

## Eating Behavior in Response to Food-Cue Exposure: Examining the Cue-Reactivity and Counteractive-Control Models

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Many studies have demonstrated that those high in weight-related concerns eat more after food-cue exposure, which is consistent with predictions of the cue-reactivity model. However, the counteractive-control model predicts that exposure to fattening foods activates dieting-related goals and behavior in weight-concerned individuals. Although these models seem incongruous, the authors hypothesized that the salience of the cue could represent a critical factor in determining which model is activated. The authors predicted that attending to salient food cues would result in increased intake (cue reactivity) in individuals with high weight-related concerns, whereas incidental food-cue exposure would result in decreased intake (counteractive control), relative to control exposure. The authors employed a 3 (attended vs. incidental vs. control cue)  $\times$  2 (low vs. high weight-related concerns) design. As expected, participants with high weight-related concerns who attended to a food cue ate more than did both those with high weight-related concerns in the control condition and those with low weight-related concerns in the attended-cue condition; however, intake of individuals with high weight-related concerns who were exposed to the incidental cue did not differ from that of those in the control condition. The manner of food-cue presentation may be a critical factor in determining eating behavior.

*Keywords:* food cue, cue reactivity, counteractive control, intake, weight concerns

The “obesigenic” environment in which humans live is often blamed for the rise in overweight and obesity. This environment includes exposure to copious cues for high-caloric foods, which are easily accessible and aggressively marketed (e.g., Blundell et al., 2005). Indeed, Wansink and Sobal (2007) reported that individuals make over 200 food-related decisions each day, suggesting that the average person is constantly being confronted by food-related cues and having to make decisions about whether to indulge upon each exposure. The long-term effects of constant exposure to food cues are not known, as the majority of research on the effects of food-cue exposure on eating behavior has been conducted in laboratories. However, there is some evidence that an abundance of food-related cues in the environment is associated with higher body mass index (BMI). Women who live in closer proximity to supermarkets or who have a higher density of small grocery stores in their neighborhood have an increased risk for being overweight, independent of socioeconomic status and individual factors such as age, smoking status, and physical activity (Wang, Kim, Gonzalez, MacLeod, & Winkleby, 2007). Wang and colleagues (2007) speculated that the link between the presence of

food stores and BMI may stem from greater exposure to high-caloric foods. What might the mechanism be for a link between food-cue exposure and increased intake, though? In the current article, we compare and contrast the primary theories relating to food-cue exposure (i.e., the cue-reactivity model and the counteractive-control model) and investigate whether food-cue exposure invariably leads to increased intake.

### Cue-Reactivity Model

Early models developed by Weingarten (1985) and Woods (1991)—models based on animal research—proposed that learning mechanisms control meal initiation and food intake. The common prediction across these models is that exposure to food-related cues (e.g., the sight or smell of food) results in cephalic phase responses that prepare the animal (or human) for food intake. Jansen (1998) extended these models with her inclusion of individual differences in dietary restraint as a predictor of cue reactivity. Jansen proposed that food, when consumed (an unconditioned stimulus), elicits metabolic responses (an unconditioned response) and becomes associated with food-related cues, such as the sight and smell of food. These food-related cues act as conditioned stimuli, which in turn elicit “cue reactivity” (a conditioned response). Jansen proposed that this cue reactivity leads to conditioned responses of both a psychological nature (i.e., cravings or strong desire to eat) and a physiological nature (i.e., cephalic phase responses, including insulin release and increased salivation), which in turn increases the probability of an episode of overeating. According to Jansen’s model, individuals who chronically diet and have high weight-related concerns display particularly strong conditioning because they tend to experience initial food deprivation and then eat large amounts (strong unconditioned stimuli) in the

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presence of a limited set of cues (conditioned stimuli, which include triggers for disinhibited eating, such as emotional agitation or exposure to palatable food). Therefore, food-related cues were proposed to be a disinhibitor for those with high weight-related concerns.

