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I am submitting herewith a thesis written by Jessica L Sieber entitled "Stress and Eating Behaviors: A Systematic Review." I have examined the final electronic copy of this thesis for form and content and recommend that it be accepted in partial fulfillment of the requirements for the degree of Master of Science, with a major in Nutrition.

Lisa Jahns, Major Professor

We have read this thesis
And recommend its acceptance:

Jay Whelan

Lana Dixon

Accepted for the Council:

Carolyn R. Hodges, Vice Provost
and Dean of the Graduate School

(Original signatures are on file with official student records)

Stress and Eating Behaviors: A Systematic Review

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Abstract

Background: The effects of psychological stress on eating behaviors either through psychological/social influences (i.e. comfort foods, learned behaviors) or psychoneuroendocrine pathways have been studied for many years; however, a review of current research is lacking. The purpose of this study is to conduct a systematic literature review of the relationship between stress and eating behaviors with a concentration on how stress and eating behaviors are measured.

Methods: PubMed and PsycINFO databases were searched to identify peer-reviewed English-language human studies published between 1966 and March 2006. Keywords and subject headings used were: stress, eating, feeding behaviors, food habits, energy intake, diet, appetite, stress-related eating, stress eating, stress induced eating, and dietary restraint. This resulted in the retrieval of 1025 citations. Numerous exclusion criteria were applied and after review, 50 articles were deemed relevant and included in the study.

Results: There is little consistency in either measurement of stress or measurement of eating behavior. Despite the heterogeneity in both exposure and outcomes, studies have found some relationships between stress and eating. Stress may impact intake by increasing or decreasing frequency of eating or increasing selection of foods high in fat, sugar, and/or salt.

Conclusions: The variety in the measurement of both stress and eating behavior in the stress-eating literature has produced wide-ranging and somewhat inconsistent results. Oftentimes the participants are studied in either a laboratory setting or at only one point in time, both of which are insufficient to measure overall changes in diet caused by stress. Further research, including more comprehensive assessment of eating behavior changes caused by stress, is needed to better understand the stress-eating relationship and its possible health effects. In the fast-paced society we live in, many individuals experience high levels of stress on a daily basis, creating the potential to significantly contribute to unhealthy dietary behaviors both immediately and long-term.

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Introduction

Stress-eating

The relationship between psychological stress (hereafter, “stress” will refer to psychological, not oxidative or disease state stress) and eating behavior has been studied for many years and thrice reviewed (Robbins and Fray 1980; Morley, Levine and Rowland 1983; Greeno and Wing 1994). Terms such as “comfort food” and “stress-eating” are commonly used in popular literature and culture to describe the changes in food preference, cravings, or amount of food eaten in response to stress.

Stress may affect eating behaviors through **1. psychological or social influences** (i.e. through comfort foods, learned behaviors) (Willenbring, Levine and Morley 1986; Stone and Brownell 1994; Weinstein, Shide and Rolls 1997; Conner, Fitter and Fletcher 1999; Oliver and Wardle 1999; Oliver, Wardle et al. 2000; Wardle, Steptoe et al. 2000; Laitinen, Ek and Sovio 2002; O'Connor and O'Connor 2004; Wallis and Hetherington 2004; Oaten and Cheng 2005; Kandiah, Yake et al 2006) and/or **2. physiological or psychoneuroendocrine pathways** (i.e. changes in cortisol and insulin levels)(Rutledge and Linden 1998; Epel, Moyer et al. 1999; Epel, McEwen et al. 2000; Epel, Lapidus et al. 2001; Epel, Jimenez et al. 2004; Takeda, Terao et al. 2004; Dallman, Pecoraro et al. 2005).

The relationship between stress and eating behavior has been found to vary not only between studies but also among individual characteristics within studies. In addition, study methodology differs by measurement of both the nature of the stress (acute vs.

long-term) and the dietary behaviors affected. Currently, there is no “best practices” measurement of this effect.

Figure A-1 (all Figures and Tables appear in the Appendix) shows the pathways by which stress may effect eating. Pathway **a** depicts the route by which a stressor is appraised by the individual. If the stressor is perceived as stress, an emotional and/or physiological response is triggered which in turn may affect eating behavior. Pathway **b** represents a benign appraisal where the individual has the adaptive capacity to handle the stressor and does not recognize the stressor as a threat; therefore no changes in the individual are made. Pathways **c** and **d** represent the ways in which stress and stress-eating may affect risk for chronic disease. The curved arrows show where and how stress and eating behaviors are measured. Effect modifiers that may affect the individual’s stress eating response are found in the oval around the figure.

An effect modifier is a variable that may change the direction or magnitude of the association between an exposure (stress) and an outcome (eating behavior) (Oleckno 2002). When an association is stratified by a potential effect modifier, relationships can be seen more clearly within a stratum than in the whole group. Effect modification is a real effect that does not need to be controlled for in research but rather should be used to help reveal the true relationship between the exposure and outcome. These effect modifiers affect the stress-eating relationship as well as risk for chronic disease throughout the entire process since these factors are inherent in the individual’s nature.

Effect modifiers studied in the stress-eating literature are restraint, disinhibition, emotional eating, gender and weight. Restrained eating is a term that refers to the control an individual places upon their eating to consciously limit their food intake to prevent

weight gain or to promote weight loss (Herman and Polivy 1975). Disinhibition is a term that is closely related with restraint. Disinhibition is the process by which a restrained individual allows themselves to eat food they would normally restrict. Emotional eating refers to eating in response to emotions or feelings rather than out of hunger. These variables along with gender and weight are investigated in the stress-eating literature.

Stress related eating may have the potential to significantly contribute to unhealthy eating behaviors. If stress-eating takes place often or even daily, these eating behaviors can result in unhealthy weight change and changes in physiologic measures such as nocturnal levels of insulin, cortisol, and blood levels of total/HDL cholesterol ratio (Epel, Jimenez et al. 2004); all of which effect onset of chronic disease.

Stress

“Stress” in itself is difficult to define. Each individual may describe “stress” differently and can experience a range of consequences (positive or negative) as a result of this stress. One well accepted definition of stress is the process by which “environmental demands tax or exceed the adaptive capacity of an organism, resulting in psychological and biological changes that may place persons at risk for disease” (Cohen, Kessler and Gordon 1995).

Stress is even more difficult to measure than to define. One common way to measure stress is to assess a person’s perceived stress level by simply asking them how stressed they feel. One objective way to measure stress is assessing changes in physiological measures such as blood pressure or cortisol levels before, during, and after exposure to a stressor.

This review will describe the numerous ways in which stress is either induced or observed in study participants as well as the variety of ways in which stress is measured. The review will also discuss the difficulties associated with finding consistent relationships between stress and eating behavior in the literature with such a large variety in stressors and stress measurements.

Eating Behaviors

In the literature, stress has been associated with changes in food preferences (certain foods or macronutrients), frequency of eating (number of meals or snacks per day), and amount eaten (eating more or less). To find an appropriate relationship between stress and eating behaviors, the investigator must be able to accurately assess eating behaviors. This requires the selection of the most suitable assessment method and sufficient justification for this choice.

In the stress-eating literature, researchers have used everything from 24-hour recalls and Food Frequency Questionnaires (FFQs), which attempt to measure long-term, usual intake, to observing participants provided with limited choices of snacks in an acute laboratory setting. The variety in methodologies used to assess eating behaviors is one of the factors affecting the inconsistencies found in the stress-eating literature.

Rationale for a Review

The wealth of new studies conducted in the decade and a half since the last review (Greeno and Wing 1994) indicates the need for a systematic assessment of current practices and findings. **The objective of this systematic review is to examine the relationship between stress and eating habits in peer-reviewed adult human studies.**

This review will categorize psychosocial and socio-demographic characteristics that may predict the direction of the relationship between stress and its effect on eating behavior. Characteristics examined include restrained eating, disinhibition, emotional eating, gender, and weight status. This review will also look closely at the measurement methodologies used in these studies to measure both stress and eating behaviors and discuss the pros and cons and implications associated with each of them.

An updated review of the literature on the association between stress and eating behaviors, with a primary focus on how stress and eating are measured, is needed to guide new research. With the lack of consistency in the methods by which both stress and eating behaviors are measured, few conclusions can be made. This is an important relationship to examine because stress can affect a population's or an individual's dietary behaviors which in turn may affect risk of chronic disease (Dietary Guidelines 2005).

The objective of this study is to provide an updated review of the literature on the association between stress and eating behaviors, with a primary focus on how stress and eating are measured and potential effect modifiers of the relationship.

Specific Aims are: 1. To compare stress and eating behavior measurement methodologies to determine if the measurements themselves affect the stress-eating results, 2. To describe individual characteristics that are potential effect modifiers of the stress-eating relationship.

Methods

Article Searches

PubMed and PsycINFO databases were searched to identify peer-reviewed English language human studies published between 1966 and May 2007. The following keywords and subject headings were used in both databases to collect all related articles: *stress, eating, feeding behavior, food habits, energy intake, diet, appetite, stress-related eating, stress eating, stress induced eating, dietary restraint*. **Figure A-2** shows the search strategy used for PubMed which was adapted for use in PsycINFO. After this initial database search, the bibliographies of relevant articles were hand searched to identify any additional related articles not already included.

Article Selection

Titles and abstracts of retrieved articles were reviewed and non-relevant articles were discarded. Full texts of the remaining articles were examined, and exclusion criteria were applied to determine which articles would be included in this review.

Articles were excluded if they used animal subjects, institutionalized or hospitalized subjects, or subjects under 18 years of age since the focus of this review was to examine free-living adult humans. Excluded were those articles that looked at non-psychological stress such as clinical or physical stress. Also excluded were those articles that included both stress and eating as variables but did not examine a relationship between the two. Studies that investigated stress as the outcome variable were excluded

(i.e. studies that looked at stress attributable to overweight or the effects that consuming certain foods may have on stress levels). Finally, articles in which the subjects had eating disorders such as anorexia nervosa, bulimia, or night eating syndrome were excluded. Eating disorders present confounding variables that could account for changes in eating habits not associated with the stress-eating relationship. **Figure A-3** depicts the systematic review process used to retrieve the relevant articles included in this review.

Results and Discussion

Many factors have been suggested and studied extensively to determine which, if any, mediate the apparent relationship between stress and eating behaviors. Previously explored factors include restraint, disinhibition, emotional eating, gender, and weight status (Greeno and Wing 1994). This review will re-examine these factors looking at new research, but will also explore a new area: measurement issues. Considerable variety characterizes the ways in which stress and eating behaviors have been measured in the literature. This variety has an effect on our ability to make general statements or draw conclusions about stress-eating. The following sections explore measurement issues related to stress, measurement issues related to eating behavior, and factors that may mediate the stress-eating relationship (effect modifiers).

