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Research report

The effect of a pre-load experiment on subsequent food consumption. Caloric and macronutrient intake in the days following a pre-load manipulation ☆

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ABSTRACT

The current study was designed to test potential caloric and macronutrient counter-regulation or compensation amongst 76 participants who participated in a milkshake preload experiment. Participants completed food diaries for 2 days before and 2 days after participating in the pre-load experiment. It was hypothesized that dieters and restrained eaters might respond to the pre-load by compensating or counter-regulating food consumption during the rest of the day following the experiment, and on the 2 days post-experiment. Results indicated that there were no significant differences in caloric or macronutrient consumption between the experimental and control groups on the days after the experiment. There were also no interactions between restraint and dieting status and the experimental condition. However, there was a main effect of caloric intake across dieting status, with those dieting to lose weight showing lower caloric intake than those not dieting and those dieting to maintain weight. The results of this study suggests that disinhibitory food stimuli may be less powerful than once thought or relatively short acting, as long-term counter-regulation or compensation did not occur for most people. Overall, the current study provides additional insight into potential long term caloric counter-regulation or compensation in participants who participated in a preload experiment, but additional research is needed to better understand this phenomenon.

Introduction

Historically, dietary restraint has been defined as the self-administration of rules intended to regulate intake in dieting (Herman & Polivy, 2005). Previous research has indicated that restrained eaters attempt to restrict caloric intake, but any resulting weight loss is prevented by subsequent bouts of overeating (Heatherton, Polivy, & Herman, 1990; Herman & Polivy, 2005; Herman, Polivy, & Esses, 1987; Nederkoorn, Van Eijs, & Jansen, 2004; Polivy & Herman, 1985). Overeating has been demonstrated in the laboratory by disinhibiting an individual's restraint (usually via a food pre-load, stressor, or induction of dysphoric mood) and then conducting a "taste test" in which participants can engage in ad libitum eating (see Lowe, 1993 and Stroebe, 2008 for a review). Restrained eaters who are subjected to a preload traditionally engage in counter-regulatory eating, wherein they consume a larger quantity of food than would be expected.

Although this phenomenon has been demonstrated in the laboratory setting, the typical method for studying counter-regulatory eating has been criticized (Shapiro & Anderson, 2003). Because the research is conducted in a controlled setting such as a food laboratory, current understanding of how restraint may lead to counter-regulatory eating is limited to a very specific, artificial environment under which unique consummatory behavior occurs. Furthermore, the artificial lab setting can easily alter eating behavior based upon how accurately the lab environment resembles a typical meal setting (Pliner & Zec, 2007).

One concern of restraint research is that results from preload studies have often been contradictory, with some studies indicating that restrained eaters engage in counter-regulatory eating (Herman & Mack, 1975; Woody, Costanzo, Liefer, & Conger, 1981), others finding that restrained eaters eat the same amount and unrestrained eaters eat less after a preload (Jansen, Oosterlaan, Mercklebach, & Hout, 1989), and others finding no counter-regulatory eating regardless of participant's restraint status (Lowe & Kleifield, 1988; van Strien, Cleven, & Schippers, 2000; Westenhoefer, Broeckmann, Münch, & Pudel, 1994). The first type usually include studies wherein restraint is measured with the Restraint Scale (RS; Herman & Polivy, 1980); whereas the latter two typically include studies in which restraint is measured with the Cognitive Restraint Scale (CR) of the Eating Inventory (EI; Stunkard & Messick, 1985) or the Restraint Scale of the Dutch Eating Behavior Questionnaire (DEBQ, van Strien, Frijters, Bergers, & Defares,

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1986). The conflicting results limit our ability to understand how and why counter-regulatory occurs for some individuals, but not for others (Ouwens, van Strien, & van der Staak, 2003).

