Research Article

Consumption After a Diet Violation

Disinhibition or Compensation?

A. Janet Tomiyama,[1] Ashley Moskovich,[2] Kate Byrne Haltom,[1] Tiffany Ju,[1] and Traci Mann[3]

[1]University of California, Los Angeles; [2]Duke University; and [3]University of Minnesota

ABSTRACT—*Previous research, restricted to the laboratory, has found that restrained eaters overeat after they violate their diet. However, there has been no evidence showing that this same process occurs outside the lab. We hypothesized that outside of this artificial setting, restrained eaters would be able to control their eating. In Study 1, 127 participants reported hourly on their diet violations and eating over 2 days. In Study 2, 89 participants tracked their intake for 8 days, and 50 of these participants consumed a milk shake (a diet violation) on Day 7, as part of an ostensibly unrelated study. As hypothesized, dieters did not overeat following violations of their diet in either study. These findings are in contrast with those of previous lab studies and dispel the widely held belief that diet violations lead to overeating in everyday life.*

More than one third of U.S. adults were classified as obese in 2005–2006 (Ogden, Carroll, McDowell, & Flegal, 2007), so understanding the causes of overeating is vitally important. Treatments that promote long-term weight loss through behavioral changes such as dieting have been elusive (Mann et al., 2007), and further research is needed to understand why and when behavioral attempts to control eating fail.

Over the past 35 years, laboratory research has shown that restrained eaters, or chronic dieters concerned about their weight (Herman & Polivy, 1975), tend to overeat when they violate their diet. In the study that first demonstrated this phenomenon (Herman & Mack, 1975), participants were required to consume either zero, one, or two milk shakes (called the *preload*) and were then given three flavors of ice cream to taste, ostensibly so that the experimenters could determine whether the flavor of the milk shake affected participants' sensory experience of the ice cream. Restrained eaters tended to eat more ice cream if they had violated their diets with a milk-shake preload than if they had not been asked to violate their diets with a preload. At the time, this finding was highly counterintuitive. Common sense would lead most people to believe that individuals who are concerned with keeping their weight down would eat less after consuming a high-calorie milk shake. In fact, it was nonrestrained eaters who showed that pattern. The finding that restrained eaters eat more after violating a diet has since been termed the *disinhibition effect* and has been replicated numerous times in laboratory settings (for a summary, see Herman & Polivy, 1984).

An important remaining question is whether the disinhibition effect occurs in real-life settings. The trade-off between internal and external validity is an important issue in any area of science, but is particularly salient when attempting to predict health behaviors such as eating. Unless the causes of overeating demonstrated in the laboratory can be generalized to the real world, research-based interventions designed to manage overeating may be unsuccessful. To our knowledge, however, no studies have investigated the effect of diet violations in daily life.

The question of whether the disinhibition effect occurs in real life has important implications for bulimia nervosa as well. According to the dietary-restraint model of bulimic pathology, dieting causes cognitive control of eating to override physiological control of eating, rendering the dieter more vulnerable to disinhibition and subsequent binge eating (Polivy & Herman, 1985). However, recent experimental studies have obtained results that conflict with this model. For example, assignment to a low-calorie weight-loss diet *reduced* bulimic symptoms relative to a control condition (Presnell & Stice, 2003). If diet violations do not disinhibit eating outside of the laboratory, this would further challenge the traditional etiological model of bulimia nervosa.

Despite the laboratory studies suggesting otherwise, we hypothesized that diet violations would not lead to overeating in

Address correspondence to Traci Mann, University of Minnesota, Department of Psychology, N218 Elliott Hall, 75 East River Rd., Minneapolis, MN 55455-0344, e-mail: mann@umn.edu.

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daily life, for several reasons. First, the situation modeled in the laboratory studies rarely, if ever, occurs in real-life settings. In the lab, restrained eaters are fed milk shakes to violate their diet, are then required to taste each of three flavors of ice cream or other tempting food, and are then free to consume as much of the remaining food as they wish. It is hard to imagine a real-life situation in which an individual is required to taste at least a little of some forbidden food directly after breaking his or her diet. Second, laboratory studies are often advertised as food or taste-test studies. In fact, all of the studies we identified that reported recruitment information (Herman, Polivy, Lank, & Heatherton, 1987; Mills & Palandra, 2008; Polivy, Heatherton, & Herman, 1988; Ruderman & Christensen, 1983; Spencer & Fremouw, 1979; Stice, Fisher, & Lowe, 2004; Van Strien, Cleven, & Schippers, 2000; Westenhoefer, Broeckmann, Munch, & Pudel, 1994; Woody, Costanzo, Leifer, & Conger, 1981) indicated that the studies were described in such a manner (e.g., "Subjects were recruited for what they thought was a taste perception experiment"—Polivy, Heatherton, & Herman, 1988, p. 355). This might create a selection bias such that only restrained eaters who are willing to violate their diet (and, indeed, may be looking for an excuse to do so) participate. Third, restrained eaters in these studies may compensate later in the day for violating their diet during the study, negating any positive calorie balance due to their overeating. That is, restrained eaters may be disinhibited only briefly after a diet violation and then jump back on track later in the day—a *compensation* effect.

