The relationship between stress, dietary restraint, and food preferences in women

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ABSTRACT

The relationship between stress, restraint, and eating has been studied using various methods, including retrospective self-reports of stress and eating that are open to inaccuracies. Additionally, laboratory research has not systematically varied the fat content and sweetness of food items to assess how stress relates to specific food preferences. In this study of 40 women we examined the role of restraint and experimentally induced stress on the amount of sweet, salty, high-fat, and low-fat food consumed. High-restraint women ate more high-fat food than did low-restraint women, regardless of stress level. High-stressed women preferred sweet, high-fat food more than did low-stressed women, whereas low-stressed women ate more low-fat than high-fat food. There was no interaction between restraint and stress level. Social influence effects of small-group testing may have increased the ego-threat of the stressor or disinhibited high-restraint women in both stress groups. Future laboratory research is needed to assess the role of the presence of others in both stress induction and eating behaviors.

Stress plays a role in a multitude of negative human health behaviors. Researchers have investigated the relationships between stress and many different medical problems, such as cardiovascular diseases (Ohman, Nyberg, Bergdahl, & Nilsson, 2007), diabetes (Ohman et al., 2007), and cholesterol levels (Coleman, Friedman, & Burright, 1998; Van Doornen & Orlebeke, 1982). Because obesity is an underlying factor in these medical conditions, researchers (Gibson, 2006; Greeno & Wing, 1994; Macht, 2008; Torres & Nowson, 2007) have often studied the role of stress in individuals’ eating behaviors, such as the amount eaten and the types of foods consumed. Such research has generally operated within the framework of individual-difference models, which look at the relation between stress and eating as being more complicated than a general physiological process. Instead, according to individual-difference models, physiological, environmental, and psychological factors interact to produce different stress reactions among individuals (Greeno & Wing, 1994).

One key psychological factor is emotion, which can be differentially induced by or related to stress and therefore may lead to a variety of eating outcomes. Macht’s (2008) five-way model of how emotions relate to eating includes the ideas that eating (a) may be a way for individuals to regulate their negative emotions, and (b) may be caused by the stress-induced disruption of individuals’ cognitive self-regulation. These two theoretical paths have been investigated extensively in studies involving emotional eaters (those who tend to eat in response to negative affect) and in restrained eaters (those who consciously try to restrict their food intake in order to lose or maintain weight). Both emotional and restrained eating have been tied to obesity, bulimia nervosa, and binge eating disorders (Delinsky & Wilson, 2008; Gluck, 2006); therefore, they play an important role in physical and psychological health.

Numerous researchers have been particularly interested in restraint theory (see Greeno & Wing, 1994). Competing ideas have evolved attempting to understand the mechanisms underlying the relation between restrained eating, stress, and food intake. One explanation in dietary restraint theory is that restrained eaters can become temporarily “disinhibited” by strong emotions or thoughts and then lose the energy needed to restrain their eating (Ruderman, 1986). An alternate idea (Ward & Mann, 2000) is that it is not the stress-induced emotional reactions of restrained eaters that cause disinhibition, but instead is a stressful task’s “cognitive demand” (or “cognitive load”) occupying so much of the restrained eaters’ mental capacity that they no longer have the cognitive ability to restrict their eating.

Much research has been devoted to the relationships between restraint, stress, and food intake. Restraint has generally been measured through self-report, using one of several available measures. Because stressors often elicit negative affect, some researchers (Macht & Mueller, 2007a; Oliver, Wardle, & Gibson, 2000) have chosen to include measures of emotional eating in their studies of dietary restraint and eating, as well. In terms of stress, some previous research has examined chronic, naturalistic stress
via self-report (e.g., Liu et al., 2007; Macht et al., 2005; Sims et al., 2008). These assessments of stress are valuable in that they are naturalistic and they attempt to measure chronic stress—a form of stress that has been linked to many negative psychological and physical outcomes. However, these measures are problematic due to being retrospective self-reports of stress occurring during the last month or year, thus being open to inaccuracies and biases.

In response to the potential measurement problems of retrospective self-report measures, as well as to investigate the effects of acute stress on eating behaviors, other researchers (e.g., Haynes, Lee, & Yeomans, 2003; Schotte, Cools, & McNally, 1990; Wallis & Hetherington, 2004) have measured stress that has been induced in an experimental setting. These measures of acute stress, then, do not rely on retrospective accounts and can be systematically manipulated and controlled by the researchers. Such experimentally induced stressors may also involve high or low cognitive load (i.e., mental capacity), may include ego threats (e.g., failure, social comparison), and may elicit one of several different negative emotions (e.g., anxiety, fear, sadness). This variability in stressors increases the representativeness of results, yet also creates difficulty in making comparisons across studies. However, the experimental control gained by these measures of acute stress has afforded researchers many insights into the complex nature of stress-induced eating.