A typical pre-load study does not assess what occurs once the participant leaves the study setting; therefore, little is known about the impact of a calorie-rich pre-load on eating behavior that occurs later in the day or even days later. To date, only one study has specifically addressed longer-term eating behavior and attitudes outside the lab following participation in a preload study. Tomiyama, Moskovick, Haltom, Ju, and Mann (2009) suggested that following a pre-load, restrained eaters who engaged in disinhibited eating would compensate for their eating behavior in the lab by later reducing intake (Tomiyama et al., 2009). In the second of two studies, Tominyama and colleagues had participants consume a milkshake preload (but not any subsequent food), and found that those who did consume a preload did not have significantly different caloric intake than those who did not consume a milkshake. Although informative, there are a number of limitations to Tomiyama and colleagues study in terms of understanding caloric intake after a traditional pre-load experiment. While a milkshake is a dietary violation, in traditional pre-load studies restrained eaters consume even more calories after a dietary violation (during the "taste test"). It is possible that the consumption of these extra calories in the laboratory is needed to trigger either compensation (reduction of calories or macronutrients in order to account for the calories consumed in the lab) or further disinhibited (consumption of more food) eating after the experiment. Furthermore, Tomiyama and colleagues used the CR as their measure of restraint. Historically, disinhibited eating has not been observed in restrained eaters when restraint is determined by scores on the CR (see Stroebe, 2008 for a review). Given that Tomiyama and colleagues did not assess restraint with the RS, it is difficult to extrapolate their findings to traditional pre-load experiments wherein restraint was measured with the RS. Finally, Tomiyama and colleagues research did not provide any information regarding the type of food consumed in the days after the pre-load. Since restrained eaters are not actually in a negative caloric balance (Stice, Cooper, Schoeller, Tappe, & Lowe, 2007; Stice, Fisher, & Lowe, 2004), it is likely that they are "restraining" themselves by eating less of certain kinds of food. Thus, an equivalent level of caloric consumption (as by Tomiyama and colleagues) provides no information regarding whether or not restrained eaters attempt to avoid high fat food or foods higher in carbohydrates, even if their actual caloric content is not substantially different from not-restrained eaters. Therefore, it is possible that in the days following a pre-load, restrained eaters might be more likely to change the type of food they are eating rather than making a noticeable change in caloric content.

The current study was designed to give insight into potential caloric counter-regulation or compensation in participants who participated in a milkshake preload experiment. Tracking such information provides insight into the longer-term consequences of a pre-load study on eating behaviors across restrained dieters, restrained non-dieters, and unrestrained non-dieters. It was hypothesized that there would be no significant differences in caloric intake across pre-load and no pre-load groups for the 2 days before participating in the experiment (Days 1 and 2). While evidence indicates that after a pre-load individuals high in restraint eat significantly more calories in the laboratory than individuals low in restraint (Herman & Mack, 1975), it was not expected that overall caloric intake on the day of the taste test would change following participation in the experiment (Day 3; Wardle & Beales, 1987). It was hypothesized that overall caloric intake would not change in the 2 days following the taste test, but that the macronutrient content of food consumed would. Specifically, a change in fat and carbohydrate intake was expected for individuals both high and low in restraint. It was predicted that the latter group would compensate for increased caloric intake in lab by reducing fat/carbohydrate consumption over the next 2 days (deCastro, 1998). No specific hypothesis regarding the directionality of individuals high in restraint was made, as they could either continue to engage in disinhibited eating or they could attempt to compensate for consumption of ice cream in the laboratory by reducing fat/carbohydrate intake in the 2 days following the taste test. Given that restraint is often confused with dieting (Lowe & Timko, 2004), the macronutrient intake of current dieters was also explored, although there were no specific hypotheses.

Methods

Participants

Seventy-six normal weight (BMI between 18 and 25, $M = 20.91$, SD = 1.93) women ages 18–40 ($M = 19.37$, SD = 2.77) consented to participate in this study. Men were excluded because the vast majority of pre-load studies focus on women, and limiting the sample allowed for comparisons to previously conducted research. The sample was ethnically diverse, with just under half identifying as Caucasian (47.9%); 30.7% as Asian, 7.9% as African American, 5.0% as Hispanic, and 9.0% as other. These women were a sub-set of participants in a larger pre-load study (Hormes et al., 2010; Total $N = 140$ before exclusion, 105 normal weight women who were included in data analysis). There were no significant differences on any demographic data between those who only participated in the larger study and those who also participated in the current study (all p's > .05). Participants were enrolled as undergraduates at a large urban university and received extra credit in a course for their participation. While overweight and underweight individuals were not barred from participation, their data was not included in the analyses. Subjects were excluded from the study if they were lactose intolerant. Any impact that menstruation cycle, smoking, physical activity level, and various genetic and metabolic diseases could have had on eating behavior were controlled for via random assignment, which should have equally distributed these variables throughout the two study groups. This study was approved by the Office of Regulatory Affairs at the University of Pennsylvania.