Measurement Issues: Stress

References in this review used a variety of different techniques to induce/observe stress. In experimental studies, stress must be induced acutely in the laboratory setting. Stress, in this setting, may be induced by physical threat, viewing of a stressful film, cognitive tasks, or ego-threatening tasks. In longer-term observational studies, stress is observed, not induced. Long-term stressors are based on life events such as school exams, work schedules, or daily hassles.

Stress can be measured in many different ways. The two most general categories of stress measurement are self-report and objective measures. The type of stressor

examined or the way in which stress is measured may influence the results. This section will explore the most commonly measured stressors as well as the ways in which stress can be measured.

Acute Stress

Acute stress refers to those stressors that are experimentally induced in a laboratory/research setting. Acute stressors in these studies include physical threat, film-induced stress, cognitive load stress, and ego-induced stress. **Table A-1** summarizes the participant population (n, age, sex), type of stressor used, the stress measurement, the eating behavior measurement, type of behavior measured, and the results found for each of the acute stressor studies.

Physical Threat. Threat of physical harm was used as a stressor in only two of the studies included in this review (Herman and Polivy 1975, Heatherton, Herman and Polivy 1991). Both created the stress condition by informing the subjects that they would receive “a fairly painful shock.” No subjects were actually shocked, however, the expectation of shock was enough to induce a stress response. Both studies found that unrestrained eaters ate significantly less than baseline while restrained eaters (those individuals that exert control over what foods they eat to intentionally limit their intake) ate non-significantly more.

Film-Induced. Film-induced stress was used in five of the included studies (Wardle and Beales 1988; Schotte, Cools and McNally 1990; Cools, Schotte and McNally 1992; Grunberg and Straub 1992; Lattimore 2001). To induce stress, four of the studies showed a frightening horror film and the other showed clips of industrial accidents. In addition to showing these films, one attached electrodes to the participants' hands to further increase level of stress (Wardle and Beales 1988) and another also looked at the effects of viewing a comedic film (Grunberg and Straub 1992). All film-induced stress (from both frightening and comedic films) studies showed consistent results: restrained eaters ate more in the stress condition versus the control settings and ate more than unrestrained eaters. One study compared an ego-threat task to film-induced stress and found that the ego-threat task produced more anxiety and greater ice cream consumption (Lattimore 2001).

Cognitive Load. One technique used to induce stress in these studies is requiring participants to complete a stressful task that requires a high cognitive load. A high cognitive load task requires that the participant's full attention be directed towards the task at hand. Such a task had been hypothesized to distract restrained participants from the control they normally placed towards their food intake (Ward and Mann 2000; Wallis and Hetherington 2004).

Cognitive load tasks used in these studies include: anticipation or completion of a memory-recall test (Mitchell and Perkins 1998; Ward and Mann 2000), a Stroop test which involves stating the colors the words are written rather than reading the words themselves (i.e. if the word "blue" is written in red ink, the participant is asked to say

“red” instead of reading the word “blue”) (Mitchell and Epstein 1996; Rutledge and Linden 1998; Wallis and Hetherington 2004), mental arithmetic, and a word scramble task (Rutledge and Linden 1998). Five of the six studies that use a cognitive task to induce stress looked at disinhibition (the reduction of control one places on oneself) and/or restrained eaters. These studies showed that high cognitive load stress (which served as a distraction from restraint) triggered disinhibition, resulting in a loss of control over eating for restrained eaters. Restrained eaters in these studies ate more in response to the cognitive load task.

Ego-threat. Ego-threat stressors effect the participant’s self-esteem (ego) to induce stress. The two most common types of ego-threatening stressors used in these studies were failure at an easy task, such as a Stroop task or a cognitive function task (Heatherton, Herman and Polivy 1991; Polivy and Herman 1999; Tanofsky-Kraff, Wilfley and Spurrell 2000; Epel, Lapidus et al. 2001; Haynes, Lee, and Yeomans 2003; Lattimore and Caswell 2004; Zellner, Loaiza et al. 2006) or anticipation of giving a speech (Herman et al. 1987; Heatherton, Herman, and Polivy 1991; Epel, McEwen et al. 2000; Oliver, Wardle and Gibson 2000; Tanofsky-Kraff, Wilfley and Spurrell 2000). Two studies used different ego-threatening stressors; one study used a variation of the Stroop test that used threatening words to stress participants (Lattimore 2001), and the other used an ostracism/argument role-play situation to induce ego-threatening stress (Oliver, Huon et al. 2001).

The most common effect seen in the ego-threatening stress studies was a significant increase in eating in restrained subjects and non-significant decreases in eating in non-

restrained subjects (Herman, Polivy et al. 1987; Heatherton, Herman and Polivy 1991; Tanofsky-Kraff, Wilfley and Spurrell 2000; Oliver, Huon et al. 2001; Haynes, Lee and Yeomans 2003; Lattimore and Caswell 2004). Another three ego-threat studies found either an increase in caloric intake on stress days for all participants (Epel, Lapidus et al. 2001) or changes in type of food consumed under ego-threat stress (Oliver, Wardle and Gibson 2000; Zellner, Loaiza et al. 2005).

Cognitive Load and Ego-Threat. Two studies looked at both cognitive-load and ego-threatening stress to determine which stressor had the strongest association with stress-induced eating (Lattimore and Maxwell 2004; Wallis and Hetherington 2004). Restrained eaters ate more after each task, both cognitive and ego-threat, in both studies. There were some differences, however, in the magnitude of the effects. A greater increase in intake was seen with restrained eaters in the ego-threat task compared to the cognitive task in one study (Wallis and Hetherington 2004). In contrast, another (Lattimore and Maxwell 2004) study saw a greater effect in restrained eaters with the high cognitive load task. These studies show that both cognitive and ego-threatening tasks effect the stress-eating response in restrained eaters. It is unclear which task creates the larger response.

Although there is variety in the types of stressors that have been used in the acute setting, the results have been fairly consistent for one group of individuals, restrained eaters. Restrained eaters in this setting tend to eat more when under stress. What is unclear is how and if stress can affect eating behaviors in unrestrained eaters and also if these findings stand when participants are removed from the laboratory setting. The next

section looks at the relationship between “long-term” stressors, which are observed rather than induced by the investigators in the participants’ usual life setting, and eating behaviors.

Long-Term Stress

“Long-term” stressors are those stressors which are found outside the laboratory/experimental setting, in everyday life. The long-term stressors measured in these studies include academic stress, work stress, and daily stress. **Table A-2** is a summary of the participant population (n, age, sex), type of stressor used, the stress measurement, the eating behavior (food) measurement, type of food measured, and the results found for each of the long-term stressor studies.

Academic Stress. In an academic setting, exams are one example of stressors that students confront. Mid-term or final exam weeks have been studied as a marker of stress in the stress-eating literature in seven studies (Griffin, Friend et al. 1993; Pollard, Steptoe et al. 1995; Weidner, Kohlmann et al. 1996; Epel, Jimenez et al. 2004; O’Connor and O’Connor 2004; Macht, Haupt and Ellgring 2005; Oaten and Cheng 2005).

These studies all looked at university students during stressful exam periods and during control non-exam periods. Results were much more varied in this group than with any of the acute setting stressors, suggesting that the stress-eating relationship may be more complex than can be evaluated in an experimental setting.

Two studies found a decrease in “healthy nutrition practices” during exam periods (Weidner, Kohlmann et al. 1996) and a preference for junk food (Oaten and Cheng 2005).

Another study found an improvement in “healthy nutrition practices” the week following exams. This improvement suggests some sort of rebound effect where students compensate for their lack of healthy practices during the exam period by improving their nutrition the following week (Griffin, Friend et al. 1993).

One study looked at anxiety and social support under stress and found that participants with low anxiety decreased energy intake during the exam stress period and participants with either high anxiety or “low social support” increased intake during exams (Pollard, Steptoe et al. 1995). Another study looked at snacking during baseline and exam periods. This study found that women who were trying to lose weight, were perfectionists, and had low “self-conscientiousness” reported eating more snacks during exam periods (O'Connor and O'Connor 2004).

The final study looked at physiological changes in response to exam stress. Investigators found that, over time, stress-eaters gained more weight and had increases in nocturnal insulin, cortisol, and blood levels of total/HDL cholesterol during exam periods (Epel, Jimenez et al. 2004).

One group of researchers offered a suggestion for the reason a stress-eating response occurs during exam periods. They hypothesized that students could be using food as a distracter from the exam stress (Macht, Haupt and Ellgring. 2005). Exams (and the associated exam-stress) are inevitable for students and may have long term effects on health and chronic disease if healthy eating behaviors routinely decline during exam periods.

Work Stress. Two studies in this review looked at workload as a stressor (McCann, Warnick and Knopp 1990; Wardle, Steptoe et al. 2000). One looked at employees of a university's grant services office and the other looked at employees of a department store. Both found that during high-stress periods participants changed the amount and type of food consumed; they ate more calories, greater amounts of fat and saturated fat and a greater percentage of calories from total fat. The consistency in these results suggest that work stress may be an important dependable factor in determining an individual's overall eating behavior change in response to stress, although further studies are warranted.

Daily Stress. The final two studies looking at long-term stress measures assessed daily hassles and stress levels for individuals over numerous days (Stone and Brownell 1994; Conner, Fitter and Fletcher 1999). In one study, participants recorded the number and severity of hassles they experienced for seven days as well as the number of daily snacks consumed. The researchers found that the number of snacks per day was positively associated with the number of hassles for all participants (statistically significant for women only) (Conner, Fitter and Fletcher 1999). The second study followed married couples for 84 days. This study found that on reported higher-stress days, most participants changed their eating habits (ate either more or less). They also found that the direction of change was consistent for each participants (they almost always ate more or almost always ate less in response to stress) (Stone and Brownell 1994). This finding suggests that classifying a subject as either a "stress-more" or "stress-less" eater is an appropriate distinction.

Overall, studies that examined long-term stressors found that most individuals did experience a change in eating behaviors; either in the amount or type of food eaten when stressed. This relationship can not be easily explained by a single variable such as was apparent with restrained eaters in the experimental setting. This relationship is instead, much more complex. Further research on the relationship between stress and eating behavior in these long term stress studies may help determine if stress-induced eating may affect an individual's risk for chronic disease. Both psychological and physiologic changes as well as changes in eating behaviors occur in response to these long term stressors. The effects of stress on the individual may add up over time which can lead to unhealthy weight change and/or other risks for chronic disease.

Perceived Stress

Perceived stress is the most commonly used measurement of stress. Perceived stress refers to one's own appraisal that stress exists. There are a number of methods and tools used to measure perceived stress, most of which minimally ask participants if they are stressed and/or how stressed they are. In this review alone more than 4 different methods are used to measure perceived stress: Perceived Stress Scale (PSS), State Trait Anxiety Index (STAI), Profile of Mood States (POMS), Positive and Negative Affect Scales (PANAS), and various other measures either developed by the researchers themselves or adapted from another scale.