For example, Wallis and Hetherington (2004) used a Stroop color-naming task in which some participants were exposed to several types of ego-threatening words (e.g., “inefficient,” “ridiculed”) and other participants (the control group) were exposed to neutral words not involving ego threat. The researchers found that female participants in the stressful ego-threatening condition ate more chocolate than those in the control condition. In addition, these researchers included an “incongruent” condition (i.e., cognitive-load condition) in which the names of colors were printed in colors that were not consistent with the color name. They discovered that participants in the stressful cognitive load condition ate more chocolate than did those in the control condition. Like Wallis and Hetherington (2004), Lattimore and Maxwell (2004) conducted a study using a Stroop task with ego-threatening words, but these researchers chose to increase cognitive load by requiring additional memorization of words for an upcoming test. They found increased eating of potato chips, dried fruit, and chocolate items by participants in the high cognitive load condition that involved ego threat, particularly by highly restrained eaters. The role of ego-threatening situations on eating behavior was also found by Tanofsky-Kraff, Wilfley, & Spurrell (2000). Using three different tasks to induce ego-threatening stress (i.e., failure at a spatial puzzle, an anticipatory speech, being shunned by confederates in an interpersonal task), the researchers discovered greater ice cream consumption by restrained participants in the stressful conditions than in the control condition, and that the greatest amount of ice cream was eaten by those experiencing interpersonal ego-threatening stress.

As is evident from previously cited research, the variable of food intake has also been measured various ways in previous studies. Some research has relied on self-report (e.g., Macht et al., 2005; Oliver & Wardle, 1999; Tuschl, Laesle, Platte, & Pirke, 1990); however, due to the potential inaccuracies and biases inherent to self-report data, other researchers (e.g., Haynes et al., 2003; Lattimore & Maxwell, 2004; Oliver et al., 2000; Wallis & Hetherington, 2004) have surreptitiously assessed the amount of food eaten in a laboratory setting. Importantly, as Greeno and Wing (1994) summarized, many past laboratory studies provided participants with only one food to eat, and often one high in fat such as chocolate, ice cream, cookies, or buttered popcorn. Therefore, such studies have not been able to investigate whether there are particular kinds of food that individuals are likely to eat during times of stress.

Fortunately, several researchers have realized the importance of not only food amount, but also food choice, when examining the relationship between stress and eating behavior. The importance of stress-induced food preferences surfaced in animal studies, which showed that rats under mild stress increase their intake of fat (Diane, Victoriano, Fromentin, Tome, & Larue-Achagiotis, 2008) and sweet items (Rowland & Antelmann, 1976). Humans’ preference for sweet, high-fat items appears related to the food’s palatability (Drewnowski & Greenwood, 1983; Macht & Mueller, 2007b) and such “comfort foods” tend to reduce negative mood and stress (Dallman et al., 2005; Macht & Mueller, 2007b). Surprisingly, a few studies that offered participants a variety of foods did not measure the impact of stress on the intake of specific food categories, but instead focused on the overall weight of food each participant consumed (Rutledge & Linden, 1998; Tice, Bratslavsky, & Baumeister, 2001). Other researchers (Liu et al., 2007; Oliver & Wardle, 1999; Wardle, Steptoe, Oliver, & Lipsey, 2000) have used participants’ self-reported consumption of different types of foods as the measure of food choice, despite the known problems associated with self-report measures. A small number of studies (Grunberg & Straub, 1992; Haynes et al., 2003; Levine & Marcus, 1997; Shapiro and Anderson, 2005; Zellner et al., 2006) investigating stress-induced food preferences, though, have presented participants with several foods of varied levels of sweetness, saltiness, and fat content to discover more specific relations between stress and eating.

Considering the variety of measures utilized in the multitude of studies investigating the relation between stress and food preferences, it is hardly surprising that results are varied. For example, a few large-scale studies have found that individuals’ self-reported stress relates to a diet high in fat (Ng & Jeffery, 2003) and sugar (Kandiah, Yake, Jones, & Meyer, 2006; Wardle et al., 2000). However, other research investigations have found no relation between stress and food preferences (Macht et al., 2005; Oliver et al., 2000).

With respect to the role of restraint in stress-induced eating, research has produced more consistent results. Most findings indicate that restrained eaters are likely to eat more when stressed than when unstressed, and that stressful situations elicit increased eating in restrained eaters but not in unrestrained eaters (Cools, Schotte, & McNally, 1992; Lattimore & Caswell, 2004; Polivy, Herman, & McFarlane, 1994; Schotte et al., 1990; Tanofsky-Kraff et al., 2000; Wallis & Hetherington, 2004). Many of these studies, however, did not assess the types of food preferred, but instead presented participants with only one food to eat.