Measures

A battery of questionnaires was administered to participants a minimum of 2 days and maximum of 8 days prior to participation in this experiment. The questionnaires were used to assess the participants' attitudes towards food and dieting behaviors, and included the Restraint Scale (RS; Herman & Polivy, 1980) as the classic measure of restraint. When disinhibited eating occurs in a pre-load experiment, restraint is usually measured with the RS. This measure has 10 items and has been shown to have two sub-scales: current dieting and weight fluctuation (Heatherton, Herman, Polivy, King, & McGree, 1988). Cronbach's alpha in this study was 0.83.

As restraint is often confused with dieting (Lowe & Timko, 2004), participants were also asked to self-identify as dieting to lose weight, dieting to maintain weight, or not dieting. Identification of dieters in this fashion has been demonstrated to be a valid method (Lowe & Timko, 2004). Participants were asked a number of questions about their dieting history, including current weight and height, their highest weight ever, whether or not they were concerned about gaining or losing weight, and whether or not their parents were concerned about them gaining/losing weight while at college.

The Eating Inventory (EI; Stunkard & Messick, 1985) was included as it was relevant to the hypothesis of the primary study (Hormes et al., 2010). However, since counter-regulatory eating is usually not observed with the EI, it was not used as a measure of restraint in this study. Finally, a number of measures including the Power of Food Scale (PFS; Lowe et al., 2009) and Dieting Habits Questionnaire (Timko, Juarascio, Perone, & Lewis, in preparation). These measures were unrelated to the current study and were included primarily for scale validation purposes. A number of filler questionnaires were also included in order to lend credence to the cover story. These fillers included: items regarding allergies and food preferences, questionnaire regarding the frequency of food consumption, questionnaire regarding food and taste preferences.

Procedure

The current study had two phases, both of which occurred within a ten day period. In order to mask the true research interest, participants were informed that researchers were investigating whether or not consumption of a hot or cold food would subsequently impact the taste perception of other hot or cold foods. Recruitment measures did not detail information about the type of food to be consumed; however, during the consent process participants were lead to believe that they would consume either a variety of cold foods (e.g., ice cream), a variety of hot foods (e.g., pizza) or a combination of the two. The first phase of the study was conducted in group format (approximately 20 participants at a time) and was solely for the completion of questionnaires. After the completion of the questionnaire packet, participants were scheduled for Phase II, or the "taste test." This was conducted on an individual basis at least 48 h after completion of the questionnaires (but no more than 8 days later) in order to avoid any priming effects from the questionnaires but to increase the likelihood that those who identified as dieting to lose or maintain weight during the completion of the questionnaires still considered themselves to be dieting. Participants included in the current study also consented to take part in an ostensibly unrelated study on dietary intake. These participants were asked to keep food diaries for 2 days prior to the taste test, the day of the taste test, and 2 days after the taste test. Food diaries were accessible on-line for participants to complete throughout or at the end of each day. Subjects were instructed on how to accurately complete the food diaries after consent and additional instructions (including written examples) were provided on accurate completion of the food diaries on-line.

Phase II consisted of the experimental manipulation. Participants were scheduled for the experimental session between 11:00 a.m. and 7:00 p.m. They were asked not to eat for the two hours prior to the experiment. This length of fast has been used in prior research (e.g., Fedoroff, Polivy, & Herman, 1997; Provencher, Polivy, & Herman, 2009). Upon arrival in the laboratory, participants were given a form that ranked their hunger using a 7-point Likert scale with points ranging from 1 to 7 with 1 being "very hungry" and 7 being "very full." The average hunger rating was 5.06 ($SD = 1.58$), indicating that participants were moderately hungry at the time of the study. They were also asked to note the last time they ate. The average time since last meal was 3.29 h ($SD = 3.22$). There were no differences between the experimental and control groups on hunger ratings or time since last meal.