PSS. The Perceived Stress Scale (PSS) is a 14-item instrument that was developed in 1983 to measure perceived stress (Cohen, Kamarck and Mermelstein 1983). The PSS is the most commonly used measure of perceived stress in the stress-eating literature (Griffin, Friend et al. 1993; Pollard, Steptoe et al. 1995; Wardle, Steptoe et al. 2000; O'Connor and O'Connor 2004; Oaten and Cheng 2005; Rideout, Linden and Barr 2006). It is a validated measure of recent stressful experiences and is correlated with other measures of stressful life events (Cohen, Kamarck and Mermelstein 1983). Each item on the questionnaire is labeled on 5-point Likert scale (0=never, 4=very often). An example question is “In the last month, how often have you felt that things were going your way?”

STAI. The State Trait Anxiety Index (STAI) was developed (Spielberger, Gorsuch and Lushene 1970) in 1970 to measure anxiety. This 20-item scale generates a range of scores from 20-80 with the higher the score indicating greater anxiety. “Anxiety” represents a measure of stress in the studies for which the STAI is used (Herman, Polivy et al. 1987; Wardle and Beales 1988; Mitchell and Perkins 1997; Weinstein, Shide and Rolls 1997; Lattimore 2001; Lattimore and Maxwell 2003; Wallis and Hetherington 2003; Lattimore and Caswell 2004; Newman, O'Connor and Conner 2006).

POMS. The Profile of Mood States (POMS) is a 65-item questionnaire with six subscales (Tension, Anger, Fatigue, Depression, Vigor, and Confusion) each of which is scored on a scale of 1-4 (1=low, 4=high) and then used to calculate a total mood disturbance score (McNair, Lorr and Droppleman 1971). POMS is used in four studies to detect mood and changes in mood related to the applied or observed stressor to determine

if the stressor was effective or not (Schotte, Cools and McNally 1990; Cools, Schotte and McNally 1992; Epel, Lapidus et al. 2001; Haynes, Lee and Yeomans 2003).

PANAS. The Positive and Negative Affect Scales (PANAS) were developed in 1988 and consist of two 10-item scales (Watson, Clark and Tellegen 1988). Each item, which represents a mood state, gets a rating from 1-5 (1= very slightly or not at all, 5= extremely) on how much you are feeling that mood currently or over a previous short history (Weidner, Kohlmann et al. 1996; Rutledge and Linden 1997; Oliver, Wardle and Gibson 2000).

Other Instruments. The remaining studies' researchers either produced their own instrument to measure stress or stress-eating (Herman and Polivy 1975; Willenbring, Levine and Morley 1986; McCann, Warnick and Knopp 1990; Grunberg and Straub 1992; Mitchell and Epstein 1996; Oliver and Wardle 1999; Epel, Jimenez et al. 2004; Kandiah, Yake et al. 2006; Zellner, Loaiza 2006), used a scale different from those already mentioned (Heatherton, Herman and Polivy 1991; Polivy and Herman 1999; Tanofsky-Kraff, Wilfley and Spurrell 2000), or used a revised or shortened version (sometimes a single question) of a scale.

An example of a perceived stress measurement that was developed by the researcher is "On a scale of 1 to 100 (where 100 is the death of a friend or family member and 1 is a minor annoyance) how stressful would you rate this problem or situation?" (Stone and Brownell 1994). One example of a researcher using a single item from a different scale is a single question from the Ways of Coping Checklist, "I tried to make myself feel better

by eating, drinking, using medications, etc.,” to measure stress-related eating (Laitinen, Ek and Sovio 2002).

The sizeable variety in the ways in which perceived stress is measured may affect the accuracy in which conclusions can be drawn about the stress-eating relationship across studies. Many of the above mentioned instruments do not directly measure stress but rather measure a marker of stress such as anxiety or mood changes. Anxiety and mood changes may be very good markers of stress for many individuals, but may be unassociated for others. Each scale is also a little bit different and therefore has different means of interpretation. An individual could potentially be considered under high levels of perceived stress when using one scale but no stress at all when using another. The large assortment of measurement tools and the variety in stress level results adds to the difficulty of discovering consistent findings in the relationships between stress and eating behavior.

Objective Measures of Stress

Although perceived stress is a quick, easy, and fairly accurate measure of an individual's level of stress, the use of objective measures of stress are also needed to accurately assess stress levels. The objective measures used to measure stress in the stress-eating literature include: physiological measurements (i.e. cortisol, blood lipids, and salivation) and documented numbers of academic exams and work hours/tasks.

Cortisol. Cortisol level is one of the physiologic measurements researched in the stress-eating field (Epel, McEwen et al. 2000; Epel, Lapidus et al. 2001; Epel, Jimenez et al. 2004; Rideout, Linden and Barr 2006; Newman, O'Connor and Conner 2007). In one study, women who reported higher stress levels secreted more cortisol and had larger waist-to-hip ratios. High-stress participants also showed a lack of adaptation to the stressors. They continued to secrete high levels of cortisol during all 3 days of the study while their less stressed counterparts adapted and secreted less cortisol (Epel, McEwen et al. 2000).

The same group of researchers decided to next examine if stress-induced cortisol was related to eating after stress (Epel, Lapidus et al. 2001). They found that high-cortisol reactors did consume more calories during stress as well as ate more sweet foods. In a subsequent study, these same researchers looked at stress-eaters' risk for Metabolic Syndrome and found that during stress (exams) "stress more-eaters" (those that self-report to eat more when stressed) had higher levels of cortisol, insulin, total cholesterol/HDL cholesterol ratio, and had increases in weight (Epel, Jimenez et al 2004).

Two other groups also looked at cortisol levels in stress-eating. One study found that women with high restraint scores excreted more cortisol (regardless of current stress level) and its researchers suggested that restraint itself may be a source of stress for these individuals (Rideout, Linden and Barr 2006). The only difference in eating behaviors found in this study was that restraint individuals tended to eat a larger proportion of their calories from protein. The final study looking at cortisol levels found that only high cortisol reactors (those who secrete higher amounts of cortisol when stressed), not their

low cortisol reactor counterparts, reported an increase in the number of daily snacks with increasing number of reported daily hassles (Newman, O'Connor and Conner 2007).

It appears in these studies that high cortisol reactors have increased intake in response to stress as well as increased physiological issues such as higher waist to hip ratios. This higher waist to hip ratio alone places these individuals at higher risk for chronic disease (Kissebah and Krakower 1994).

Blood Lipids. Blood lipid levels have also been examined in the stress-eating literature. As mentioned earlier, one group of researchers found an increase in total cholesterol/HDL cholesterol ratios in high-cortisol reactors during stress (Epel, Lapidus et al 2001). In contrast, another group found no significant increases in total cholesterol, LDL cholesterol, VLDL cholesterol, or HDL cholesterol and found only somewhat higher triglycerides in university employees during stress (McCann, Warnick and Knopp 1990). Another study also found no significant differences in blood lipids between baseline and stress periods (Pollard, Steptoe et al. 1995). The effect of stress on blood lipids in these studies is inconsistent and therefore, the relationship is unclear.

Salivation, Heart Rate, Blood Pressure. Salivary volume and heart rate were measured in one study. This study found that salivation decreased for all participants during the trials, and heart rate increased during the stress session for participants in the stress group. Even with the measured physiologic changes, the researchers found no differences between restrained and unrestrained individuals and no changes in food intake (Mitchell and Epstein 1996). In another study, the stressor did not produce an

increase in blood pressure but did increase heart rate. Stress did not significantly affect eating behavior in this study either (Oliver, Wardle and Gibson 2000).

A different study looked at blood pressure and heart rate and saw an increase in both during the stress task. The physiological changes in this study were significantly related to a decrease in food consumption, but only in unrestrained eaters (Rutledge and Linden 1998). These studies suggest that measures of blood pressure, heart rate, and salivation must be further examined to determine if they would be effective measures of stress in stress-eating research.

Academic Stress. Academic stress is measured objectively in seven studies by analyzing the number of exams and/or papers and projects due to determine the participant's level of stress. (Griffin, Friend et al. 1993; Pollard, Steptoe et al. 1995; Weidner, Kohlmann et al. 1996; Epel, Jimenez 2004; O'Connor and O'Connor 2004; Macht, Haupt and Ellgring 2005; Oaten and Cheng 2005). Most studies also reported a measure of perceived stress which proved to be closely correlated with the objective measures. As described previously, results were varied, but all studies did see a change in eating behavior in response to academic stress.

Work Stress. Work stress is measured objectively in two of the included studies (McCann, Warnick and Knopp 1990; Wardle, Steptoe, et al. 2000). Objective work stress is measured by number of hours worked in one and number of grant proposals received (the greater number of grants received indicates a greater amount of work to be done) in

the other. Both found correlations between high stress periods and changes in the amount and type of food consumed - particularly an increase in calories, fat, and saturated fat.

Objective measures of stress report inconsistent results across the whole group but fairly consistent results within the work stress subgroup. This may mean that some objective measures of stress are more accurate at capturing the true stress-eating relationship or that an individual truly varies vastly in their stress-eating tendencies depending on the type of stress - making the relationship nearly impossible to measure.

Measurement Issues: Eating Behavior

Assessing eating behavior is a difficult task both in and outside the laboratory setting. Some of the difficulties in assessing a person's usual daily intake include: in retrospective dietary assessment, participants often have difficulties remember exactly what it is they ate the previous day or in the last few months. In studies that ask participants to keep track of what they are eating, while they are eating, it is still difficult to estimate the amount you are eating as well as know the ingredients in the foods you are eating, especially if it's something prepared away from home. There are numerous techniques used to assess an individuals' usual intake in the stress-eating literature such as 24 hour recalls and food records.

In the laboratory setting, it is much easier to know exactly what (investigators provide the food, so they have total control over what is eaten) and how much (food is weighed both before and after the participant eats) a participant is eating. To measure food intake, investigators in the stress-eating research have used a single food, categories

of food, a variety of foods, or a full test meal. The problem with assessing diet under these conditions is that it cannot be assumed that the participant would eat similarly in their normal life, making it difficult to extrapolate this information past what is seen in the lab.

A few studies in the stress-eating literature looked at a subjective measure of eating behavior. These studies used a variety of methods such as reporting recent eating history, answering a questionnaire, listing foods, and filling out a wellness scale. Each of these techniques to assess eating behaviors will be discussed in greater detail in the following paragraphs.