In the current study our aim is to build on previous laboratory research investigating the role of stress, dietary restraint, and food preferences. Grunberg and Straub’s (1992) study of stress-induced eating demonstrated that women in the high stress condition consumed slightly more sweet food than women in the low stress condition, but their intake of salty food did not vary by stress level. Zellner et al. (2006) also found in their sample of female college students that laboratory-induced stress related to food choice. The researchers presented participants with four food options varying on two dimensions: sweet versus salty and healthy versus unhealthy. Under stress, participants ate more sweet, unhealthy food (chocolate M&Ms) than sweet, healthy food (grapes). In addition, stressed individuals ate more M&Ms and fewer grapes than unstressed participants. There were no significant findings concerning salty foods and the researchers suspected that this could have been due to both salty items (potato chips, salted peanuts) being high in fat. Taken together, these two studies suggest that stressed females will be more likely than nonstressed females to eat sweet, high-fat food. However, the role of restraint was not investigated in either experiment.
Laboratory research investigating the effects of both stress and restraint on food preferences has been conducted by Haynes et al. (2003). They presented women in both the high-stress and low-stress conditions with a lunch tray containing five savory foods (cheese sandwiches, egg sandwiches, cheese cubes, cherry tomatoes, potato chips) and three sweet foods (cakes, cookies, chocolate). Participants also filled out questionnaires concerning restraint and disinhibition (e.g., emotional and external eating) and were divided into four groups based on their scores. Contrary to the findings stated above, Haynes et al. discovered that stress had no effect on the consumption of sweet food. Restraint did not relate to the preference for sweet food; however, the high disinhibited group ate more sweet food than did low disinhibited group. In terms of savory foods, women high in restraint consumed less than women low in restraint. Overall, highly restrained participants ate more in the stress condition than in the unstressed condition. Unfortunately, all savory and sweet foods except one (cherry tomatoes) were high in fat, so it is difficult to interpret the results in terms of preference for high-fat versus low-fat items.

Current study

Our procedure is modeled after Zellner et al.'s (2006) with a few modifications and improvements. Consistent with their methodology, we utilized an unsolvable puzzle as a stress inducer and explained the inclusion of the foods in the procedure as being a thank-you for participation (rather than as a taste-test measure, as other researchers have done). In addition, we followed Zellner et al.'s procedure by using the sweet, high-fat food of plain chocolate M&Ms and the salty, high-fat food of potato chips. However, to improve upon their design, we chose to use pretzels for the low-fat, salty item and honey-flavored graham crackers for the low-fat, sweet item. In this way we varied food items systematically on two dimensions: sweetness/saltiness and low-fat/high-fat. In addition, although Zellner et al. did not investigate the role of dietary restraint, we observed that previous research has consistently shown it to be an important mediating variable and we therefore felt it necessary to include in our study.

One final improvement we made upon previous laboratory research was to conduct the experiment in small groups (i.e., three to five individuals), so that participants were in the presence of others when eating and attempting to solve the puzzle. Numerous previously cited, naturalistic studies of stress and eating have measured self-reported consumption of food items. Because eating is commonly done in social contexts, presumably many, if not most, of these self-reported foods were eaten in the presence of others. However, laboratory studies that have objectively assessed food intake have only measured participants’ solitary eating behavior, thus removing the social component of eating and thereby reducing the generalizability of the findings. We believe that it is more externally valid to assess eating behavior not in isolation, but instead within a social context—a context shown to play a role in both facilitating and inhibiting individuals’ eating practices (Herman & Polivy, 2005; Stroebele & De Castro, 2004).

Hypotheses

Recent research has shown that restrained eaters appear to be more hedonically responsive than unrestrained eaters to palatable (versus neutral) food cues (Papies et al., 2007), even if the cues are merely food-related words. Because palatability is directly related to the fat content and sweetness of food, one would expect that individuals high in restraint will be more likely than those low in restraint to consume high-fat, sweet foods when such items are easily available. In addition, as previous research has shown, highly stressed participants tend to eat more sweet, high-fat food than do those low in stress. Based on these findings, we hypothesize that restrained eaters, especially those experiencing higher stress, will be more likely than unrestrained eaters, especially those experiencing low stress, to consume high-fat, sweet food. In terms of salty food, we expect that fat content will again play a role so that highly stressed women (especially those high in restrained eating) will be more likely than lower stressed women (especially those low in restrained eating) to eat salty, high-fat food.

Method

Participants

A sample of 40 female students was obtained from the subject pool of a Midwestern commuter university. At this university the subject pool consists of students enrolled in an introductory psychology course who select studies in which to participate in order to fulfill a course requirement. (All studies are approved by the university’s Institutional Review Board.) Participants were informed on the sign-up sheet for the experiment that snacks would be offered. This was done to minimize participants’ suspicion about the purpose of the study once they arrived at the testing room. To check for suspicion, we asked participants halfway through the experiment what they thought was the purpose of the study.