Following the hunger rating, participants in the pre-load condition were informed that they were in the cold/cold taste perception condition. They were given a 400 ml (~449 calories) chocolate milkshake and asked to consume the entire shake. A milkshake was chosen as the disinhibitory stimuli and ice cream as the test food because they have been used in prior pre-load research and allowed for greater consistency with pre-established data (e.g., Ouwens et al., 2003; van Strien et al., 2000; Westenhoefer et al., 1994). Generally speaking, milkshakes and ice cream are considered forbidden foods; the use of forbidden foods is believed to increase the likelihood of a dietary violation and subsequent counter-regulatory eating (Stroebe, 2008). After completing the shake, participants were asked to rate the flavor and coldness of the shake in order to support the cover story. When the participant finished rating the milkshake, she was given three bowls of ice cream (vanilla, chocolate and strawberry) that were presented in a counter-balanced order. Each bowl had 350 g of ice cream presented in a haphazard way and slightly over-flowing the bowl in order to ensure the amount of ice cream eaten could not be easily discerned. The calories and macronutrient breakdown of the ice cream presented is reported in Table 2. The participant was asked to consume as much ice cream as necessary to rate the taste of the ice cream and instructed to taste and rate each flavor before proceeding to the next one. Participants were also informed that after the experiment, the ice cream would be disposed of, so she could feel free to eat as much as she liked. At this point the experimenter left the participant alone in a small room for 10 min. At the end of 10 min, the experimenter returned and removed the ice cream and rating forms from the participant.

The procedure for control participants was identical; however, they were informed that they were in the "cold" taste perception control group and thus would only be asked to rate a series of cold flavors (three flavors of ice cream). The instructions for participants in the control condition were identical to those in the pre-load condition for everything except the milkshake consumption.

Data analysis

The entries made by each participant in their food diaries were manually entered into Nutritionist5 software in order to analyze the macronutrient content of each of the daily diets. Daily macronutrient breakdowns were then entered into SPSS for further analysis. A series of regression analyses was conducted to test for differences between the control and experimental group (independent variable) in terms of caloric intake and macronutrient consumption (dependent variables) on the days before, during, and after the experiment. An additional series of regression analyses was conducted to examine interactions between the independent variables of restraint (as measured by the Restraint Scale) and condition, both on the days before, day of, and days after the experiment. Because dieting status contained three levels, a one-way ANOVA was used to examine interactions between the independent variables dieting status and condition in predicting the dependent variables of caloric intake and macronutrient consumption. In order to examine the impact of restraint and dieting together, four groups were created: non-restrained non-dieters, restrained non-dieters, restrained + dieting to maintain weight, and restrained + dieting to lose weight; a one-way ANOVA was conducted in order to compare caloric and macronutrient intake by women in each of the four groups on the days following the experiment. Post-hoc tests for the ANOVAs used a bonferroni procedure. As noted above, the sample for this study was a subsample of a larger, adequately powered study. Participants in this study opted in for participation, limiting the total number of women who could be recruited. Tomiyama et al. (2009) conducted a similar research (reviewed above) with 139 and 89 participants; the number of participants in this study was comparable to Tominyama and colleagues' second sample.

Results

Prior to the pre-load

In the days prior to the experiment (Days 1 and 2), a regression analysis revealed that there were no significant differences in the average number of calories consumed pre-test (Days 1 and 2) between the experimental and control groups ($B = 186.37$, $t = 1.80$,