Daily Intake Assessment

As stated previously, usual intake assessment aims to measure what a participant normally eats. Twenty-four hour recalls and food diaries are used in the stress-eating literature to capture all the food eaten and the amounts consumed for the days in question.

Twenty-four hour recalls. Two studies used 24 hour recalls to assess dietary intake (Pollard, Steptoe et al. 1995; Wardle, Steptoe et al. 2000). Twenty-four hour recalls assess participants' previous days' food intake in detail. A trained interviewer asks the participant to describe in detail all foods and beverages consumed over the previous 24 hours. It is typically recommended to collect at least three days of recall (2 weekdays and 1 weekend) to most accurately assess a person's usual intake. In both of the studies that used 24 hour recalls, 1 day of recall at baseline and stress sessions was collected. Both of these studies looked at participants in their "normal" (not in a laboratory) school and

work environments. In both studies, restrained/high anxiety subjects increased their daily energy intake during the stress periods.

Food Records. Food records/diaries were collected to assess diet in six of the studies (McCann, Warnick and Knopp 1990; Conner, Fitter and Fletcher 1999; O'Connor and O'Connor 2004; Macht, Haupt and Ellgring 2005; Rideout, Linden and Barr 2006; Newman, O'Connor and Conner 2007). Food records traditionally require participants to record details of everything they had to eat or drink during a specific number of days. Food records in these studies asked individuals to either record their entire days' intake, as traditionally asked, (McCann, Warnick and Knopp 1990; Rideout, Linden and Barr 2006) or record only eating occasions they considered to be "snacks" (defined by the researchers as food eaten that was not considered a main meal) (Conner, Fitter and Fletcher 1999; O'Connor and O'Connor 2004; Macht, Haupt and Ellgring 2005; Newman, O'Connor and Conner 2007). Food records were appropriate measures for these studies because the goal was to measure stress-eating in the participant's everyday environment which can be captured using this method.

Laboratory Intake Assessment

Laboratory studies use much different techniques to measure food intake. Due to limited time and cost inherent in laboratory assessments, many of the studies provide participants either a single food or a limited number of foods and base their analysis of the stress-eating response on the amount of food consumed during or after the stress

session in the laboratory. As stated previously, an advantage of this type of assessment is that the type food can be controlled and the amount eaten can be determined by precise weighing of the food before and after eating. A disadvantage is that it is difficult to make predictions about an individual's real life response to stress based on a limited number of foods available in a laboratory setting. Many circumstances inside a lab are very different than the real world making it hard to suggest that participants respond similarly in both situations.

Single Food. Ten studies looked at stress-eating in the laboratory using a single type of food; ice cream (Herman and Polivy 1975; Herman, Polivy et al. 1987; Heatherton, Herman and Polivy 1991; Polivy and Herman 1999; Tanofsky-Kraff, Wilfley and Spurrell 2000; Lattimore 2001), popcorn (Schotte, Cools and McNally 1990; Cools, Schotte and McNally 1992), yogurt (Mitchell and Epstein 1996), or chocolate candies (Wallis and Hetherington 2004).

In the ice cream and yogurt studies (Herman and Polivy 1975; Herman, Polivy et al. 1987; Wardle and Beales 1988; Heatherton, Herman and Polivy 1991; Mitchell and Epstein 1996; Polivy and Herman 1999; Tanofsky-Kraff, Wilfley and Spurrell 2000; Lattimore 2001), the food was presented to participants under the guise of a taste test. Participants were required to taste the products and rate them on different scales based on how much they liked or did not like them.

This is a useful way to present food to an individual in the laboratory setting, but may not capture what the individual would normally do in a stress situation. Some people may not eat at all when stressed (but are required to do so to rate the foods in these

experiments). Others may feel the need to eat more than they normally would to get their ratings of the food correct; while some individuals may feel uncomfortable eating normally in the laboratory situation. Most of these studies found that restrained eaters ate significantly more of the ice cream or yogurt after stress (especially when they were hungry) (Herman and Polivy 1975; Herman, Polivy et al. 1987; Wardle and Beales 1988; Heatherton, Herman and Polivy 1991; Mitchell and Epstein 1996; Tanofsky-Kraff, Wilfley and Spurrell 2000; Lattimore 2001). A few studies found a significant decrease in intake for unrestrained participants (Herman and Polivy 1975; Herman, Polivy et al. 1987; Heatherton, Herman and Polivy 1991).

In the popcorn (Schotte, Cools and McNally 1990; Cools, Schotte and McNally 1992) and chocolate (Wallis and Hetherington 2004) studies participants were provided the food and were told to eat as much as they would like (some required that they at least try the foods provided) (Cools, Schotte and McNally 1992). These analyses model normal eating habits a little bit more because subjects were not required to rate the food but rather were allowed to eat at will. All three of these studies found a significant increase in eating for restrained eaters under stress.

Categories of Food. In nine of the laboratory studies, a limited number of categories of foods (i.e. sweet, salty, savory, bland, high or low fat) were provided to participants. These foods were either consumed as part of a taste test or provided to eat freely at different points in the experiments.

Taste test foods were used in four of the studies. Foods used in these taste tests were: four different types of diet bars that had similar appearances but varied in water activity

(crunchy vs. chewy texture) and flavor (apple or lemon/grape) (Willenbring, Levine and Morley 1986), different categories of snack foods such as sweet (chocolate bars, dried fruit), salty (salted crisps, peanuts), and bland (plain crackers) (Oliver, Huon et al. 2001; Lattimore and Caswell 2004; Lattimore and Maxwell 2004).

Results varied; three of these studies did not report any differences between the consumption of different types of foods but found that restrained eaters/ high disinhibitors ate more while unrestrained eaters/low disinhibitors ate less (Oliver, Huon et al. 2001; Lattimore and Caswell 2004; Lattimore and Maxwell 2004). One study reported preferences for certain foods found that “stress-more eaters” tended to prefer sweet foods while “stress-less eaters” tended to prefer salty foods (Willenbring, Levine and Morley 1986).

Variety of Foods. Some studies provided a larger variety of foods while still providing foods from different categories; sweet, salty, bland, and high and low fat. Participants were allowed to eat at will in these studies. A few investigators reported finding differences in food intake among the types of foods. One studies found that restrained eaters ate more salty foods under stress than unrestrained eaters (Mitchell and Perkins 1998). Another found that high-cortisol reactors ate more sweet food and less salty food than low-reactors (Epel, Lapidus et al. 2001). Another found that all participants (stress and controls) ate more sweets, but the difference was that the stressed groups chose less healthy sweets (chocolate over grapes) (Zellner, Loaiza et al. 2006).

Studies that looked at overall intake in this category reported that restrained eaters (Wardle and Beales 1988; Mitchell and Perkins 1998; Rutledge and Linden 1998; Ward

and Mann 2000) or high-cortisol reactors (Epel, Lapidus et al. 2001) ate more food when stressed and that unrestrained eaters decreased overall intake when stressed (Mitchell and Perkins 1998; Rutledge and Linden 1998; Ward and Mann 2000). One study reported differences between men and women and found that women ate more overall as well as ate twice as many sweets on stress days, while men decreased intake (Grunberg and Straub 1992).

Full Meal. Two laboratory studies provided a full meal to measure intake (Oliver, Wardle and Gibson 2000; Haynes, Lee and Yeomans. 2003). The meal both studies included a range of foods; sweet, salty, bland, and savory items. The first study found no significant differences in total food consumed in the stress vs. control session but did find that men ate significantly more bland and salty foods than women; no difference found for sweet foods (Oliver, Wardle and Gibson 2000). They found an effect of stress on eating in emotional eaters only. Emotional eaters increased their intake of sweet, fatty foods under the stress condition. The other study found no significant differences in type of food preferred in control vs. stress sessions and results were varied for overall intake between restraint and disinhibition groups (Haynes, Lee and Yeomans 2003).

Subjective Intake Assessment

The remainder of the stress-eating studies did not exactly measure eating behavior but rather used a subjective measure of perceived stress-eating. The subjective measures

included: reporting of recent eating history, answering a questionnaire, listing foods, and filling out a wellness scale.

Eating History. Two studies asked questions about recent history of eating to measure food intake during stress and non-stress times. The first study looked at undergraduates at two different time periods, during a baseline non-stress period and after a 2-week exam period (stress period) (O'Connor and O'Connor 2004). In each round they asked the participants to rate on a scale of 1-5 (1 = much less than usual, 5 = much more than usual) how many snacks they thought they had consumed. They found that students perceived themselves as eating more snacks than usual during stress periods. Dietary habits of undergraduate students were assessed in the second study through a questionnaire inquiring about the previous week (Oaten and Cheng 2005). They found that during stress, junk food intake increased and healthy eating habits and exercise decreased for the exam-stress group while no changes occurred for the control group.

Questionnaire. A number of studies assess stress-eating by asking either just one or a few brief questions. The most simple of these being “Do you eat much less than usual, less than usual, the same as usual, more than usual, or much more than usual in response to stress?” Four studies asked a question similar to this one (Stone and Brownell 1994; Weinstein, Shide and Rolls 1997; Oliver and Wardle 1999; Epel, Jimenez et al. 2004).

The first study found that eating less was the predominant response to high level of stress (Stone and Brownell 1994). The second study found that females with high disinhibition scores reported eating more when stressed, while low disinhibition females

and males did not report eating more (Weinstein, Shide and Rolls 1997). Subjects in the third study reported eating more snack type foods (73% of subjects reported eating more snacks) and less meal type foods when stressed (Oliver and Wardle 1999). The final study using this question found that “stress more-eaters” gained more weight, and had increases in insulin, cortisol, and total/HDL cholesterol in a year while the other participants did not (Epel, Jimenez et al. 2004).

Another study used a single question from the Ways of Coping Checklist, “I tried to make myself feel better by eating, drinking, using medication, etc.,” and determined a stress driven eater to be anyone who responded “used quite a bit or a great deal” (Laitinen, Ek and Sovio 2002). They found that stress driven eaters ate more sausages, hamburgers, pizza and chocolate and drank more alcohol than others.

List of Foods. One study simply had participants list foods they eat when stressed and foods they eat when not stressed in 5 different categories (mixed dishes, salty/crunchy foods, sweet foods, creamy foods, beverages) (Kandiah, Yake et al. 2006). They found that when stressed, participants tended to chose more sweets and more mixed dish type foods.

Wellness Scales. Two studies used wellness scales that included a score for nutrition to analyze stress-eating (Griffin, Friend et al. 1993; Weidner, Kohlmann et al.1996). Nutrition questions from these scales analyze healthy eating habits, for example, amount of fruit and vegetable intake. One study found that nutrition suffered during exam-stress

periods (Weidner, Kohlmann et al. 1996); the other discovered a possible rebound effect where nutrition improved the week following exams (Griffin, Friend et al. 1993).