A variety of other factors have been established to disinhibit the eating of individuals with high weight-related concerns (i.e., those who score high on the Restraint Scale; Polivy, Herman, & Howard, 1988), including negative and positive affect (e.g., Cools, Schotte, & McNally, 1992), ego threats (e.g., Heatherton, Herman, & Polivy, 1991), consumption of a preload (e.g., Herman & Mack, 1975), or consumption of alcohol (Polivy & Herman, 1976; see Polivy, 1996, for a review of the effects of chronic dieting). Those who score high on the Restraint Scale tend to be characterized as individuals who have high weight- and shape-related concerns and intentions to lose weight but are unsuccessful in achieving or maintaining significant weight loss as a result of the numerous factors that can trigger episodes of overeating in these individuals. In fact, numerous studies have been conducted in order to investigate whether those who score high on this measure do successfully restrict their intake, and many studies conducted with both self-report and objective measures have failed to find successful food restriction (see, e.g., Laessle, Tuschl, Kotthaus, & Pirke, 1989; Ouwens, van Strien, & van der Staak, 2003; Stice, Fisher, & Lowe, 2004; van Strien, Cleven, & Schippers, 2000). Therefore, given that individuals who score high on the Restraint Scale appear to be easily triggered to overeat and are therefore unable to successfully inhibit their consumption, it is not surprising that these individuals fail to lose weight (see, e.g., Heatherton, Herman, Polivy, King, & McGree, 1988). According to Jansen's (1998) cue-reactivity model, it is not actual dietary restraint that is hypothesized to lead to increased cue reactivity but rather the pattern of (intentions toward) restriction of intake and subsequent episodes of overeating that is associated with increased cue reactivity. In fact, only unsuccessful dieters (but not those who successfully restrain their intake and sustain weight loss) appear to exhibit cue reactivity (Jansen, Stegerman, Roefs, Mulken, & Arntz, 2008).

Jansen's (1998) cue-reactivity model is consistent with some of the existing literature on the effects of food-cue exposure, in terms of both the conditioned cue reactivity and the subsequent increased intake. Teff and Engelman (1996) demonstrated that cephalic phase insulin release in response to a food cue was positively associated with dietary restraint scores, while Klajner, Herman, Polivy, and Chhabra (1981) determined that those with high scores on the Restraint Scale salivated more than did those with low scores after smelling and looking at pizza. Food consumption after cue exposure follows a similar pattern of results in which weight-concerned individuals are more responsive to food cues than are individuals with low weight-related concerns. For example, Rogers and Hill (1989) reported that individuals with high scores on the Three-Factor Eating Questionnaire (TFEQ; Stunkard & Messick, 1985) who were exposed to a food cue (looking at food and imagining its taste and texture) subsequently ate more than did those in the no-cue condition. In contrast, for those with low scores on the TFEQ, food-cue exposure led to decreased intake relative to the no-cue controls. Jansen and van den Hout (1991) obtained a similar pattern of results, with those with high scores on the Restraint Scale eating more after exposure to a food cue (smelling large plates of food and concentrating on the smell) and those with

low scores eating (nonsignificantly) less than did no-cue controls. Collins (1978) also reported that individuals who scored high on the Restraint Scale ate more than did those with low scores after exposure to a food cue (rating recipes and photos of food) and also ate more than did individuals with high scores on the Restraint Scale who were in the control condition (rating scenery photos).

Fedoroff, Polivy, & Herman (1997, 2003) extended these findings by studying the types of food cues that elicit disinhibited eating in individuals who had high scores on the Restraint Scale (i.e., weight-concerned individuals). Fedoroff et al. (1997) demonstrated in two separate studies that exposure to olfactory (i.e., smell of pizza) and cognitive (i.e., thoughts about pizza) food cues increases cravings and food intake in individuals with high (but not low) weight-related concerns. Cue reactivity also exhibits specificity: Weight-concerned individuals eat more pizza if they are exposed to a pizza food cue (smelling pizza and thinking about pizza) but not when exposed to a cookie food cue (Fedoroff et al., 2003). This finding is in accordance with learning-based theories of food-cue exposure, which predict that external cues elicit cravings for specific foods (i.e., Weingarten, 1985).

#### Counteractive-Control Model

Whereas Jansen (1998) predicted that exposure to food-related cues leads to increased intake in chronic dieters and individuals with high weight-related concerns, Trope and Fishbach (2000) proposed that exposure to temptations activates counteractive self-control, which helps individuals stick to their goals. According to the predictions of the counteractive-control model (Trope & Fishbach, 2000), when individuals who are concerned about their weight are confronted with tempting foods, they will be reminded of their goal of dieting and will refrain from indulging in the temptation. Supporting this model, Fishbach, Friedman, and Kruglanski (2003) demonstrated that weight-concerned individuals reported more intentions to avoid consuming fattening foods after exposure to a food cue (a basket of fattening foods, including chocolate and chips, and a gourmet food magazine in the testing room) and were more likely to choose an apple (as opposed to a chocolate bar) as a gift, compared with those exposed to neutral, non-food-related cues. Fishbach and colleagues suggested that exposure to food temptations leads to activation of the higher order goal of dieting in individuals who are concerned about their weight. They demonstrated that, in line with this purported mechanism, in a lexical decision task, exposure to food prime words led to faster recognition of dieting-related words compared with neutral (non-food-related) primes. Further support for the counteractive-control model was provided by Coelho, Polivy, Herman, & Pliner (2008), who demonstrated that exposure to a food-related cue (smell of cookies baking) inhibited eating in individuals who scored high on the Restraint Scale, as they consumed less than did individuals in the control, no-food-cue condition.