$R^2 = 0.04$, $p = 0.08$). There were also no significant differences in macronutrient content (Carbohydrates: $B = 24.11$, $t = 1.41$, $R^2 = 0.02$, $p = 0.16$; Protein: $B = -6.51$, $t = 1.25$, $R^2 = 0.02$, $p = 0.21$; Fat: $B = 5.37$, $t = 1.12$, $R^2 = 0.02$, $p = 0.26$). Those not dieting consumed more calories (1616.36 ± 580.12) than those dieting to lose weight (1336.32 ± 464.48) or dieting to maintain weight (1388.31 ± 153.78; $B = 287.63$, $t = 2.87$, $R^2 = 0.06$, $p = 0.05$). There were no significant differences in macronutrient consumption by dieting status (Carbohydrate: $B = 7.59$, $t = -0.78$, $R^2 = 0.01$, $p = 0.48$; Protein: $B = 2.95$, $t = 0.90$, $R^2 = 0.01$, $p = 0.37$; Fat: $B = -2.38$, $t = -.78$, $R^2 = 0.01$, $p = 0.43$). There were no significant differences in total calories pre-experiment between those high (1283.78 ± 496.08) and low (1333.78 ± 610.75) in restraint ($B = -17.02$, $t = -1.94$, $R^2 = 0.13$, $p = 0.08$). There were also no significant differences in macronutrient content across restraint status, although trends were seen for lower consumption of fat and protein amongst restrained individuals (Carbohydrate: $B = -2.01$, $t = -1.38$, $R^2 = 0.01$, $p = 0.16$; Protein: $B = -0.76$, $t = -1.73$, $R^2 = 0.03$, $p = 0.09$; Fat: $B = -0.73$, $t = -1.82$, $R^2 = 0.03$, $p = 0.07$).

Day of the pre-load experiment

Counter-regulatory eating was not observed in the current study. When using the RS as the measure of restraint, condition ($B = -53.27$, $t = -1.87$, $R^2 = 0.13$, $p = 0.05$), but not restraint or restraint × condition, was a significant predictor of total grams consumed. Women in the control condition consumed more ice-cream ($M = 145.33$, SD = 79.46) than those in the experimental condition ($M = 99.21$, SD = 77.45; $t(128) = -3.35$, $p < 0.001$), but restraint status did not moderate these findings as anticipated .

The number of calories consumed on the day of the pre-load (Day 3) was significantly different between the control and the experimental groups, with the experimental group ($M = 1150.59$, SD = 477.3) consuming significantly fewer calories than the control group ($M = 1470.60$, SD = 573.36; $B = 320.01$, $t = 2.60$, $R^2 = 0.07$, $p = 0.01$). Significant differences were also found for carbohydrates ($B = 42.57$, $t = 2.16$, $R^2 = 0.05$, $p = 0.03$) and Fat ($B = 14.1$, $t = 2.77$, $R^2 = 0.08$, $p < 0.01$), with the experimental group consuming significantly less of both macronutrients on the day of the experiment. There were no significant differences in protein ($B = 9.55$, $t = 1.68$, $R^2 = 0.03$, $p = 0.09$). Regression analyses revealed no main effects for restraint or interaction effects for restraint by condition for caloric or macronutrient consumption on the day of the preload (Calories: $B = -21.28$, $t = -0.63$, $R^2 = 0.09$, $p = 0.52$; Carbohydrate: $B = 0.45$, $t = 0.99$, $R^2 = 0.10$, $p = 0.62$; Protein: $B = 2.68$, $t = 0.76$, $R^2 = 0.07$, $p = 0.45$; Fat: $B = 0.26$, $t = 0.26$, $R^2 = 0.04$, $p = 0.79$) . To assess the effect of dieting status (self identifying as dieting to lose weight, dieting to maintain weight, or not dieting regardless of restraint status) on caloric and macronutrient consumption, a one way ANOVA was conducted. This ANOVA revealed no significant differences in total calories ($F(3, 70) = 0.44$, $p = 0.72$, $\eta_p^2 = 0.02$) or any of the macronutrients (Protein: $F(3, 70) = 0.15$, $p = 0.92$, $\eta_p^2 = 0.01$; Carbohydrates: $F(3, 70) = 0.72$, $p = 0.54$, $\eta_p^2 = 0.03$; Fat: $F(3, 70) = 0.37$, $p = 0.77$, $\eta_p^2 = 0.02$) on the day of the experiment.