While these scales will not provide detailed information about the changes in eating behavior in response to stress, they help give a general overview of the stress-eating response. It may be beneficial for future researchers to include one of these subjective stress-eating measures in their studies along with the other eating behavior and stress measurements to measure the individuals' perception of their stress-eating response and compare that to the other study variables.

Changes in Intake

Changes in food intake in response to stress have been reported in a variety of ways in these studies. Results have been reported as changes in types of food or macronutrient content of foods eaten, changes in eating patterns, changes in overall intake, and/or changes in reasons to eat.

Type of Food. Many studies report changes in type of food eaten or changes in macronutrient content of food chosen (i.e. higher fat foods) when stressed. The results vary among the studies, but most report a movement towards less healthy choices when stressed. One study reported that while 80% of participants make healthy eating choices during normal conditions, only 33% state they make healthy choices when stressed (Kandiah, Yake et al. 2006). Another found that 73% of subjects report that they overeat

when stressed and the foods they eat are foods that they would avoid normally; sweets were the most common foods chosen (Zellner, Loaiza et al. 2006). A study looking at general healthy habits during stress found that junk food intake increased and overall healthy eating habits and exercise decreased during stress periods in the stress group (no changes seen in controls) (Oaten and Cheng 2005).

An increase in high fat, sweet or high calorie dense food choices when stressed was found in many of the studies (Willenbring, Levine and Morley 1986; McCann, Warnick and Knopp 1990; Oliver and Wardle 1999; Oliver, Wardle and Gibson 2000; Laitinen, Ek and Sovio 2002). Stressed emotional eaters were found to eat more sweet, high fat foods and a more energy-dense meal than unstressed and non-emotional eaters (Oliver, Wardle and Gibson 2000). One study found a pattern towards higher energy dense, snack type foods (Oliver and Wardle 1999). More specifically, one study found that a greater percentage of stress-driven eaters ate sausages, hamburgers, and pizza (all high fat foods) under stress than non-stress-driven eaters (Laitinen, Ek and Sovio 2002).

A preference for sweet foods under stress was a common theme seen throughout studies (Grunberg and Straub 1992; Oliver and Wardle 1999; Epel, Lapidus et al. 2001; Kandiah, Yake et al. 2006; Zellner, Loaiza et al. 2006). In one study, women ate twice the amount of sweet foods under stress conditions compared to the control (Grunberg and Straub 1992). One study found an overall preference for sweets in both the stress and non-stress groups. The difference was that the stressed groups chose the less healthy sweets, M&Ms chocolate candies, while the non-stress group chose grapes (Zellner, Loaiza et al. 2006).

Stress-eating preference for salty foods is varied. Restrained eaters in one study consumed significantly more salty snacks when stressed than unrestrained eaters (Mitchell and Perkins 1998). While on stress days in another study, high-cortisol reactors (more stressed participants) ate less salty foods than low reactors (Epel, Lapidus et al. 2001).

Only one study found changes in protein intake. In this study, restrained eaters chose a higher proportion of energy as protein than non-restrained eaters under stress (Rideout, Linden and Barr 2006).

The term “comfort food” comes to mind when discussing preferences for certain types of foods when stressed. One study found that 53% of participants who eat when stressed say they do so because it makes them feel better (Zellner, Loaiza et al. 2006). Comfort foods may have psychological associations with happiness and joy, and thus, when stressed, individuals may turn to those comfort foods to help themselves feel better.

Eating Pattern. Changes in eating patterns are also reported in many studies in response to stress. An increase in the number of snacks consumed per day under stress was the most common eating pattern change seen in the stress-eating literature (Conner, Fitter and Fletcher 1999; Oliver and Wardle 1999; O'Connor and O'Connor 2004; Newman, O'Connor and Conner 2007). In one study, 73% of participants reported eating more snacks than usual when stressed, and only 13% reported eating less (Oliver and Wardle 1999). In two studies that looked at daily hassles; the number of snacks per day was significantly positively correlated with the number and intensity of daily hassles (as

the number and intensity of daily hassles increased, number of daily snacks increased) (Conner, Fitter and Fletcher 1999; Newman, O'Connor and Conner 2007).

Amount Eaten. Some studies report changes in overall amount eaten (increase or decrease in daily consumption) in response to stress.

The most common finding was that participants ate more under stress than the control group as well as more than the control session (McCann, Warnick and Knopp 1990). Restrained eaters were fairly consistently found to increase intake in response to stress (Herman and Polivy 1975; Herman, Polivy et al. 1987; Wardle and Beales 1988; Schotte, Cools and McNally 1990; Heatherton, Herman and Polivy 1991; Cools, Schotte and McNally 1992; Mitchell and Epstein 1996; Rutledge and Linden 1998; Tanofsky-Kraff, Wilfley and Spurrell 2000; Wardle, Steptoe et al. 2000; Lattimore and Caswell 2004; Lattimore and Maxwell 2004; Wallis and Hetherington 2004). High-cortisol reactors were also found to have higher calorie intake than low reactors in response to stress (Epel, Lapidus et al. 2001). High-anxiety participants and participants who reported low social support also increased energy intake from baseline to exam period (Pollard, Steptoe et al. 1995).

Some studies also report that participants ate significantly less in response to stress (Stone and Brownell 1994; Mitchell and Epstein 1996). For unrestrained participants more often than not, they were found to eat less during stress (Herman and Polivy 1975; Herman, Polivy et al. 1987; Schotte, Cools and McNally 1990; Heatherton, Herman and Polivy 1991; Rutledge and Linden 1998). Participants with low anxiety also decreased energy intake during exam (stress) periods (Pollard, Steptoe et al. 1995).

Type of stressor may play a role in the direction of the stress-eating response. One study that compared high cognitive load and low cognitive load stress tasks found that unrestrained eaters consumed more food in the low cognitive load task than in the high cognitive load task. Restrained eaters did the opposite, eating more food in the high cognitive load task (Ward and Mann 2000).

Gender may also affect the direction of the stress-eating response. Stress in one study was found to decrease consumption in men (significantly) and increased consumption in women (not significantly) (Grunberg and Straub 1992).

Although it is unclear whether stress causes an individual to eat more or less, one study showed that participants seem to be consistent in the direction of their stress-eating (either almost always eat more or almost always eat less) (Stone and Brownell 1994).

Reasons to Eat. Only one study looked at changes in participants' stated reason to eat from a normal state to a stress period. Motivation to eat was increased for all during stress periods. The reported reason to eat during the normal state was most commonly because of hunger; during stress, participants more commonly said they ate to feel better and/or provide distraction from the stress (Macht, Haupt and Ellgring 2005).

Results from intake measurements in response to stress vary but some patterns do emerge. As previous reviews have found, the stress-eating relationship shows some consistency with the restraint variable. High-restraint individuals tend to eat more while unrestrained individuals tend to eat less. A shift towards less healthy foods such as sweets and foods high in fat is found during stress as well as an increase in daily snacks. An

increase in number of snacks does not necessarily represent a decline in healthy eating behaviors itself, but if participants are choosing sweets and higher fat foods as snacks then snacking could affect health.

Potential Effect Modifiers

Several possible effect modifiers have been studied for the stress-eating relationship: restraint, disinhibition, emotional eating, gender, and weight status.

Restraint

This characteristic has been studied extensively in the stress-eating literature and has revealed some consistencies in its findings. Restraint has been studied in experimental settings as well as in natural settings.

Similar to all of the stress-eating studies, most of the restraint studies examine university undergraduate subjects, often females only. This is both good and bad; we have a wealth of information about female undergrads and may be able to predict how stress affects eating habits based on dietary restraint status in this group, but we may not be able to extrapolate the information beyond this specific group.

Most studies have shown that under control conditions restrained and unrestrained individuals eat similar amounts of food. Under stress, restrained individuals tend to eat more (sometimes significantly and sometimes not) and unrestrained individuals tend to

eat less (sometimes significantly and sometimes not) than the controls (Herman and Polivy 1975; Herman, Polivy et al. 1987; Wardle and Beales 1988; Schotte, Cools and McNally 1990; Cools, Schotte and McNally 1992; Mitchell and Epstein 1996; Mitchell and Perkins 1998; Rutledge and Linden 1998; Tanofsky-Kraff, Wilfley and Spurrell 2000; Ward and Mann 2000; Wardle, Steptoe et al. 2000; Haynes, Lee and Yeomans 2003; Lattimore and Caswell 2004; Lattimore and Maxwell 2004; Wallis and Hetherington 2004; Zellner, Loaiza et al. 2006). Some studies have also shown differences between restrained and unrestrained persons in preferences for types of food, such as salty or high-fat foods, when under stress (Mitchell and Perkins 1998; Wardle, Steptoe et al. 2000). One study found that after a stress experiment, restrained eaters were more likely to attribute their negative feelings in the experiment to eating the ice cream rather than to the experiment itself, possibly suggesting that eating was used to mask their failure-induced negative feelings (Polivy and Herman 1999).

Other studies have found no differences based on restraint (Oliver, Wardle and Gibson 2000) and one group of researchers argue that the relationship seen is not caused by either restraint or stress (Lowe and Kral 2006). These researchers acknowledge that many studies looking at stress-eating have found a relationship modified by restraint; however, they warn that there may not be evidence that restraint is causally connected to the stress response or that stress is the factor responsible for the eating response.

Disinhibition

In the stress-eating literature disinhibition is closely associated with restraint. It is often not studied alone, but is considered to be a factor on the causal pathway of the restraint-modified stress-eating response found (Haynes, Lee and Yeomans 2003). It is believed that stress may cause disinhibition of eating habits for those individuals who most often try to control their eating (restraint eaters). Stress removes cognition from eating and places it elsewhere, disinhibiting the individuals and allowing them to eat differently (either amount or type of food) than they normally would attempt. One study that looked at disinhibition specifically found that high disinhibitors ate more sweets than low disinhibitors under stress (Oliver, Huon et al. 2001).

Emotional eating

Emotional eaters are those individuals who change their eating habits based on emotional arousal. Although emotional eating is not the focus of this paper, it is explored here because the eating response of emotional eaters to stress has been studied. Emotional eating has been shown to alter the amount or types of foods selected during a stress-eating response.

All three emotional eating studies that were included examined university students (one included university staff along with the students) (Lyman 1982; Macht and Simons 2000; Oliver, Wardle and Gibson 2000). One study found that while stress did not affect overall intake, stressed emotional eaters ate more sweet, high-fat foods and a

more energy-dense meal than unstressed and non-emotional eaters (Oliver, Wardle and Gibson 2000). The other two studies showed preference changes for certain foods during different emotional states. Healthful foods were more often preferred in positive emotions. During negative emotions, the motivation to eat was higher as was the tendency to choose “junk foods” (Lyman 1982; Macht and Simons 2000). Stress may often be correlated with any number of emotions (both positive and negative) making the relationship between the types of foods chosen during these emotions important in understanding the stress-eating response.