#### Consolidating the Cue-Reactivity Model and Counteractive-Control Model

Taken at face value, the predictions of the cue-reactivity model (Jansen, 1998) and the counteractive-control model (Trope & Fishbach, 2000) appear to be at odds with one another. If exposure to fattening foods, such as chocolate,

reminds weight-concerned individuals of their goals of dieting (as per the predictions of the counteractive-control model), then how can this be reconciled with the fact that researchers have demonstrated overeating in weight-concerned individuals who had been exposed to food cues (i.e., Fedoroff et al., 1997, 2003; Jansen & van den Hout, 1991; Rogers & Hill, 1989)? After examination of the differences between the methodologies of some of the studies supporting each model, it appears as though the manner of food-cue presentation may be a critical factor in determining whether overeating occurs in weight-concerned individuals. In the studies supporting the cue-reactivity model, participants were typically provided with plates of food in front of their faces and were asked to intensely smell the food and to concentrate on it. In contrast, the type of food-cue exposure in the studies supporting the counteractive-control model was more distal and incidental, with a basket of food sitting on a table (as in Fishbach et al., 2003) or the smell of cookies baking in another room (as in Coelho et al., 2008). Furthermore, participants in these latter studies were not directed to attend to the food cue and were occupied with other tasks while in the presence of the food cues. Given these methodological differences, it is possible that in fact the two models are not contradictory, but rather that different mechanisms are at play depending on the potency of the food cue to which participants are exposed. In line with this postulation, Fishbach and colleagues (2003) also speculated that food cues that are particularly salient may lead to inhibition of higher order goals, such as dieting.

### Purpose and Hypotheses

The current study was designed to test whether different types of food-cue exposure (i.e., incidental vs. attended cues) lead to differential effects on food intake, particularly in weight-concerned individuals. We tested food intake in individuals with low versus high weight-related concerns who had been randomly assigned to one of three conditions: control (non-food-related) exposure, incidental food-cue exposure (as in Fishbach et al., 2003), and attended food-cue exposure (as in Fedoroff et al., 2003). We expected that, compared with participants in the neutral-cue control condition, individuals with high (but not low) weight-related concerns would eat more after attending to a food-related cue (according to the cue-reactivity model) but eat less after exposure to an incidental food cue (according to the counteractive-control model). We were also interested in testing whether corresponding changes in hunger, satiety, or affective state would emerge. Little research has investigated changes in affective states after food-cue exposure in nonclinical participants; however, some researchers have demonstrated that food-cue exposure leads to decreases in happiness and increases in tension (Sobik, Hutchison, & Craighead, 2005). We expected that food-cue exposure in the current study would lead to similar increases in negative affect and decreases in positive affect and were interested in examining whether weight-concerned individuals in particular would exhibit these changes in affective state after attending to a food cue.

## Method

### Participants

A total of 83 female students completed this study. Participants were between the ages of 18 and 43 years ( $M = 21.2$ ,  $SD = 3.6$ ). All participants were tested individually between the hours of 11 a.m. and 6 p.m. and received either partial credit toward their psychology courses or a voucher for €7.50 (US\$10.75) as compensation for their participation.

### Materials

The foods used for the attended-cue exposure and the taste test were M&M's (Masterfoods; 484 kcal/100 g), bite-sized KitKat pieces (Nestlé; 519 kcal/100 g), sweet pepper-flavored potato chips (Crocky; 528 kcal/100 g), and garlic-flavored coated peanuts (Duyvis Production BV; 530 kcal/100 g).

### Procedure

Participants were told that the purpose of the study was to investigate sensory perception and were asked to refrain from eating in the 2 hr before their experimental session. Upon arriving at the laboratory, participants were asked to complete a 9-item Likert-style questionnaire on which they rated a variety of "feelings" they were experiencing at that moment (e.g., pleased, distressed, bored) on a 7-point scale ranging from 1 (*not at all*) to 7 (*completely*). Embedded within this questionnaire were two items pertaining to current hunger and satiety, to assess for potential group differences in hunger or satiety at baseline. After completing this measure, participants were exposed to one of the three cue conditions to which they had been randomly assigned: non-food-related control cue, incidental food cue, or attended food cue. Participants were unaware of the different experimental conditions and were not informed of the experimental condition to which they had been assigned. The manipulation of the food cues occurred as follows:

*Control.* A basket of office supplies and three neutral (non-food-related) magazines about home and gardening were placed on a table in the testing room. After completing the ratings of hunger and satiety, participants were asked to write about a neutral perceptual experience for 7 min (i.e., what they might see/hear/smell if they were to go back to visit their elementary school building when it was empty).