The women in the sample ranged in age from 18 to 41 years (M = 21.35, S.D. = 5.23) and consisted largely of self-identified Whites (n = 24) and Arab Americans (n = 10), with smaller numbers of African Americans (n = 3), Hispanics (n = 2), and Asian Americans (n = 1). The mean BMI (kg/m²) for the sample, based on participants’ self-reported weight and height, was 23.17 (S.D. = 4.27).

Measures

Stress level: Half of the participants were randomly assigned to the High Stress condition, where they were given, unbeknownst to them, an unsolvable Sudoku puzzle to try to complete in 15 min. The other participants were randomly assigned to the Low Stress condition, where they received a very easy Sudoku puzzle to complete in the same amount of time. Sudoku puzzles are mathematical rather than linguistic; therefore, we expected that this male-stereotyped task would help induce stress, cognitive load, and possibly also ego-threat in our female participants, especially for those with the unsolvable puzzle.

The Sudoku puzzle was administered to the participants in small groups of three to five. Participants were seated in rows of desks (with one empty desk between each participant) alternating for stress condition. Thus, each participant was seated next to one or two participants in the other stress condition. As a result, those getting the impossible Sudoku could observe that the other nearby participant(s) had successfully completed their puzzle within the allotted time. We expected that this arrangement would make the impossible Sudoku condition more ego-threatening and therefore more stressful, as previous research has found (Wallis & Hetherington, 2004).

After they finished working on the puzzles, participants in both the High Stress (i.e., impossible Sudoku) and Low Stress (i.e., easy Sudoku) conditions responded to four items in which they rated their level of stress and frustration on a 6-point scale (1 = Not at all, 6 = Extremely). Two items pertained to the level of stress and frustration they experienced while working on the puzzle and two items pertained to their current levels of stress and frustration. A Pearson product moment correlation coefficient showed that the two items concerning stress and frustration participants felt during the Sudoku were highly correlated (r = .82, p = .0001). These
items were combined to create a Stress During Sudoku measure. The two items concerning stress and frustration experienced currently by the participants were also highly correlated (r = .94, p = .0001) and were combined to create a Stress After Sudoku measure.

**Amount of food eaten:** During the experiment participants were provided with four different snack foods to eat, with food items varying on two factors: Taste (sweet or salty) and Fat Level (low or high). The four items were plain M&M chocolate candies (sweet, high fat), honey-flavored Teddy Grahams (sweet, low fat), sour cream and onion flavored Pringles potato chips (salty, high fat), and Snyder’s of Hanover pretzels (salty, low fat). These items were chosen in order to improve upon Zellner et al.’s (2006) design in which they used M&Ms, potato chips, grapes, and salted peanuts as their food choices. As Zellner et al. acknowledged, peanuts, although healthy in terms of protein content, are also high in fat, just as potato chips are. Thus, we included the salty, low-fat option of pretzels instead of peanuts. We used Teddy Grahams rather than grapes for two reasons. First, grapes are perishable and were therefore difficult to keep fresh. Second, to increase standardization we wanted to insure that all four items were snack foods having a crunchy, non-moist texture. Table 1 presents the nutritional value of each food item.

All foods were unwrapped and each category of food was placed in a separate paper bowl on the desk in front of the participant. All bowls appeared full and each participant was given approximately the same amount of each food item. In order to determine the amount of food eaten, the experimenter weighed each bowl of items before the participants arrived for the experiment and then again after the completion of the session. Measurements were computed in number of ounces and were made using a 5-lb capacity, digital scale (with accuracy to the .10 oz).

**Restrained eating:** The 10-item Restrained Eating subscale of the Dutch Eating Behavior Questionnaire (DEBQ; Van Strien, Frijters, Berger, & Defares, 1986) was used to assess how much each participant attempts to restrict her eating in order to keep from gaining weight. Participants respond using a 5-point scale, ranging from 1 (never) to 5 (very often). The scale includes items such as: “If you have put on weight, do you eat less than you usually do?” and “Do you try to eat less at mealtimes than you would like to eat?” Cronbach’s alpha computed for this sample showed high internal consistency (α = .94).

Each participant’s mean score was computed and we followed the example of others (Lattimore & Caswell, 2004; Oliver et al., 2000) by then using a median split (median = 2.45) to divide individuals into Low Restrained and High Restrained groups. This was done so that restrained eating level could be entered as a between-subjects factor in the analyses to see if it interacted with stress level to affect participants’ food preferences. Eight participants in the High Stress condition were low in restrained eating and 12 were highly restrained. A Pearson χ² analysis showed that the two stress level groups did not significantly differ in their level of restrained eating.