Gender

As stated previously most of the stress-eating literature has centered on female undergraduate students; however, there are a few studies that look at both males and females and the differences found between them. Students were still a favorite subject in most of these studies (Grunberg and Straub 1992; Weinstein, Shide and Rolls 1997; Conner, Fitter and Fletcher 1999; Oliver and Wardle 1999; Zellner, Loaiza et al. 2006), which found that there are differences in the eating response for women and men and that the response is mediated by individual factors.

Women in these studies tend to be more susceptible to stress-eating, in particular overeating, than men (Grunberg and Straub 1992; Conner, Fitter and Fletcher 1999; Oliver and Wardle 1999; Zellner, Loaiza et al. 2006). An “eating less” response was either similar between men and women, or sometimes slightly greater in men than women (Grunberg and Straub 1992; Oliver and Wardle 1999; Zellner, Loaiza et al.

2006). One study that looked at food preferences for stress eating reported that women were more likely report an “eating more” response for sweets and chocolate and “eating less” response for meats, fish, fruits, and vegetables (Oliver and Wardle 1999).

Women tend to report higher restrained and emotional eating scores, which may be the factors driving the differences seen between the sexes (Conner, Fitter and Fletcher 1999; Oliver, Wardle and Gibson 2000). One study found no differences between males and females with intake response due to stress but did find differences in which variables were associated with a change. Restraint was the only factor that was correlated with changes in eating behavior for males, while females had a much more complex relationship with stress overeating. Female stress-eating response was correlated with restraint score, disinhibition, trait anxiety, and perceived hunger (Weinstein, Shide and Rolls 1997).

The only study looking at gender differences not in the student population looked at a group of married couples. This study found that on days of higher stress, both males and females changed their intake amounts and that individuals were consistent in which direction their intake tended to change in response to stress. The predominant response in this study for men and women was eating less in response to stress (and this response increased as stress increased). A similar proportion of males and females tended to eat more under stress but this effect was more pronounced in females (Stone and Brownell 1994).

Weight Status

Stress-eating in obese versus normal weight subjects was compared in the most recent review (Greeno and Wing 1994). They found inconsistent results in the direction (increase amount eaten or decrease amount eaten) of stress eating in either obese or normal subjects and therefore, could not draw any conclusions. Two studies have looked at the effect of weight status since this review (Epel, McEwen et al 2000; Laitinen, Ek and Sovio 2001).

The first study looked at waist-to-hip ratios and cortisol secretion (Epel, McEwen et al). They found that women with a higher waist-to-hip ratio secreted more cortisol and reported more chronic stress, placing them at higher risk for stress-eating as well as for development of chronic disease (Kissebah and Krakower 1994; Epel, Lapidus et al. 2001).

The second study found that stress-related eating and drinking were associated with obesity, especially in women. Among women, “stress-driven eaters” had the highest Body Mass Index (BMI); the rates of obesity in this group were twice as high as all others groups. Male “slightly stress-driven” eaters had the highest BMI, but BMI was not significantly different between any of the stress-eating groups (Laitinen, Ek and Sovio 2001). Since so few new studies have been conducted, a conclusion about the effect of weight status on the stress-eating relationship remains unclear.

Conclusions

The variety in the measurement methodologies for both stress and eating behavior in the stress-eating literature has produced wide-ranging and somewhat inconsistent results. It is unclear whether these inconsistencies truly exist in the stress-eating relationship or if they can be mostly attributed to the variety in measurement modalities.

Some consistent associations have emerged in spite of the inconsistent measurements of stress and eating behaviors. Just as previous reviews have found, restrained eating is a fairly consistent effect modifier. Restrained eaters tend to eat more under stress while unrestrained eaters tend to eat less under stress.

Some patterns of eating behavior change have also emerged in response to stress. The movement towards choosing less healthy foods such as sweets and high fat foods is consistent. Also, a change in eating patterns marked by an increase in the number of snacks consumed per day when stressed has been shown. This change in snacking pattern is not inherently a bad change, especially if healthy snack foods were chosen, but this is not the case as sweets and high fat foods are preferred.

Stress related eating may have the potential to significantly contribute to unhealthy eating behaviors. In the fast-paced society we live in, many individuals experience high levels of stress on a daily basis. If stress-eating takes place often or even daily, these eating behaviors can result in unhealthy weight change and changes in physiologic markers such as nocturnal levels of insulin, cortisol, and blood levels of total/HDL cholesterol ratio (Epel, Jimenez et al. 2004); all of which may affect the onset of chronic disease.

Deciphering which stressors and which individual variables affect stress-eating is important so that these issues may be addressed and possibly resolved. More studies evaluating long-term stressors and usual intake are needed to observe individuals in their normal daily settings and see how they respond. If an individual always eats more when stressed and their daily work schedule is one of their biggest stressors then an intervention for this individual would be to address their stressful environment at work to reduce their risk for unhealthy weight gain and risk for other chronic diseases.

Oftentimes the participants are studied in either a laboratory setting or at only one point in time, both of which are insufficient to measure overall changes in eating behavior caused by stress. Further research, including more comprehensive assessment of eating behavior changes caused by stress, is needed to better understand the stress-eating relationship and its possible health effects, both immediately and long-term.

Future researchers interested in studying the stress-eating relationship ought to pay particularly close attention to the ways in which they choose to measure stress and eating behavior. To fully examine the stress-eating relationship, researchers should include a tool measuring perceived stress as well as an objective measure of stress. To analyze the real affects of stress on the participant's usual intake outside the laboratory setting, they should collect three days of 24 hour recalls at each of the control and stress settings. This study design would allow for the investigator to more completely see how stress affects eating behavior and how this may in turn affect risk for chronic disease. Collaboration between experts from disciplines such as health psychology, nutrition, psychoneuroendocrinology, and public health is recommended to strengthen investigation of the relationship between mind-body interactions such as stress-eating behaviors.

List of References

List of References

- Cohen, S., Kamarck, T., and Mermelstein, R. (1983) "A global measure of perceived stress." J Health Soc Behav. 24: 385-396.
- Cohen, S., Kessler, R.C., and Gordon, L.U. (1995). Measuring stress: A guide for health and social scientists. New York. Oxford University Press.
- Conner, M., Fitter, M., and Fletcher, W. (1999). "Stress and snacking: A diary study of daily hassles and between-meal snacking." Psychology and Health. Vol 14(1): 51-63.
- Cools, J., Schotte, D.E., and McNally, R.J. (1992). "Emotional arousal and overeating in restrained eaters." Journal of Abnormal Psychology. 101(2): 348-351.
- Dallman, M. F., Pecoraro, N.C. et al. (2005). "Chronic stress and comfort foods: self-medication and abdominal obesity." Brain Behav Immun 19(4): 275-80.
- Department of Health and Human Service, United States Department of Agriculture. Dietary Guidelines for Americans 2005. Available at: <http://www.healthierus.gov/dietaryguidelines>. Accessed September 25, 2007.
- Epel, E., Jimenez, S. et al. (2004). "Are stress eaters at risk for the metabolic syndrome?" Ann N Y Acad Sci 1032: 208-10.
- Epel, E., Lapidus, R. et al. (2001). "Stress may add bite to appetite in women: a laboratory study of stress-induced cortisol and eating behavior." Psychoneuroendocrinology 26(1): 37-49.
- Epel, E., Moyer, A.E. et al. (1999). "Stress-induced cortisol, mood, and fat distribution in men." Obes Res 7(1): 9-15.
- Epel, E., McEwen, B. et al. (2000). "Stress and body shape: stress-induced cortisol secretion is consistently greater among women with central fat." Psychosom Med 62(5): 623-32.
- Greeno, C., Wing, R. (1994). "Stress-induced eating." Psychol Bull 115(3): 444-64.
- Griffin, K., Friend, R. et al. (1993). "Effects of environmental demands, stress, and mood on health practices." J Behav Med 16(6): 643-61.
- Grunberg, N., Straub, R. (1992). "The role of gender and taste class in the effects of stress on eating." Health Psychol 11(2): 97-100.
- Haynes, C., Lee, M., Yeomans, M. (2003). "Interactive effects of stress, dietary restraint, and disinhibition on appetite." Eating Behaviors Vol 4(4): 369-383.
- Heatherton, T., Herman, C., Polivy, J. (1991). "Effects of Physical Threat and Ego Threat on Eating Behavior." J Personality and Social Psychol 60(1):138-43.
- Herman, C., Polivy, J. (1975). "Anxiety, restraint, and eating behavior." J Abnorm Psychol 84(6): 66-72.
- Herman, C., Polivy, J. et al. (1987). "Anxiety, hunger, and eating behavior." J Abnorm Psychol Vol 96(3): 264-269.
- Kandiah, J., Yake, M. et al. (2006). "Stress influences appetite and comfort food preferences in college women." Nutrition Research 26: 118-123.
- Kissebah, A., Krakower, G. (1994). "Regional adiposity and morbidity." Physiol Rev. 74: 761-811.