Days following the pre-load

The number of calories consumed on the days following the pre-load (Days 4 and 5), did not differ significantly between experimental and control groups ($B = 83.55$, $t = 0.78$, $R^2 = 0.01$, $p = 0.43$).There were also no significant differences in macronutrient content between those in the experimental and control groups during the post-test days (Carbohydrates: $B = 11.65$, $t = 0.65$, $R^2 = 0.01$, $p = 0.51$; Protein: $B = 1.04$, $t = 0.22$, $R^2 = 0.01$, $p = 0.82$; Fat: $B = 3.44$, $t = 0.74$, $R^2 = 0.01$, $p = 0.46$).

Regression analyses revealed no significant main effects of restraint or interactions between restraint or condition for caloric or macronutrient consumption on the days following the pre-load [see Table 1 for results]. A trend was revealed for those dieting to lose weight to consume less calories (1315.52 ± 240.85) than those dieting to maintain weight (1707.38 ± 261.83; $F(1,66) = 2.44$, $p = 0.06$, $\eta_p^2 = 0.16$). Those not dieting (1519.82 ± 129.45) were not significantly different from either group. As the number of calories did not differ between the three groups before the day of the experiment, this finding suggests those dieting to maintain weight showed a substantial increase in calories consumed on the days after the experiment (pre: 1388.31 and post: 1707.38). ANOVAs revealed significant differences amongst those dieting to lose, dieting to maintain, and non-dieters for grams of protein ($F(2,66) = 4.40$; $p = 0.02$, $\eta_p^2 = 0.14$), with those dieting to lose weight consuming significantly less grams of protein than those dieting to maintain weight. There were no differences in fat intake ($F(2,66) = 2.12$; $p = 0.12$) or carbohydrate intake ($F(2,66) = 1.65$; $p = 0.19$). There were also no significant interactions between dieting status and condition in predicting caloric or macronutrient content consumed on the days following the pre-load [see Table 3 for these results].

Differences in intake following the pre-load were also compared across dieters when taking into account restraint status. Restraint (as measured by the Restraint Scale) was dichotomized into high (>16) and low (⩽15) restraint based on the suggestions by Jansen et al. (1989). This resulted in four groups: non-restrained non-dieters, restrained non-dieters, restrained dieters who were dieting to maintain weight, and restrained dieters who were dieting to lose weight. Overall, results trended towards a significant difference in caloric intake ($F(3,65) = 2.71$; $p = 0.08$, $\eta_p^2 = 0.09$) and revealed a significant difference between groups for protein grams consumed ($F(3,65) = 3.09$; $p = 0.03$, $\eta_p^2 = 0.11$), but not for fat and

Table 1
Interaction between experimental condition and restraint in predicting caloric and macronutrient consumption on the days following a pre-load (Days 4 and 5).

Interaction term	B	T	R^2	p
Calories				
Restraint	−27.10	−0.94		.35
Condition	−75.71	−0.25		.79
Restraint × condition	9.87	0.53	.04	.59
Protein				
Restraint	−0.61	−.049		.62
Condition	1.65	0.13		.89
Restraint × condition	0.41	0.51	.01	.61
Carbohydrates				
Restraint	−0.81	−0.64		.52
Condition	−5.20	−0.40		.68
Restraint × condition	1.78	0.57	.02	.59
Restraint	−3.98	−0.82		.41
Condition	−16.07	−0.32		.74
Restraint × condition	0.09	0.11	.03	.92

Note: Results indicate that there were no significant differences in caloric or macronutrient content based on restraint.

Table 2
Caloric and macronutrient breakdown of ice cream presented during the "taste test" portion of the study.

	Total calories	Fat grams	Protein grams	Carbohydrate grams
Strawberry	520	28	68	8
Chocolate	560	32	68	12
Vanilla	600	32	68	12

Note: All ice cream was Pott's brand ice cream.

Table 3
Series of ANOVAs examining the interaction between experimental condition and dieting status in predicting caloric and macronutrient consumption on the days following a pre-load (Days 4 and 5).