We report two studies that investigated the effect of diet violations on eating in real life. Both studies used electronic daily diaries, which have several advantages beyond the fact that they allow assessment of behavior in daily life (see Smyth et al., 2001, who recommended that eating research use this methodology). Electronic diaries have time stamps that confirm when a response was made and lock-out features that prevent retrospective responding. They also provide confidentiality by having potentially sensitive information locked.

In Study 1, we tested the disinhibition effect in restrained eaters by examining eating patterns immediately after a diet violation and during the hour following the diet violation. In Study 2, we tested the disinhibition effect again and, further, tested for a potential compensation effect. Study 2 used a hybrid laboratory/daily-diary methodology that matched the standardized diet violation used in the laboratory studies (e.g., Herman & Mack, 1975) while also measuring, in an ostensibly unrelated study, eating patterns in participants' daily lives over the course of a week.

STUDY 1

Method

Participants

Participants in Study 1 were 137 female students (mean age = 19.4 years) at two universities. They were enrolled in an introductory psychology class and received course credit for their participation. We focused on undergraduate females because the prevalence of restrained eating tends to be higher in this population than in other populations (Phillips & Pratt, 2005). The study was advertised as a "health habits" study rather than as a food study. Complete, uncorrupted data were available for 127 participants (93%). The response rate among these participants was high: A predetermined minimum of 20 complete diary entries over the 2-day period was required for participants to be retained for analysis, and 93% (n = 118) of participants met this criterion. These participants (86% of the original group) completed 2,834 diary observations, for an average of 24 hourly entries each. Self-reported racial-ethnic background of the sample was as follows: 41% Asian American, 37% Caucasian, 16% Latina, 3% "other," 1.5% African American, and 1.5% American Indian.

Procedure

All procedures were approved by the institutional review boards of both the University of California, Los Angeles, and the University of Northern Colorado. Prior to using the daily diaries, in a separate session, participants completed the Dietary Restraint Scale (DRS; Polivy, Herman, & Howard, 1988), a widely used measure that assesses attitudes toward eating, frequency of dieting, and weight fluctuations on a scale from 0 to 4 (higher scores indicate greater dietary restraint). Cronbach's alpha in the current sample was .85. Participants were then taught how to estimate the portion sizes of foods and how to use the electronic diary.

Participants were paged once an hour (± 10 min) over the following 2 days, excluding sleep times. They were instructed not to respond to any pages that occurred during incompatible activities (e.g., testing or driving), but to otherwise engage in normal activities and respond when paged. Multiple-choice questions assessed whether participants had eaten a meal or snack since the last time they were paged, as well as the number of servings consumed. Participants were not asked to report what foods they had consumed. Another question asked whether participants had violated their typical diets. This diet-violation question was embedded in 12 distractor questions (e.g., "To what extent were you tired or sleepy since you were last paged?") to decrease its salience. To avoid making the general idea of eating itself too salient, we mixed these questions (diet-violation question plus distractor questions) with a number of questions on other health habits, such as smoking.

Data Analysis

Multilevel modeling was conducted because the data were nested. Using HLM 6.0 (Scientific Software International, Lincolnwood, IL), we built two-level models that estimated outcomes both in the same diary entry as the diet violation (current-hour models) and in the following diary entry (lag-hour models). In one set of models, the dependent variable was the number of servings of food, a continuous outcome measure. Diet violation (whether or not the participant had violated her diet) was a dichotomous Level 1 (within-subjects) predictor and was entered uncentered. DRS score served as the Level 2 (between-subjects) predictor and was entered grand-centered. The second set of models was analogous to the first, but had a dichotomous outcome of whether or not the participant had eaten, and therefore used the "logit link" function. Error at Level 2 was modeled in all cases. If the error terms were not significant, they were dropped, and the model was reestimated.

Results

Descriptive Statistics

Participants' average body mass index was 22.31 (SD = 3.53), and the average DRS score was 12.75 (SD = 5.57). Participants ate a meal or a snack in 34.7% of the 2,834 assessed intervals and reported violating their diet in 20% of the intervals (567 diet violations).