*Incidental food cue.* A basket of fattening foods (i.e., several packages of chocolates and chips), along with three gourmet food magazines were placed on a table in the testing room. After completing the ratings of hunger and satiety, participants were asked to write about a neutral perceptual experience for 7 min (as in the control condition).

*Attended food cue.* A basket of fattening foods and three gourmet food magazines were placed on a table in the testing room. After completing the ratings of hunger and satiety, participants were presented with small dishes of four types of foods (M&M's, KitKat pieces, chips, and coated peanuts) and were asked to spend 7 min writing about their thoughts about these foods and their perceptual qualities (i.e., the look and smell of the foods). Participants were instructed not to taste any of the foods, and the dishes were surreptitiously weighed in order to ensure compliance.

Following the 7-min exposure period, all participants were asked to complete the Positive and Negative Affect Scale (Watson, Clark, & Tellegen, 1988), to which two questions relating to current hunger and satiety had been added to allow for assessment of possible changes in these states after food-cue exposure. After participants had completed this measure, the experimenter brought in a tray of food and informed participants that they would now complete the taste perception task. In order to deflect from the true purpose of the experiment (i.e., measuring participants' consumption), the experimenter emphasized her interest in the taste ratings the participants would complete for the M&M's, Kit Kat, chips, and nuts. Participants were instructed to try each of the foods and to rate the perceptual qualities of the foods (e.g., the saltiness, crunchiness, appearance, and overall taste of the foods). They were informed that they had 10 min to complete ratings for all four foods, and they were invited to help themselves to as much food as they liked. Participants were presented with heaping bowls of each of the foods, which was equivalent to approximately 350 g of M&Ms, Kit Kats, and peanuts and 150 g of chips. All food was surreptitiously weighed before and after presentation to participants, in order to determine the total amount consumed.

After 10 min had elapsed, the experimenter returned to collect the foods and asked participants to record what they thought the main purpose of the study was, in order to probe for suspicion regarding the experimental procedures. Finally, the experimenter asked them to complete the Restraint Scale,<sup>1</sup> measured their heights and weights, and asked them to report how long it had been since they last ate prior to arriving for the experimental session, to ensure compliance with the instructions to abstain from eating in the 2 hr prior to the session. All participants were provided with a written debriefing at the end of the study.

### Measures

**Restraint Scale (Polivy et al., 1988).** This 11-item scale was designed to assess individuals' weight fluctuations and concern with dieting. Individuals who score high on this measure are characterized by intermittent periods of food restriction followed by episodes of disinhibited eating and overeating, which in turn generally precludes actual sustained weight loss. In other words, the Restraint Scale identifies individuals who are chronically, unsuccessfully dieting (for a discussion of the issue of the concept of restrained eating, see Heatherton et al., 1988).

Participants were provided with a Dutch translation of this measure. In accordance with previous research, dietary restraint scores were treated dichotomously, with participants classified as high in weight-related concerns if they scored 15 or above on the scale ( $n = 33$ ,  $M = 18.0$ ,  $SD = 2.7$ ) and as low in weight-related concerns if they scored less than 15 ( $n = 50$ ,  $M = 9.8$ ,  $SD = 3.4$ ).

**Positive and Negative Affect Schedule (PANAS; Watson et al., 1988).** The PANAS is a 20-item questionnaire used to assess affect on a 5-point scale ranging from 1 (*not at all*) to 5 (*extremely*). Two additional questions, pertaining to hunger and satiety, were embedded in this measure. Participants were provided with a Dutch translation of this measure and were instructed to rate their mood "right now, at this moment" when completing the questionnaire.

### Data Analyses

A total of 83 participants completed this study; however, data were dropped from participants who indicated that they were suspicious that their food intake was being measured or who indicated that they believed that the purpose of the study was to investigate the effects of food-cue exposure on cravings and intake ( $n = 7$  with low weight-related concerns and  $n = 5$  with high weight-related concerns). One outlier on total intake was removed from food-intake analyses, given that the participant ate more than 3 times the standard deviation plus the mean for her group (control exposure), and food-intake data were excluded from one participant in the attended-cue condition due to experimenter error in the timing of the taste test. Partial eta-squared was used to estimate effect sizes.