**Emotional eating:** Following the suggestion of Macht and Mueller (2007a), we included emotional eating as a covariate in analyses because of its possible interaction with restrained eating. We used the 13-item Emotional Eating subscale of the DEBQ (Van Strien et al., 1986) to assess the extent to which participants eat in response to emotionally aroused states such as fear and stress. Each participant’s mean score was calculated. Examples of items on this scale are: “Do you have the desire to eat when you are irritated?” and “Do you have a desire to eat when you are feeling lonely?” High internal consistency was obtained with this sample (α = .94).

**Dieting and taste preferences:** Participants were asked to indicate (yes or no) if they are currently on a diet. They also responded to two items where they rated on a 1-to-5 scale how much they like sweet foods and how much they like salty foods, with 1 indicating love and 5 indicating hate. Participants’ mean scores indicated a liking for both tastes.

### Procedure

The room in which the experiment was administered was a standard classroom with 40 seats. Chairs faced the experimenter in parallel rows and each participant was instructed to sit facing the front of the room. Participants had a large, opened three-ring binder placed on the desk on either side of them to try to keep them from seeing their neighbors’ work. However, the binders were short enough so that if a participant wanted to look over at another’s work, this was still possible. Small groups of three to five participants were studied at the same time in order to try to increase ego-threat and to improve the external validity of the study by having participants in the presence of others while eating. All sessions took place between noon and 2:00 p.m. in order to control for time of day.

Upon arrival, participants were greeted by the female experimenter. To assure anonymity, participants were assigned numbers, which were printed on each handout received. Participants were told that the experiment was investigating psychological variables associated with problem-solving skills used in Sudoku puzzles. As a standard explanation for the presence of snack foods on each table, the experimenter casually stated: “I felt like I needed to give people some type of incentive to be a part of this study, that’s why there are snacks on the table in front of you. I figured if the study did not sound interesting, the food would encourage people to come. So feel free to eat whatever you like—they are here for you.” Although, the food was an integral part of the experiment, we hoped that this deception would convince participants otherwise.

Participants were then asked to sign a consent form agreeing to participate in the study. They were then administered either an “easy” or an “impossible” Sudoku puzzle with attached written directions on how to complete a Sudoku and a model puzzle. Participants were unaware that there were two different types of puzzles. Based on pilot work, it was expected that the easy Sudoku would require about 10 min for completion. To ensure that participants in the low-stress condition would be able to complete their Sudoku, each participant was allotted 15 min to work on the puzzle. All participants in the easy condition did in fact complete their Sudoku puzzle.

While participants worked on the Sudoku puzzles, the four bowls with different foods were available. The bowls were present within easy reach on the tables where participants were working and, to increase standardization, the left-to-right order of the snacks (i.e., pretzels, Teddy Grahams, M&Ms, potato chips) was randomly determined and was the same for every participant.

After the Sudoku puzzles were collected, each participant was asked to complete a brief questionnaire assessing how stressed and frustrated they were both while working on the puzzle and afterwards. At this point the experimenter left the room, informing

### Table 1

<table>
<thead>
<tr>
<th>Food item</th>
<th>Serving size</th>
<th>Total fat</th>
<th>Sugars</th>
<th>Sodium</th>
</tr>
</thead>
<tbody>
<tr>
<td>Plain M&amp;M chocolate candies</td>
<td>50 g</td>
<td>13 g</td>
<td>38 g</td>
<td>35 mg</td>
</tr>
<tr>
<td>Honey-flavored teddy graham</td>
<td>30 g</td>
<td>5 g</td>
<td>9 g</td>
<td>75 mg</td>
</tr>
<tr>
<td>Sour cream and onion flavored</td>
<td>30 g</td>
<td>10 g</td>
<td>1 g</td>
<td>325 mg</td>
</tr>
<tr>
<td>Pringles potato chips</td>
<td>30 g</td>
<td>.7 g</td>
<td>8 g</td>
<td>384 mg</td>
</tr>
</tbody>
</table>

Note: The serving size for M&Ms was larger than that of the other food items in order to make the bowl of M&Ms appear as full as the others.
the participants that she had forgotten the necessary questionnaires, and that she would be returning in approximately 2 min. The experimenter’s absence provided participants with the opportunity to eat without the experimenter observing them. Upon reentering the room, the experimenter provided participants with the packet containing the Restricted eating scale, the Emotional eating scale, and the demographic questions. The questionnaire phase of the study took approximately 15 min.

A script encompassing everything said to participants during the experiment was created and served to ensure that the statements used during experimentation were standardized.

The total experiment took approximately 35 min. When finished, participants were thanked and were later debriefed via e-mail once all the trials of the experiment were completed.