- Laitinen, J., Ek, E, Sovio, U. (2002). "Stress-related eating and drinking behavior and body mass index and predictors of this behavior." Prev Med 34(1): 29-39.
- Lattimore, P., Caswell, N. (2004). "Differential effects of active and passive stress on food intake in restrained and unrestrained eaters." Appetite 42(2): 167-73.
- Lattimore, P., Maxwell, L. (2004). "Cognitive load, stress, and disinhibited eating." Eating Behaviors Vol 5(4): 315-324.
- Lattimore, P. (2001). "Stress-induced eating: an alternative method for inducing ego-threatening stress." Appetite 36(2): 187-8.
- Lowe, M., Kral, T, (2006). "Stress-induced eating in restrained eaters may not be caused by stress or restraint." Appetite Vol 46(1): 16-21.
- Lyman, B. (1982). "The nutritional values and food group characteristics of foods preferred during various emotions." Journal of Psychology Vol 112(1): 121-127.
- Macht, M., Haupt, C., Ellgring, H. (2005). "The perceived function of eating is changed during examination stress: a field study." Eat Behav 6(2): 109-12.
- Macht, M., Simons, G. (2000). "Emotions and eating in everyday life." Appetite Vol 35(1): 65-71.
- McCann, B., Warnick, R., Knopp, R. (1990). "Changes in plasma lipids and dietary intake accompanying shifts in perceived workload and stress." Psychosom Med 52(1): 97-108.
- McNair, D., Lorr, M., Droppleman, L. (1971). Profile of Mood States. San Diego, CA: Educational and Industrial Testing Services.
- Mitchell, S., Epstein, L. (1996). "Changes in taste and satiety in dietary-restrained women following stress." Physiol Behav 60(2): 495-9.
- Mitchell, S., Perkins, K. (1998). "Interaction of stress, smoking, and dietary restraint in women." Physiol Behav 64(1): 103-9.
- Morley, J., Levine, A., Rowland, N. (1983). "Minireview. Stress induced eating." Life Sci 32(19): 2169-82.
- Nakagawa, M., Mizuma, K., Inui, T. (1996). "Changes in taste perception following mental or physical stress." Chem Senses 21(2): 195-200.
- Newman, E., O'Connor, D., Conner, M. (2007). "Daily hassles and eating behaviour: the role of cortisol reactivity status." Psychoneuroendocrinology 32(2): 125-32.
- O'Connor, D., O'Connor, R. (2004). "Perceived changes in food intake in response to stress: The role of conscientiousness." Stress and Health: Journal of the International Society for the Investigation of Stress Vol 20(5): 279-291.
- Oaten, M., Cheng, K. (2005). "Academic examination stress impairs self-control." Journal of Social and Clinical Psychology Vol 24(2): 254-279.
- Oleckno, W.A. (2002). Essential Epidemiology: Principles and Applications. Waveland Press. Prospect Heights, Illinois. pgs. 220-21.
- Oliver, G., Wardle, J. (1999). "Perceived effects of stress on food choice." Physiol Behav 66(3): 511-5.
- Oliver, G., Wardle, J., Gibson, E. (2000). "Stress and food choice: A laboratory study." Psychosomatic Medicine Vol 62(6): 853-865.
- Oliver, K., Huon, G. et al. (2001). "The role of interpersonal stress in overeating among high and low disinhibitors." Eating Behaviors Vol 2(1): 19-26.

- Polivy, J., Herman, C. (1999). "Distress and eating: why do dieters overeat?" Int J Eat Disord 26(2): 153-64.
- Pollard, T., Steptoe, A. et al. (1995). "Effects of academic examination stress on eating behavior and blood lipid levels." Int J Behav Med 2(4): 299-320.
- Rideout, C., Linden, W., Barr, S. (2006). "High cognitive dietary restraint is associated with increased cortisol excretion in postmenopausal women." J Gerontol A Biol Sci Med Sci 61(6): 628-33.
- Robbins, T., Fray, P. (1980). "Stress-induced Eating: Fact, Fiction or Misunderstanding?" Appetite 1: 103-133.
- Rutledge, T., Linden, W. (1998). "To eat or not to eat: affective and physiological mechanisms in the stress-eating relationship." J Behav Med 21(3): 221-40.
- Schotte, D., Cools, J., McNally, R. (1990). "Film-induced negative affect triggers overeating in restrained eaters." Journal of Abnormal Psychology Vol 99(3): 317-320.
- Spielberger, C., Gorusch, R., Lushene, R. (1970). The STAI manual for the State Trait Anxiety Inventory. Palo Alto, CA.
- Stone, A., Brownell, K. (1994). "The stress-eating paradox: Multiple daily measurements in adult males and females." Psychology and Health Vol 9(6): 425-436.
- Takeda, E., Terao, J. et al. (2004). "Stress control and human nutrition." J Med Invest 51(3-4): 139-45.
- Tanofsky-Kraff, M., Wilfley, D., Spurrell, E. (2000). "Impact of interpersonal and ego-related stress on restrained eaters." Int J Eat Disord 27(4):411-8.
- van Strein, T., Frijters, J. et al. "The Dutch Eating Behaviour Questionnaire for assessment of restrained, emotional, and external eating behaviour. Int J Eat Behav. 5: 295-315.
- Wallis, D., Hetherington, M. (2004). "Stress and eating: the effects of ego-threat and cognitive demand on food intake in restrained and emotional eaters." Appetite 43(1): 39-46.
- Wansink, B., Cheney, M. et al. (2003). "Exploring comfort food preferences across age and gender." Physiology and Behavior. 79(4-5): 739-747.
- Ward, A., Mann, T. (2000). "Don't mind if I do: disinhibited eating under cognitive load." J Pers Soc Psychol 78(4): 753-63.
- Wardle, J., Beales, S. (1988). "Control and loss of control over eating: An experimental investigation." J Abn Psychol. 97(1): 35-40.
- Wardle, J., Steptoe, A. et al. (2000). "Stress, dietary restraint and food intake." J Psychosom Res 48(2): 195-202.
- Watson, D., Clark, L., Tellegen, A. (1988) "Development and validation of brief measures of positive and negative affect: the PANAS scales." J Pers Social Psychol. 54: 1063-70.
- Weidner, G., Kohlmann, C. et al. (1996). "The effects of academic stress on health behaviors in young adults." Anxiety, Stress, and Coping 9: 123-33.
- Weinstein, S., Shide, D., Rolls, B. (1997). "Changes in food intake in response to stress in men and women: psychological factors." Appetite 28(1): 7-18.

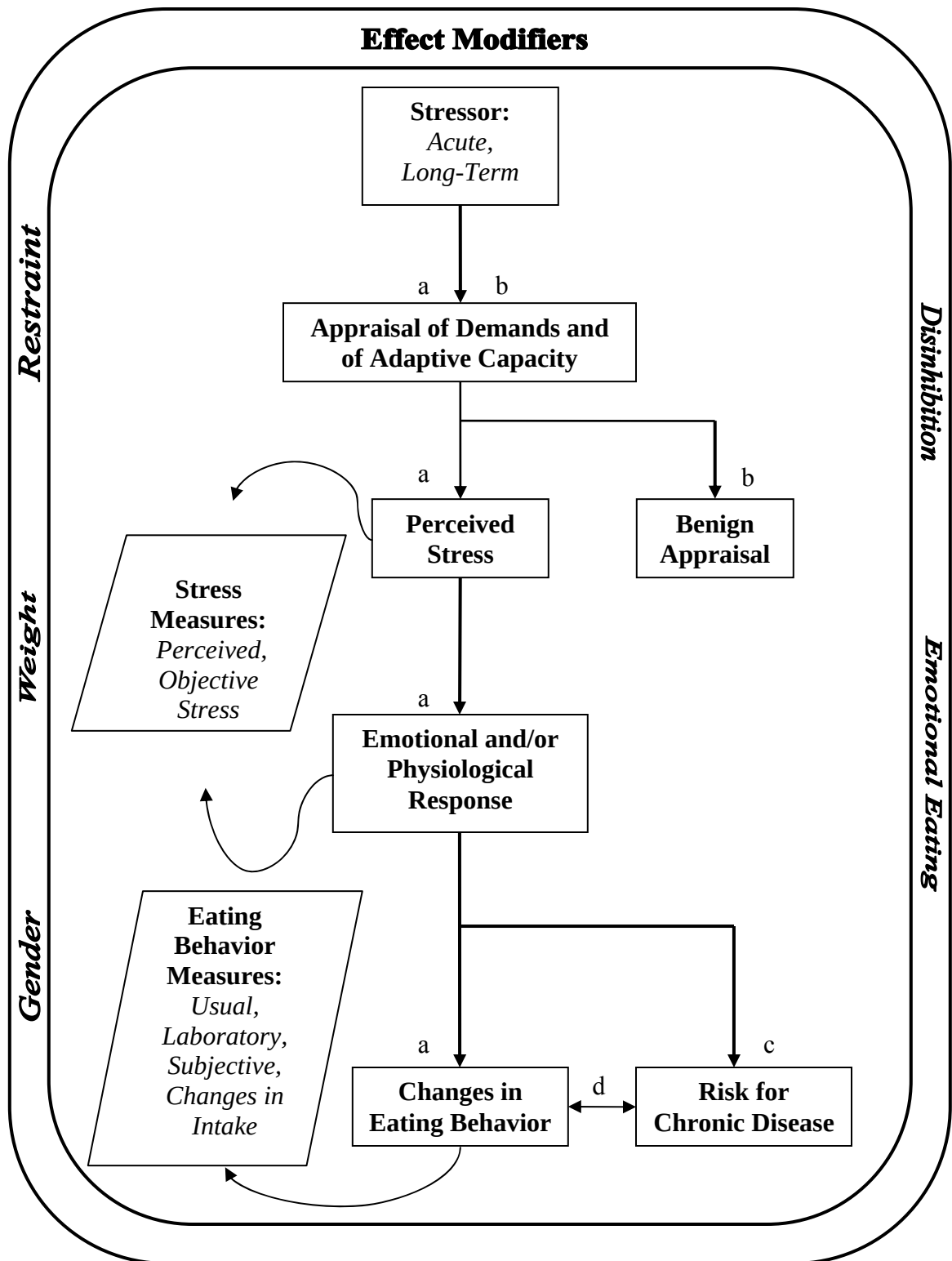
Willenbring, M., Levine, A., Morley, J. (1986). "Stress induced eating and food preference in humans: A pilot study." International Journal of Eating Disorders Vol 5(5): 855-864.

Zellner, D., Loaiza, S. et al. (2006). "Food selection changes under stress." Physiol Behav 87(4): 789-93.

Appendix

Figure A-1 shows the pathways by which stress may effect eating. Pathway **a** depicts the route by which a stressor is appraised by the individual. If the stressor is perceived as stress, an emotional and/or physiological response is triggered which in turn may affect eating behavior. Pathway **b** represents a benign appraisal where the individual has the adaptive capacity to handle the stressor and does not recognize the stressor as a threat; therefore no changes in the individual are made. Pathways **c** and **d** represent the ways in which stress and stress-eating may affect risk for chronic disease. The curved arrows show where and how stress and eating behaviors are measured. Effect modifying factors that may affect the individuals stress eating response are found in the oval around the figure. Effect modifying factors affect the stress-eating relationship as well as risk for chronic disease throughout this entire process since these factors are inherent in the individuals' nature.

Figure A-1. The stress-eating relationship with confounders and measurements of stress and food intake



Adapted from Cohen, Kessler, and Gordon 1995.

Figure A-1. Continued

Figure A-2. The following PubMed search strategy was used and adapted for use with PsycINFO^a.

1. Eating [MeSH]
2. Feeding Behavior [MeSH]
3. Energy Intake [MeSH]
4. Diet [MeSH:noexp]
5. Appetite [MeSH]
6. “restrained eating”[tiab] OR “restrained eater”[tiab] OR “restrained eaters”[tiab]
7. “dietary restraint”[tiab]
8. “external eating”[tiab]
9. “comfort food” [tiab] OR “comfort foods” [tiab]
10. snack*
11. “eating pattern”[tiab] OR “eating patterns”[tiab]
12. “disinhibited eating”[tiab]
13. #1 OR #2 OR #3 OR #4 OR #5 OR #6 OR #7 Or #8 Or #9 Or #10 OR #11 Or #12
14. “stress eating” OR “stress related eating” OR “stress induced eating”
15. Stress, Psychological [MeSH]
16. Stress [MeSH]
17. “daily hassles”
18. #15 OR #16 OR #17
19. #18 AND #13
20. #19 OR #14

^a Unless stated otherwise, search terms are free text terms; MeSH: Medical Subject Heading; an asterisk (*) is a truncation symbol.