Multilevel-Modeling Results

Models for the two outcomes yielded identical patterns, as did the current-hour and lag-hour analyses, so we report here only the lag-hour results for the model with the dichotomous outcome. Whether a participant had violated her diet did not predict eating in the next hour (odds ratio, or OR = 1.09, 95% confidence interval = 0.84–1.41, p = .80, p_{rep} = .57). This relationship was not significant even when we accounted for dietary restraint as a Level 2 moderator ($\Delta OR = -0.01$, p = .62, p_{rep} = .64). Thus, even among individuals high in dietary restraint, a diet violation had no effect on whether or how much they ate in the next hour. Given the large number of Asian American participants, we tested the same hypotheses using ethnicity as a moderator and found the same pattern of results (OR = 0.79, 95% confidence interval = 0.420–1.478, p = .46, p_{rep} = .70).

Summary

In contrast to laboratory studies, in which participants high in dietary restraint overeat following a diet violation, Study 1 revealed no evidence of overeating following diet violations in daily life, even among individuals with the highest levels of dietary restraint. These findings question the external validity of the lab studies of the disinhibition effect. However, there are two issues to consider.

The first concerns reactivity to the diary methodology. Participants may have refrained from overeating after violating their diets because they were monitoring their intake. However, our participants engaged in significantly less food monitoring than participants in other naturalistic eating studies (see de Castro, 2000, for a review). In those studies, participants have typically recorded every bite of food they consumed, whereas in our study, participants only had to answer simple questions about whether they had eaten and how many servings they had. Nevertheless, although the monitoring our participants conducted was minimal, it was still more monitoring than participants have to do in laboratory studies of eating. Further, in laboratory studies, the researchers' interest in eating as an outcome variable is effectively hidden by surreptitious measurement of the food before and after eating. Because we asked participants about eating every hour in our study, we could not hide our interest in their eating.

A second issue concerns our operationalization of diet violations. In laboratory studies, a diet violation is clearly operationalized as consumption of an 8-oz milk shake. In our study, participants may have considered very different quantities of foods to be diet violations. Participants may have called a very small amount of food intake a diet violation if the food was forbidden, but a small portion may not have been large enough to cause the disinhibition effect.

We conducted a second study to address these concerns. To address the issue of operationalization, we used the same standardized diet violation (an 8-oz milk shake) used in laboratory studies, and we essentially required participants to violate their diets. To address the issue of reactivity, we separated the food-monitoring component of the study from the diet-violation component by creating two ostensibly unrelated studies—one in which participants were asked to simply monitor their food intake (to "test new food-monitoring software") and another in which participants were asked to perform a "taste and memory" task, which included the diet violation. In addition, in Study 2, we tested whether participants compensated for their diet violations, by comparing their calorie consumption on the diet-violation day with their consumption on the other days of food monitoring.

STUDY 2

Method

Participants

Eighty-nine participants were initially enrolled in the study. Because of missing and corrupted data, results from 84 participants (94%) are reported. All participants were female (mean age = 19.16 years), were enrolled in an introductory psychology class, and received course credit for being in the study. Self-reported racial-ethnic background of the sample was as follows: 44% Asian American, 29% Caucasian, 10% Latina, 6% Middle Eastern, 4% American Indian, 4% "other," and 3% African American.

Procedure

All procedures were approved by the institutional review board of the University of California, Los Angeles. In a pretesting session, students in the class completed the Three-Factor Eating

TABLE 1
Restraint Scores and Dietary Consumption for Participants Who Violated Their Diet in Study 2

Measure	Mean	Standard deviation	Minimum	Maximum
Restraint score	6.58	1.92	4.00	10.00
Non-diet-violation days				
Kilocalories consumed	1,496.87	433.38	753.81	2,862.54
Fat consumed (g)	49.41	19.58	18.94	129.41
Diet-violation day				
Kilocalories consumed	1,410.33	705.19	18.96	3,273.90
Fat consumed (g)	45.71	28.01	3.60	115.72

Questionnaire (TFEQ; Stunkard & Messick, 1985), along with a battery of unrelated measures for other researchers. Cronbach's alpha for the TFEQ in the current sample was .74. The Restraint subscale for this measure consists of 17 true/false statements, with "false" given a value of 0 and "true" given a value of 1. Participants who scored at or above the median (4) on the Restraint subscale[1] (Cronbach's $\alpha = .71$) were contacted to participate in a study ostensibly designed to test a health-habits monitoring program to help improve its usability for future research studies. They were not told the specific reason they were selected.