Results

Stress manipulation check

To make certain that the two Sudoku versions did indeed produce differential acute stress levels, we conducted two separate independent-samples t-tests comparing the High Stress and Low Stress conditions in terms of participants’ stress levels both during and after working on the Sudoku puzzle. Participants in the High Stress condition scored significantly higher (M = 8.25, S.D. = 2.83) than those in the Low Stress condition (M = 4.45, S.D. = 2.74) on Stress During Sudoku, t(38) = 4.20, p = .0001. Those in the High Stress condition also scored significantly higher (M = 6.15, S.D. = 3.65) than those in the Low Stress condition (M = 3.25, S.D. = 1.89) on Stress After Sudoku, t(38) = 3.16, p = .003. The fact that the Low Stress group’s mean scores were 4.45 and 3.25 on the 10-point scale suggests that the male-stereotyped mathematical task was successful in inducing stress even for the lower stressed group.

Similarity of Low Stress and High Stress groups

We conducted independent-samples t-tests to find out if the two stress level groups were comparable in terms of BMI, Emotional eating, liking for sweet foods, liking for salty foods, and age. All analyses showed no significant differences between the two groups. In addition, Pearson χ² analyses showed no significant stress condition differences in current dieting or in suspicion about the purpose of the study.

The effects of stress and restrained eating on food preferences

To discover if high acute stress increases the consumption of sweet, high-fat foods, especially for restrained eaters, we conducted a mixed-design analysis of variance (ANOVA) with the between-subjects factors of Stress level (low, high) and Restricted eating (low, high) and the two within-subjects factors of Taste (sweet, salty) and Fat Level (low, high). Mauchly’s test of Sphericity was computed for all within-subject effects, but none was significant.

The ANOVA demonstrated a main effect of Stress Level on the total amount of food consumed, F(1, 36) = 7.30, p = .01, η² = .17. Overall, irrespective of participants’ restrained eating level and the food’s Taste or Fat Level, participants in the High Stress condition ate more food (M = 56.30, S.D. = 25.83) than participants in the Low Stress condition (M = 34.50, S.D. = 24.31). Three participants ate nothing and all three were in the Low Stress group. There was also a significant overall effect of Taste on the amount of food eaten, F(1, 36) = 12.07, p = .001, η² = .25. Regardless of their restraint level, stress level, or the fat content of the food, participants were overall more likely to eat sweet food (M = 28.95, S.D. = 21.93) than salty food (M = 16.45, S.D. = 14.21).

The relations between stress level, restrained eating, and food preferences were clarified by the four significant interactions in the ANOVA. First, we found a significant interaction between Stress Level and Taste, F(1, 36) = 17.69, p = .001, η² = .33. Post hoc analyses (Bonferroni correction) showed that the High Stress group ate significantly more sweet food (M = 41.50, S.D. = 20.45) than did the Low Stress group (M = 16.40, S.D. = 15.41). The two groups did not differ in the amount of salty food consumed. In addition, post hoc analyses indicated that participants in the High Stress condition were significantly more likely to eat sweet food (M = 41.50, S.D. = 20.45) than salty food (M = 14.80, S.D. = 11.58), whereas there was no significant difference in preference for sweet or salty items in the Low Stress group.

The second significant interaction was between Stress Level and Fat Level, F(1, 36) = 21.76, p = .0001, η² = .38. Post hoc (Bonferroni correction) analyses demonstrated that individuals in the High Stress condition ate significantly more high-fat food (M = 36.80, S.D. = 20.10) than did those in the Low Stress condition (M = 7.35, S.D. = 9.84). There was no stress level difference in the consumption of low-fat food, however. Additionally, the post hoc analyses showed that highly stressed participants were more likely to consume high-fat food (M = 36.80, S.D. = 20.10) than low-fat food (M = 19.50, S.D. = 16.07). In contrast, participants in the Low Stress condition were significantly more likely to eat low-fat food (M = 27.15, S.D. = 20.64) than high-fat food (M = 7.35, S.D. = 9.84).

The third significant two-way interaction was between Restrained Eating Level and Fat Level, F(1, 36) = 6.36, p < .01, η² = .15. Post hoc analyses (Bonferroni correction) showed that highly restrained eaters were more likely (M = 29.25, S.D. = 23.98) than low restrained eaters (M = 14.90, S.D. = 16.55) to eat high-fat food. There was also a marginally significant finding that low restrained eaters were more likely (M = 28.55, S.D. = 21.20) than highly restrained eaters (M = 18.10, S.D. = 14.43) to eat low-fat food. Post hoc analyses showed that individuals with Low Restraint were more likely to prefer low-fat food than high-fat food. There was also a trend that participants with High Restraint were slightly more likely to choose high-fat food over low-fat food.