Figure A-2. Search Strategy

Figure A-3 shows the process by which articles were chosen to be included in this review. 1025 articles were retrieved through initial database searches. 928 were excluded initially based on titles and abstracts that were not relevant to this review. The remaining 97 articles were reviewed in full, 47 of which were removed based on exclusion criteria. 50 articles remained and were included in the review.

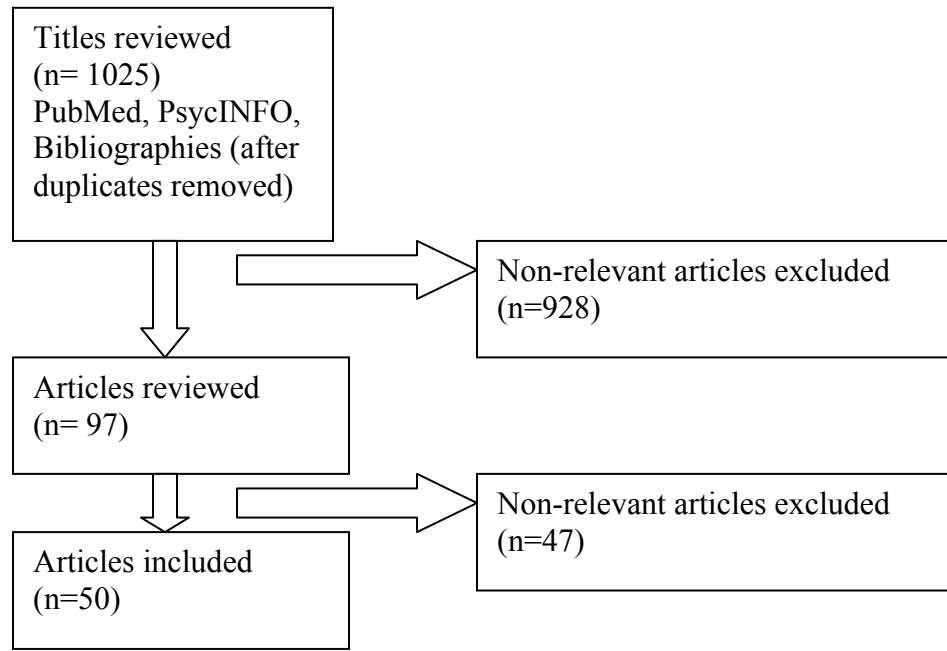


Figure A-3. Article Retrieval Process.

Table A-1. Articles Measuring Acute Stressors

Study	Participants	Stress	Stress Measure	Food Measure	Types of Food Measured	Results
Herman and Polivy 1975	42 female undergrads	physical threat	mood scale	taste test	ice cream	restrained ate more, unrestrained ate less
Heatherton, Herman and Polivy 1991	75 female undergrads	physical threat, ego threat	STAI ^a	taste test	ice cream	restrained ate more, unrestrained ate less
Wardle and Beales 1988	26 women 40yrs old	film-induced	100-mm anxiety scale	ad lib	test meals	diet group ate 3x as much as other groups
Schotte, Cools and McNally 1990	60 female undergrads	film-induced	POMS ^b	ad lib	popcorn	restrained ate more, unrestrained ate less
Cools, Schotte and McNally 1992	91 female undergrads	film-induced	POMS ^b	ad lib	popcorn	restrained ate more, unrestrained ate less
Grunberg and Straub 1992	26 male, 28 female undergrads	film-induced	researcher developed questionnaire	ad lib	high and low fat sweet, salty, and bland	men ate less, women ate more, all ate more sweets than other food
Lattimore 2001	20 female undergrads	ego-threat, film induced	STAI ^a	taste test	ice cream	more ice cream was consumed in ego-threat task than film-threat
Mitchell and Epstein 1996	32 female 24yrs old	cognitive load	physiologic measures	taste test	yogurt	restrained ate more, unrestrained ate less
Mitchell and Perkins 1997	48 female 18-40yrs old	cognitive load	STAI ^a , SACL ^c	ad lib	tray of snack foods	unrestrained smokers ate more, restrained nonsmokers ate more
Rutledge and Linden 1998	77 female undergrads	cognitive load	PANAS ^d	ad lib	cookies, crackers	restrained ate more, unrestrained ate less
Ward and Mann 2000	60 female undergrads	cognitive load	Likert scale 1-7	ad lib	chips, chocolate, cookies	unrestrained ate more in low cognitive load task, restrained ate more in high cognitive load task
Wallis and Hetherington 2004	38 female undergrads and staff	cognitive load, ego-threat	PSS ^e , STAI ^a	ad lib	chocolate	restrained ate more after both tasks, emotional eaters ate more only after ego-threat
Lattimore and Maxwell 2004	119 female undergrads	cognitive load, ego-threat	STAI ^a	taste test	chips, chocolate, dried fruit	restrained eaters ate more after cognitive task only when combined with ego-threat

Table A-1. Continued

Herman, Polivy et al 1987	80 female undergrads	ego-threat	STAI ^a	taste test	ice cream	dieters ate more, nondieters ate less
Polivy and Herman 1998	137 female undergrads	ego-threat	Self-Esteem Scale	taste test	ice cream	restrained ate more, unrestrained ate less
Oliver, Wardle and Gibson 2000	27 male, 41 female undergrads and staff	ego-threat	PANAS ^d	ad lib	buffet meal	men ate more bland and salty foods, emotional eaters ate more sweets, no difference between restrained and unrestrained eaters
Tanofsky-Kraff, Wilfley and Spurrell 2000	82 female undergrads	ego-threat	Sensation Questionnaire	taste test	ice cream	restrained eaters ate more
Epel, Lapidus et al. 2001	59 females 30-45yrs old	ego-threat	salivary cortisol, POMS ^b	ad lib	basket of snacks	high cortisol reactors ate more than low cortisol reactors, negative mood increased consumption
Oliver, Huon et al. 2001	57 female undergrads	ego-threat	TFEQ ^f	taste test	chocolate, chips	high disinhibitors ate more sweets than low disinhibitors
Haynes, Lee and Yeomans 2003	80 female undergrads and staff	ego-threat	TFEQ ^f , POMS ^b	ad lib	full breakfast and lunch	high disinhibitors ate more sweets, high restrained ate less savoury food, under stress all groups ate similar amounts
Lattimore and Caswell 2004	40 female undergrads	ego-threat	STAI ^a	taste test	sweet, salty, and bland snacks	restrained eaters ate more, unrestrained eaters ate less
Zellner, Loaiza et al. 2006	34 female undergrads	ego-threat	rating of stress level (11 point scale)	ad lib	chocolate, peanuts, chips, grapes	the no-stress group ate more grapes, the stress group ate more chocolate

^a STAI = State Trait Anxiety Index

^b POMS = Profile of Mood States

^c SACL = Stress Arousal Checklist

^d PANAS - Positive and Negative Affect Scales

^e PSS = Perceived Stress Scale

^f TFEQ = Three-Factor Eating Questionnaire

Table A-2. Articles Measuring Long-Term Stress

Study	Participants	Stress	Stress Measure	Food Measure	Types of Food Measured	Results
Griffin, Friend et al. 1993	32 male, 47 female undergrads	academic stress	# of exams/papers due, likert scale (1-7), PSS ^a , PANAS ^b	Wellness Inventory	none	improvement in health practices (nutrition) the week following exams
Pollard, Steptoe et al. 1995	80 male, 99 female undergrads	academic stress	STAI ^c , PSS ^a , exam period	24-hr recall	full day intake	high anxiety-low social support ate more, low anxiety and high social support ate less
Weidner, Kohlmann et al. 1996	46 male, 123 female undergrads	academic stress	# of exams, papers, projects, PANAS ^b	Wellness Inventory	none	decrease in positive affect and increase in negative affect in response to stress associated with decreased quality of nutrition
Epel, Jimenez et al. 2004	15 males, 16 female med students	academic stress	exam period	single question: Do you eat more, less, or the same under stress?	none	Stress "more-eaters" gained more weight, had increases in cortisol, insulin, and lipid profile
O'Connor and O'Connor 2004	132 female undergrads	academic stress	PSS ^a , exam period	single question: How many snacks have you eaten in the previous two weeks?	none	low conscientious and dieting or perfectionist consumed more snacks under stress
Macht, Haupt and Ellgring 2005	42 male and female undergrads	academic stress	exam period	recorded reason for eating, what they had eaten, and how much	full day intake	increase in motivation to eat to provide distraction during stress, no change in overall intake
Oaten and Cheng 2005	16 male, 41 female undergrads	academic stress	DASS ^d , PSS ^a , exam period	multiple questions about food choice in the past week	none	a decrease in healthy eating was reported during stress
McCann, Warnick and Knopp 1990	3 male, 11 female university employees	work stress	stress level scale (1-100), # grants received	4-day food records	full day intake	calories, total fat, and % calories from fat were higher during high workload periods
Wardle, Steptoe et al. 2000	27 male, 44 female department store employees	work stress	# hours worked, PSS ^a	24-hr recall	full day intake	restrained eaters ate more calories, fat, and saturated fat under stress, unrestrained had no change

Table A-2. Continued

Study	Participants	Stressor	Stressor Measure	Food Measure	Types of Food Measured	Results
Stone and Brownell 1994	158 males and females mean age 43	daily stress	daily questionnaire booklet where described most bothersome event of the day and rated severity	single question: Did you eat more, less, or the same today as compared with how much you usually eat?	none	subjects were consistent in their direction of stress eating (always ate more or always ate less), males ate less under stress, females ate more
Conner, Fitter and Fletcher 1999	27 male, 33 female undergrads	daily stress	recorded number and severity of hassles	recorded type and number of snacks eaten	none	numbers of snacks increased with increased number of hassles

^a PSS = Perceived Stress Scale

^b PANAS - Positive and Negative Affect Scales

^c STAI = State Trait Anxiety Index

^d DASS = Depression Anxiety Stress Scale

Vita

Jessica L Sieber was born in Kingston, NY on September 25, 1983. She was raised in West Hurley, NY. She graduated from Onteora Jr./Sr. High School in 2001. From there, she went to Pennsylvania State University and received a B.S. in Nutritional Sciences with a minor in Health Policy Administration in 2005.

Jessica is currently pursuing her Masters of Science in Nutrition and Masters of Public Health in Community Health Education at The University of Tennessee and will continue on for her Doctorate in Nutritional Sciences.