and contract your stomach. Hold the tension while you sense the feelings of strain and tightness. Study the tension and notice the difference between how the muscle feels when it is tensed and when it is relaxed. Then take a deep breath, hold it, and exhale long and slowly as you relax all your muscles, letting go of the tension. Notice the sense of relief as you relax.

Now you're going to tense and relax individual groups of muscles, keeping the rest of your body as relaxed as you can. You'll hold the tension for a few seconds in each part of your body while you get a clear sense of what the tension feels like: then breathe deeply, hold the breath for a moment, and let go of the tension as you exhale.

Start by making your hands into tight fists. Feel the tension throughout your hands and arms. Relax and let go of the tension. Now press your arms down against the surface they're resting on. Feel the tension. Hold it… and let go. Let your arms and hands go limp.

Shrug your shoulders tight, up toward your head, feeling the tension through your neck and shoulders. Hold… then release, letting go. Drop your shoulders down, free of tension.

Now, wrinkle your forehead, sensing the tightness. Hold… release, letting your forehead be smooth and relaxed. Shut your eyes as tight as you can. Hold… and let go. Now open your mouth as wide as you can. Hold it… and gently relax, letting your lips touch softly. Then clench your jaw, teeth tight together. Hold… and relax. Let the muscles of your face be soft and relaxed, at ease.

Take a few moments to sense the relaxation throughout your arms and shoulders, up through your face. Now take a deep breath, filling your lungs down through your abdomen. Hold your breath wile you feel the tension through your chest. Then exhale and let your chest relax, your breath natural and easy. Suck in your stomach, holding the muscles tight… and relax. Arch your back… hold… and ease your back down gently, letting it relax. Feel the relaxation spreading through your whole upper body.

Now tense your hips and buttocks, pressing your legs and heels against the surface beneath you… hold… and relax. Curl your toes down, so they point away from your knees… hold… and let go of the tension, relaxing your legs and feet. Then bend your toes back up towards your knees… hold… and relax.

Now feel your whole body at rest, letting go of more tension with each breath… your face relaxed and soft… your arms and shoulders easy… stomach, chest, and back soft and relaxed… your legs and feet resting at ease… your whole body soft and relaxed.

Keeping your eyes closed and your whole body soft and relaxed, focus on the sensations of breathing. Imagine your breathing rolling in and out like ocean waves. Think quietly to yourself, "My breath is calm and effortless… calm and effortless…" Repeat this phrase to yourself as you imagine waves of relaxation flowing through your body; through your chest and shoulders, into your arms and back, into your hips and legs. Feel a sense of tranquility moving through your entire body. Continue for several minutes…

Now focus on your arms and hands. Think to yourself, “My arms are heavy and warm. Warmth is flowing gently through my arms into my wrists, hands, and fingers. My arms and hands are heavy and warm.” Stay with these thoughts and the feelings in your arms and hands for several minutes…

Now bring your focus to your legs for a few minutes. Imagine warmth and heaviness flowing from your arms down into your legs. Think to yourself: “My legs are becoming heavy and warm. Warmth is flowing through my feet… down into my toes. My legs and feet are heavy and warm.”

Now scan your body for any points of tension, and if you find some, let them go limp, your muscles relaxed. Notice how heavy, warm, and limp your body has become. Think to yourself, “All my muscles are letting go. I’m getting more and more relaxed.”

Finally, take a deep breath, feeling the air fill your lungs and down into your abdomen. As you breathe out, think, “I am calm… I am calm…” Do this for a few moments, feeling the peacefulness throughout your body. Take time to enjoy this state of relaxation for several minutes, feeling the deep calm and peace.

As I count to three, take a deep breath and exhale with each number. When you are ready, open your eyes and begin to move slowly before standing up. Stretch before going back to your activities.

**Appendix M: IRB Approval Determination Letter**

UNIVERSITY OF SOUTH FLORIDA

RESEARCH INTEGRITY AND COMPLIANCE
Institutional Review Boards, FWA No. 00001669
12901 Bruce B. Downs Blvd., MDC035 • Tampa, FL 33612-4799
(813) 974-5638 • FAX (813) 974-7091

9/24/2013

Ms. Laura Mayhew
University of South Florida
Department of Psychology
4202 East Fowler Avenue, PCD 4118G
Tampa, FL 33620

RE: **Full Board Approval for Initial Review**
IRB#: Pro00014123
Title: Effects of a brief relaxation intervention on stress-related eating
**Study Approval Period: 9/20/2013 to 9/20/2014**

Dear Ms. Mayhew:

On 9/20/2013, the Institutional Review Board (IRB) reviewed and **APPROVED** the above application and all documents outlined below.

**Approved Item(s):**
**Protocol Document(s):**
Laura Mayhew Dissertation Proposal POST PROPOSAL UPDATES

**Consent/Assent Document(s)*:**
Pro00014123 INFORMED CONSENT Version1 9.9.13

*Please use only the official IRB stamped informed consent/assent document(s) found under the "Attachments" tab. Please note, these consent/assent document(s) are only valid during the approval period indicated at the top of the form(s).

As the principal investigator of this study, it is your responsibility to conduct this study in accordance with IRB policies and procedures and as approved by the IRB. Any changes to the approved research must be submitted to the IRB for review and approval by an amendment.

We appreciate your dedication to the ethical conduct of human subject research at the University of South Florida and your continued commitment to human research protections. If you have any questions regarding this matter, please call 813-974-5638.

Sincerely,

John Schinka, Ph.D., Chairperson
USF Institutional Review Board

## Appendix N: IRB Continuing Review Approval Letter

USF
UNIVERSITY OF SOUTH FLORIDA

RESEARCH INTEGRITY AND COMPLIANCE
Institutional Review Boards, FWA No. 00001669
12901 Bruce B. Downs Blvd., MDC035 • Tampa, FL 33612-4799
(813) 974-5638 • FAX (813) 974-7091

9/19/2014

Laura Mayhew, M.A.
Psychology
4202 East Fowler Avenue, PCD 4118G
Tampa, FL 33620

RE: **Full Board Approval for Continuing Review**
IRB#: CR1_Pro00014123
Title: Effects of a brief relaxation intervention on stress-related eating

**Study Approval Period: 9/20/2014 to 9/20/2015**

Dear Ms. Mayhew:

On 9/19/2014, the Institutional Review Board (IRB) reviewed and **APPROVED** the above application and documents outlined below.

**Approved Item(s):**
**Protocol Document(s):**
Laura Mayhew Dissertation Proposal POST PROPOSAL UPDATES Version4 5.25.14.docx

**Please submit an amendment to the IRB within 30 days to update the study staff.**

As the principal investigator of this study, it is your responsibility to conduct this study in accordance with IRB policies and procedures and as approved by the IRB. Any changes to the approved research must be submitted to the IRB for review and approval by an amendment.

We appreciate your dedication to the ethical conduct of human subject research at the University of South Florida and your continued commitment to human research protections. If you have any questions regarding this matter, please call 813-974-5638.

Sincerely,

John A. Schinka, Ph.D.

John Schinka, Ph.D., Chairperson
USF Institutional Review Board