The final significant finding was a three-way interaction between Stress Level, Taste, and Fat Level, F(1, 36) = 10.16, p = .003, η² = .22. Table 2 presents the means and standard deviations for this analysis. Post hoc analyses with the Bonferroni correction demonstrated that participants in the High Stress condition ate significantly more sweet, high-fat food than did participants in the Low Stress condition. In addition, the post hoc analyses showed that participants in the High Stress condition were significantly more likely to eat sweet, high-fat items than each of the other available foods. In contrast, individuals in the Low Stress condition were significantly less likely to eat sweet, high-fat food than either of the two low-fat items. In general, low stressed individuals were significantly more likely to eat low-fat than high-fat foods, whereas highly stressed individuals were significantly more likely to eat one of the high-fat foods—the sweet one—more than all other items. Level of restrained eating, however, did not factor into these relationships.

Table 2

<table>
<thead>
<tr>
<th>Stress Condition</th>
<th>Low Fat Group</th>
<th>High Fat Group</th>
</tr>
</thead>
<tbody>
<tr>
<td>Low Stress</td>
<td>14.50 (15.78)</td>
<td>2.2 (4.93)</td>
</tr>
<tr>
<td>High Stress</td>
<td>12.35 (13.26)</td>
<td>29.15 (14.53)</td>
</tr>
</tbody>
</table>

Note: S.D.s are in parentheses.
Additional analyses

Due to Macht and Mueller’s (2007) contention that the role of emotional eating needs to be taken into account in studies of dietary restraint, as well as to the fact that emotional eating and restrained eating were highly correlated in our sample ($r = .45$, $p = .003$), we also repeated the mixed-design ANOVA with Emotional eating as a covariate to see the effect of emotional eating on food choice and whether emotional and restrained eating interacted to affect food preferences. The only change in the findings was that there was no longer a main effect for Taste. There was no overall effect of Emotional eating and there were no significant interactions with stress level, restrained eating, food taste, or food fat level.

In addition, because two participants in each stress level group were possibly aware of the purpose of the experiment, we reran each of the ANOVAs without these four individuals. No change in findings occurred.

Discussion

When placed in a high-stress condition, our participants consumed larger quantities of food than those in the low-stress condition, results similar to those reported in the Greeno and Wing (1994) review on stress-induced eating. Therefore, acute stress does alter normal eating patterns as reported by Torres and Nowson (2007). We also found support for the findings of others (Grunberg & Straub, 1992; Rutledge & Linden, 1998) that experimentally induced stress creates a preference for sweet foods. Epel, Lapidus, McEwen, and Brownell (2001) hypothesized that psychophysiological responses to stress may influence eating behavior particularly with respect to the choice of sweet foods. For example, Smith, Fillion, and Bass (1990) found that stress responses in newborns were rapidly calmed when the babies were provided with a sweet solution. Sweet foods, therefore, appear to provide comfort to the stressed individual and such comfort may be due to innate biological processes. Research (Pecina, Smith, & Berridge, 2006) has also shown the hedonic pathways in the brain related to a preference for sweet tasting items. Eating sweets may also be a reinforced behavior for individuals. Negative emotions (such as stress) are stimuli for increased eating which, through negative reinforcement, reduces the negative emotions. In addition, as suggested by Macht (2008), eating sweet foods may help one regulate negative emotions by creating positive affect that is incompatible with such negative feelings.

Our finding of an experimentally induced relationship between stress and increased consumption of high-fat food is supported by survey research results based on self-reported stress (Kandiah et al., 2006; Liu et al., 2007; Ng & Jeffery, 2003; Wardle et al., 2000). Not only did our highly stressed participants eat more high-fat food than did low stressed individuals, but those in the high-stress condition were more likely to eat high-fat than low-fat food. In addition, we found that low-stress participants ate significantly less high-fat food than low-fat food. The preference for low-fat food when stress levels are low may reflect a tendency in young women to seek out healthier foods under more normal, relaxed circumstances. Such a preference for low-fat foods during low stress may be particularly strong when women are in the presence of others, due to personal norms concerning gender and eating (Herman & Polivy, 2005). Without the negative emotions or cognitive load induced by a stressful task, women may be more attuned to their personal norms and may then act accordingly.

The strongest finding in the present study is the clear preference for foods that are both sweet and high in fat among high-stress participants relative to low-stress participants. Gibson (2008) explained that sweet, high-fat food may help alleviate stress through enhanced function of the serotonergic system. Torres and Nowson (2007), in discussing similar findings, referred to foods having these qualities as “nutrient dense.” Research has shown that the preference for sweet, high-fat foods is associated with their being viewed as more palatable (Drewnowski & Greenwood, 1983), and the stress-reduction value of these so-called “comfort foods” has also been reported (Dallman, Pecoraro, & la Fleur, 2005; Macht & Mueller, 2007a).