Interaction term	*F*	*p*	η_p^2
Calories			
Dieting status	2.44	.06	.16
Condition	0.70	.40	.01
Dieting status × condition	2.01	.14	.06
Protein			
Dieting status	4.40	.02	.14
Condition	1.84	.17	.02
Dieting status × condition	1.52	.12	.02
Carbohydrates			
Dieting status	1.79	.17	.05
Condition	0.30	.58	.01
Dieting status × condition	0.86	.42	.02
Fat			
Dieting status	2.43	.10	.07
Condition	0.62	.43	.01
Dieting status × condition	1.48	.23	.04

Note: Results indicate that there were no significant differences interactions between dieting status and condition.

carbohydrates. Post-hoc tests revealed that individuals dieting to maintain weight consumed more calories and protein grams than the other 3 groups. There were no significant differences in intake between any of the other three groups [see Fig. 1 for a graph of the calories and macronutrients consumed in the days following the pre-load].

Discussion

The current study was designed to provide a better understanding of the caloric and macronutrient consumption in the days following a high calorie pre-load; specifically to determine whether or not compensation or counter-regulatory eating of certain types of foods (protein, carbohydrates, or fat) occurred following the laboratory visit. In order to provide a comprehensive picture of food consumption after a pre-load experiment, both dieting and restraint status were taken into consideration. Overall, the study did not find any significant difference in caloric or macronutrient consumption between the experimental or control group on the days before or after the experiment; although the experimental group did consume less than the control group on the day of the experiment. There was no interaction between restraint or dieting status and the experimental conditions in predicting any of the caloric or macronutrient content consumed on the days after the pre-load. However, there was a main effect for caloric intake across dieting status, with those dieting to lose weight showing lower caloric intake than those dieting to maintain weight. This suggests that counter-regulatory eating might have occurred for those who were dieting to maintain weight (regardless of condition), as these individuals tended to eat more calories on the 2 days following the experiment. Those dieting to lose weight appeared to reduce their caloric intake back to their baseline caloric levels following the experiment, perhaps in an effort to compensate for caloric intake on the day of the experiment. Individuals dieting to lose weight also consumed less protein than the other groups following the experiment, but did not consume less of any other macronutrient.

The current study indicates that both counter-regulatory eating and compensation (measured both by caloric content and macronutrient content) may occur on the days following a pre-load experiment for those who are dieting, but not for those who are non-dieting restrained eaters. Although some research has indicated that restrained eaters are likely to be disinhibited by a pre-load and consume more food immediately after the consumption of the pre-load (Herman & Mack, 1975; Woody et al., 1981), it appears that this higher level of food consumption may be an unstable effect (i.e., not always observed) and that when it does occur it might be a relatively short term effect.

As in numerous other studies, the participants in this one did not engage in counter-regulatory eating in the laboratory. However, on the days following a pre-load, those currently dieting to maintain weight did appear to engage in counter-regulatory eating