Students who agreed to participate came to the laboratory and provided informed consent. They were then trained to use an online food-record program (Diet Analysis Plus 8.0; Cengage Learning, Florence, KY) and asked to report all the food (in number of servings) they consumed over 8 days. In the same lab room, conspicuously written on a whiteboard, was the following message: "Attention all RAs! I need to finish my dissertation so please don't forget to ask all of your subjects to be in my study too!! –MS." As participants were leaving, the experimenter stopped, pointed to the board, and asked if they were willing to participate in a different study, on taste and memory, for which they would receive more course credit or $10.[2] Participants who agreed ($n = 50$) were scheduled to return on what would be Day 7 of their 8 days of food monitoring.

When participants returned on Day 7, they provided informed consent (using a different consent form). They were asked to complete a memory task and were then given a milk shake to consume. They were told to consume the entire milk shake to keep consumption standardized across participants and were then asked to complete the memory task again. All participants received an 8-oz milk shake similar in size and preparation to the milk shake used by Herman and Mack (1975), and the milk shake was surreptitiously weighed before and after consumption. Consumption of the milk shake served as the diet violation. At the end of the 8-day food-monitoring task, participants were debriefed.

Data Analysis

We hypothesized that the forced diet violation in the lab would not lead to overeating. To test this hypothesis, we conducted both between-subjects and within-subjects analyses. We first compared participants who violated their diets (by participating in the taste-and-memory study) with those who did not (because they chose not to participate in that study). For each participant who violated her diet, we then compared food intake on non-diet-violation days with food intake the day of the diet violation.

Results

Descriptive Statistics and Compliance

Descriptive statistics for participants who completed both parts of the study (food recording and diet violation) are provided in Table 1. Overall, participants were highly compliant in making diary entries: Data were missing for only 7 days (out of 672 total days across all subjects; 1.04%). Participants were also highly compliant with the diet violation and on average drank 97.22% ($SD = 0.01$) of their milk shakes.

Between-Subjects Analyses

Participants who agreed to be in the taste-and-memory study and underwent the diet violation did not differ significantly on their restraint score from participants who did not participate in the additional study, $F(1, 83) = 0.20$, $p = .66$, $p_{rep} = .62$.

As hypothesized, participants who engaged in the diet violation did not consume significantly more kilocalories on Day 7 ($M = 1{,}410.33$, $SD = 705.19$) than participants who did not violate their diet ($M = 1{,}400.44$, $SD = 647.29$), $F(1, 83) = 0.004$, $p = .95$, $p_{rep} = .52$, $d = 0.01$. Again, given the large

[1]Some research (e.g., Van Strien et al., 2000; Westenhoefer et al., 1994) suggests that the disinhibition effect occurs only in individuals with high scores on both the Restraint and the Disinhibition subscales of the TEFQ. In our study, however, the results were the same for participants with high Restraint scores only and for participants with high scores on both subscales. Thus, calorie consumption on the diet-violation day did not differ significantly from calorie consumption on the other days among participants with high Restraint and Disinhibition scores, $t(22) = -0.07$, $p = .95$, $p_{rep} = .52$.

[2]The first 43 participants were not told that the second study would involve food consumption. Because of the institutional review board's concerns, the recruitment information was later amended to indicate that the study involved "taste and memory," so as not to deceive participants about the fact that they would be asked to eat food. We found no differences in Restraint scores, $F(1, 83) = 1.02$, $p = .31$, $p_{rep} = .76$, between participants who were and who were not told that there would be food in the study.

number of Asian American participants, we tested for and found no interaction between condition and ethnicity, $F(1, 78) = 0.13$, $p = .72$, $p_{\text{rep}} = .60$.

Within-Subjects Analyses

As hypothesized, participants did not consume more kilocalories on the day of their diet violation (M = 1,410.33, SD = 705.19) than they did on nonviolation days (Days 1–6 and 8: M = 1,496.87, SD = 433.38), $t(82) = -0.56$, $p = .58$, $p_{\text{rep}} = .65$, $d = 0.05$.

DISCUSSION

Across two studies investigating eating in real-life settings, restrained eaters did not overeat after violating their diets, even though restrained eaters do overeat after diet violations in laboratory settings. These results have specific and general implications. On a specific level, our results indicate that diet violations may not be the catastrophic occurrences that precede overeating, as they have been characterized in the eating-behavior and self-regulation literature. In fact, a compensation effect, rather than a disinhibition effect, seems to occur: Participants compensated for a diet violation by limiting their caloric intake for the rest of the day. On a general level, these results underscore the importance of considering the external validity of laboratory experiments, even when the findings are as long-standing and well replicated as in this case.