Two other factors warrant consideration as possible contributors to our finding of a preference for sweet, high-fat food during times of stress. First, many previous studies have relied on their participants’ recall of their stress levels and of their food selections. Recalled information on such emotion-laden topics is notoriously unreliable. Second, laboratory studies that avoided this problem have typically failed to carefully control the food offerings by fat content and other relevant variables. For example, although the Zellner et al. (2006) experiment did show a shift in preference from healthy low-fat food (grapes) to less healthy high-fat food (M&Ms), this comparison simultaneously varied multiple dimensions (fat, sugar, texture, palatability), thereby confounding the results. In addition, some research has at times employed multiple high-fat options but few, if any, comparable low-fat options. Our high-fat/low-fat design across sweet and salty categories may, therefore, be particularly important and worthy of further study.

Our finding of no interaction between stress level and restraint level was surprising, although in accordance with previous research (Oliver et al., 2000; Tice et al., 2001; Van Strien, Cleven, & Schippers, 2000). We found that dietary restraint level was significantly related to food preferences, regardless of stress level. A possible explanation for this high-fat food preference in highly restrained eaters compared to low restrained eaters is that those with High Restraint may ordinarily avoid high-fat foods by simply not purchasing them or avoiding them. However, when such food is provided and placed within easy reach, and when the situation requires that the individual stay put and not go elsewhere, disinhibition may occur no matter what one’s stress level. Another possibility is that very highly restrained eaters may have refrained from participating in our study after reading on the sign-up sheet that snacks would be provided. Thus, our sample may have had less variability in restrained eating scores than samples used in other research. In addition, it may be that because our participants (unlike those in previous studies) were tested in small groups, participants with High Restraint in both stress conditions experienced similar effects of social facilitation or social modeling. These social effects, then, may have proved to be stronger disinhibitors than the stress level induced by the Sudoku puzzle. As both Stroebele and De Castro (2004) and Herman and Polivy (2005) discussed in their review articles, social influence factors can play a large role in individuals’ food consumption, with people more likely to eat when others are eating. Our findings suggest that the situation may have greater influence on an individual’s eating behavior than the personality type or characteristics of the person. The power of the social influence demands of the small-group testing may well have superceded the impact of individual differences. Future research is needed to discover the relative importance of stress and social influence on individuals’ food preferences and to examine whether experimentally induced stress or the presence of others is the more potent disinhibitor of restrained eating.

Limitations and future directions

There are several limitations of our study that need mention. Our sample consisted only of college-age women; therefore, additional studies are needed on males and other age groups in order to establish the generalizability of these findings. In addition, our
random assignment to groups could have, by chance, resulted in more highly stressed individuals assigned to the Impossible Sudoku condition. Therefore, there is a slight possibility that the reported stress differences between conditions were not a matter of the stress manipulation itself but instead were due to a pre-existing difference between groups. We did not assess participants’ stress levels before the Sudoku puzzle, because we believed this could have revealed to them the purpose of the study. For the same reason, we also did not assess participants’ level of hunger before the stress manipulation began. Our attempt to control for hunger level was to conduct the experiment at the same time of day for all participants; however, this was likely not sufficient in ensuring that participants’ level of hunger was essentially the same. We successfully controlled for the effects of participants’ liking of sweet and salty foods by asking them to rate their level of liking for each taste category and finding that there were no significant differences between stress-level groups in their liking of these different tastes. We did not assess participants’ preferences for high-fat and low-fat foods to see if such preferences varied between groups; therefore, this factor could have played a role in our results.

Another limitation of our study is that the announcement on the sign-up sheets about snacks being provided could have resulted in a selection bias so that only certain women signed up to participate. It is possible, therefore, that highly restrained women refrained from signing up for this study due to the likely temptations that the publicized snacks would induce. However, numerous studies of stress, eating, and restraint have used fake taste tests as part of their methodology, with participants made aware of the eating component of the upcoming study during the informed consent process. Thus, those studies, along with ours, have run the risk of selection bias.

Despite its potential limitations, the implications of our work and others’ research on the same topic are particularly important for gaining further understanding of such critical societal issues as obesity and eating disorders. In addition, our study calls into question the effectiveness of stress-induced eating, and restricts the generalization of findings to a specific context, which is not generalizable to all dietary and emotional contexts. Therefore, our results indicate that the type of stress manipulation itself may be differentially related to dietary restraint and its role in eating behavior under stress. Future research is needed to assess the potential effects of different forms of stressors, as well as the role of eating in a social context.

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Dallman, M. F., Pecoraro, N. C., & LaFleur, S. E. (2005). Chronic stress and comfort foods: obesity and eating disorders. In addition, our study calls into question the effectiveness of stress-induced eating, and restricts the generalization of findings to a specific context, which is not generalizable to all dietary and emotional contexts. Therefore, our results indicate that the type of stress manipulation itself may be differentially related to dietary restraint and its role in eating behavior under stress. Future research is needed to assess the potential effects of different forms of stressors, as well as the role of eating in a social context.