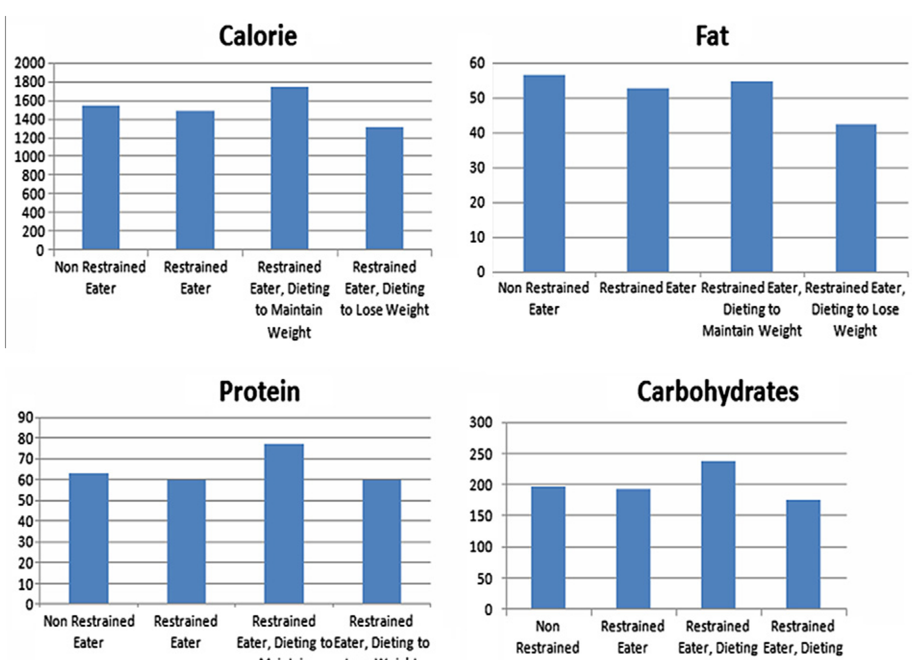

Fig. 1. Mean values of caloric and macronutrient content for the four categories of Dieting and Restraint Status on Days 4 and 5. Results suggest higher caloric, macronutrient, and carbohydrate intake for those who are restrained and dieting to maintain weight.

regardless of condition. Pre-load studies in which current dieting has been assessed indicate that individuals who are currently dieting to lose weight tend to reduce their intake following a pre-load (Lowe, 1994; Lowe, Whitlow, & Bellwoar, 1991), but the results of this study indicate that counter-regulatory eating may take place, just not immediately after consumption of the pre-load. Future research is needed to replicate this finding and to examine whether more long-term counter-regulation might occur for those who are dieting compared to more short-term counter-regulation.

The current study's results indicate that restrained individuals' restraint may not be disinhibited as easily as once thought and that, when it does occur, it may be short lived (unless the restrained eater is also dieting to maintain weight). The reasons for the lack of observed disinhibition are unknown, but it is possible that an immediate food environment consisting of easily available, varied, palatable, inexpensive, energy-dense foods in increasingly larger portion sizes may play a role. Specifically, disinhibitory food stimuli are likely to occur relatively often (Drewnowski & Rolls, 2005; Lowe, 2003; Smiciklas-Wright, Mitchell, Mickle, Goldman, & Cook, 2003) in an individual's daily life. This frequent contact could either "immunize" the individual against breaks in disinhibition or frequent disinhibitory stimuli could trigger brief periods of small amounts of counter-regulatory eating. Both of these hypotheses could explain the lack of any real caloric deficit or weight loss seen amongst restrained eaters. Further testing needs to occur to explore the (lack) of occurrence of disinhibition in a laboratory setting and any disinhibited eating that may occur outside the laboratory.

The study contains several limitations that must be considered when interpreting the results. First, the study used normal weight undergraduate women; while this could limit external validity – it is also the population most commonly used in the study of restrained eating. Results might be different in older populations, males, overweight individuals, or other ethnicities. Although attempts were made in the current study to examine ethnic differences, the number in each cell was too low for any meaningful relationships to emerge. Future research powered for these types of analyses is warranted. Additional research is needed with these populations. Second, the study relied on self-report of intake, which often tends to be under-reported (Briefel, Sempos, McDowell, Chien, & Alaimo, 1997; Klesges, Eck, & Ray, 2005). More accurate measures of food intake would allow for greater confidence in the results of this study. Lastly, the primary study failed to show counter-regulatory eating following the pre-load. Although this is relatively common in studies of counter-regulatory eating (e.g., Lowe & Kleifield, 1988; van Strien et al., 2000; Westenhoefer et al., 1994), it may have limited the ability to see changes in caloric or macronutrient content on the day following the pre-load. The study did not assess changes in physical activity during the study period, and it is possible that individuals compensated for the calories in the pre-load by engaging in additional activity. Future pre-load studies may wish to examine changes in physical activity following disinhibition. Additional research may be needed to examine whether counter-regulatory eating would continue into the following day if it occurred immediately after the pre-load as well.

Overall, the current study was designed to provide insight into potential long term caloric counter-regulation or compensation in participants who participated in a preload experiment. Tracking such information can provide insight into the longer-term consequences of a pre-load on eating behaviors across restrained eaters, dieters, and normal eaters. However, the study found that neither counter-regulatory eating nor compensation occurred on the day after the pre-load study, with individuals in both the control and experimental conditions consuming a similar number of calories and macronutrients. This finding suggests that disinhibitory food stimuli may be less powerful than once thought or relatively short acting. Future research is needed to replicate and extend these findings to allow for a better understanding of the long-term effects of disinhibitory food stimuli for restrained eating and dieters.

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