Some concerns must be addressed. First, our main findings were null results, and could have been due to Type II error. However, our lowest-powered test (the between-subjects comparison in Study 2) had .80 power to detect an effect size (Cohen's d) of 0.60, a medium to large effect, and the effect size in Herman and Mack's (1975) original study was large (Cohen's d = 2.5). Other diet-violation studies have had effect sizes ranging from medium to large (e.g., Ruderman & Christensen, 1983: Cohen's d = 0.42; Spencer & Fremouw, 1979: Cohen's d = 0.80), so our study had enough power to detect an effect. Further, the fact that we found the same results using two different methodologies, across two study sites in Study 1, and in both between- and within-subjects tests in Study 2, adds to our confidence in our findings.

A second concern is that participants may have been incapable of accurately reporting their food intake, which might have introduced enough random error into the estimates of consumption to obscure any disinhibition effect. In Study 1, however, we found an identical pattern of results regardless of whether the outcome was (a) the number of servings eaten or (b) whether or not participants had eaten at all. We believe that participants were able to accurately assess whether or not they had eaten. The accuracy of self-report is a potential issue in Study 2, in which participants were asked to report their food intake in servings. Although participants were trained in serving-size estimation and expressed confidence in using the on-line food-recording program correctly, we did not test their accuracy. However, in a separate validation study (N = 35) of our serving-size-estimation training procedures, we trained participants using the same materials and administered a pop quiz using actual premeasured foods to determine whether participants correctly estimated the number of servings. Results indicated that estimates were generally accurate, and underestimation (the primary concern) was uncommon. In fact, overestimation errors were most common: Participants underestimated serving size 8.0% of the time, were correct 73.43% of the time, and overestimated serving size 18.57% of the time.

A final concern is reactivity to the daily-diary methodology that we employed. To the extent that self-monitoring might lead to temporary success in restraining one's food intake, the method that we used to measure eating might have in fact decreased eating. Reactivity to daily-diary methods has been assessed, however, in several studies, and all have found little evidence of reactivity. For example, studies investigating pain (Stone et al., 2003) and alcohol use (Litt, Cooney, & Morse, 1998) found no differences between participants who did and did not use electronic diaries. More important, studies specifically investigating eating and binge eating also have found no evidence of reactivity (Steiger et al., 2005; Stein & Corte, 2003). Even a study that attempted to use food monitoring as an intervention failed to find any reactivity effects (le Grange, Gorin, Dymek, & Stone, 2002). Finally, it is generally thought that reactivity is most likely to occur during the early days of monitoring, and we found no difference between consumption on Day 1 (M = 1,557.23 kcal, SD = 774.22), when reactivity would be expected to be most severe, and consumption on Day 8 (M = 1,396.41 kcal, SD = 663.83), by which time any reactivity was unlikely, $t(78) = 1.55$, $p = .13$, $p_{\text{rep}} = .86$. This finding suggests that reactivity was probably not a significant concern in our studies.

What, then, might be driving the differences between the findings in laboratory and real-life settings? First, in the laboratory studies, not only was the food highly salient after the violation, but participants were told that they must taste each of the three presented flavors of ice cream or other tempting food. Had they not been required to taste all of these flavors, or had the ice cream not been offered to them immediately, it might have been easier for participants to resist the food. To stop eating a salient tempting food after being required to begin eating it is an unusually difficult self-control challenge that restrained eaters might aim to avoid in their daily lives—by escaping the situation, removing the tempting food, or distracting themselves with other activities.

A second possible explanation for the difference between our findings and the lab phenomenon is that restrained eaters might overeat immediately after a violation in the lab, but compensate by decreasing their caloric intake later in the day. This explanation is consistent with the pattern we observed in Study 2.

Indeed, the mean number of calories consumed on the diet-violation day (approximately 1,410 kilocalories) included the high number of calories in the milk shake, yet was still not significantly different from the mean number of calories consumed on the other days. It should be noted that such compensation may be intentional or may occur without explicit intention. Although the intentionality of caloric compensation could not be addressed in these studies, future studies may benefit from directly examining the psychological processes underlying compensation.

Although past research has indicated that restrained eaters respond to diet violations by overeating, our findings suggest that the way restrained eaters respond outside of the laboratory may be more complicated, such that a diet lapse may not consistently result in overeating across all settings. By combining our findings with those from laboratory studies, researchers can begin to develop a clearer picture of when dieters will lose control of their eating. In particular, dieters who are exposed to highly salient food after a diet violation, or who are expected to consume some portion of an appetizing food after a diet violation, are likely to lose control of their eating. In contrast, dieters who are able to control their environment by keeping tempting food away from themselves, or at least by making tempting food less salient after a diet violation, may be more successful at compensating for a violation of their diet over the rest of the day.

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