## Results

### Characteristics of Participants

A main effect of restraint on BMI was evident,  $F(1, 69) = 15.31$ ,  $p \leq .001$ ,  $\eta^2 = .18$ , with individuals who had high weight-related concerns having a higher BMI ( $M = 24.3$ ,  $SD = 3.4$ ) than did those with low concerns ( $M = 21.4$ ,  $SD = 2.9$ ). Controlling for BMI did not change the pattern of results for the food-intake analyses (i.e., all significant effects remained, and no nonsignificant effects emerged as significant).

There were no group differences in initial levels of hunger or satiety, nor were there group differences in the time that had elapsed since the last intake prior to the experimental session<sup>2</sup> (all  $ps > .1$ ; see Table 1 for means). Controlling for these variables in the analysis of variance (ANOVA) on food intake did not change the pattern of results (i.e., all significant effects remained, and no nonsignificant effects emerged as significant).

### Food Intake

An ANOVA was performed in order to assess total caloric intake, with weight-related concerns and food-cue condition entered as independent variables. There were no main effects of the food-cue condition,  $F(2, 63) = 1.64$ ,  $p \leq .20$ ,  $\eta^2 = .05$ , or weight-related concerns,  $F(1, 63) = 0.20$ ,  $p \leq .66$ ,  $\eta^2 = .00$ ; however, a significant interaction between these variables emerged,  $F(2, 63) = 3.77$ ,  $p \leq .03$ ,  $\eta^2 = .11$  (see Table 2 for means). Duncan's post hoc tests indicated that individuals with high weight-related concerns who were in the attended-cue condition ate significantly more than did those in the control condition and those with low weight-related concerns who were in the attended-cue condition ( $p \leq .05$ ) and tended to eat more than did those with high weight-related concerns who were in the incidental-cue condition ( $p \leq .08$ ) and those with low weight-

<sup>1</sup> As in previous experiments (e.g., Fedoroff et al., 1997; Nederkoorn & Jansen, 2002; Rogers & Hill, 1989), the Restraint Scale was administered at the end of the experimental session, in order to avoid priming participants with dieting-related thoughts just prior to measuring their intake.

<sup>2</sup> Elapsed time since last intake was subjected to a log transform in the analysis of variance to correct for a violation of homogeneity of variance; however, for clarity, the raw means are presented in Table 1.



Table 1  
Means (SDs) for Initial Hunger and Satiety Ratings and Time Elapsed Since Last Intake Across Food-Cue Conditions

Participant attitude and cue condition	Hunger	Satiety	Time since last intake (in hr)
Low weight-related concerns			
Control	4.1 (1.6)	3.4 (1.5)	3.2 (0.9)
Incidental	4.8 (1.4)	2.8 (1.5)	4.6 (4.9)
Attended	4.1 (1.4)	3.1 (1.2)	3.3 (1.0)
High weight-related concerns			
Control	5.0 (1.4)	2.8 (0.8)	5.1 (4.5)
Incidental	4.2 (1.6)	3.3 (1.4)	5.8 (4.0)
Attended	3.6 (1.7)	3.1 (1.3)	3.1 (0.7)

related concerns who were in the control condition ( $p \leq .06$ ). However, contrary to expectations, individuals who had high weight-related concerns who were in the incidental-cue condition did not eat less than those in the control condition ( $p > .5$ ). Individuals who had low weight-related concerns in the incidental-cue condition tended to eat more than did those with high weight-related concerns who were in the control condition ( $p \leq .09$ ); however, no other comparisons approached significance (all  $p$ s  $> .1$ ).

We were interested in determining, as a follow-up analysis for the finding that only attended cues, but not incidental cues, led to changes in intake for those with high weight-related concerns, whether a linear relationship exists between dietary restraint scores and intake. We therefore conducted correlational analyses on individuals' scores on the Restraint Scale and caloric intake (separately for each of the conditions). A significant correlation between these variables emerged in the attended-cue condition ( $r_{21} = .61$ ,  $p \leq .005$ ), suggesting that when individuals attend to a food cue, food intake increases as scores on the Restraint Scale increase. No significant relationship between dietary restraint scores and intake for the incidental-cue condition ( $r_{24} = .01$ ,  $p \leq .98$ ) or the no-cue condition ( $r_{24} = -.11$ ,  $p \leq .65$ ) emerged (see Figure 1 for a visual depiction of the relationship for each condition).

Table 2  
Mean Total Caloric Intake (SD) for Individuals With Low and High Weight-Related Concerns Across the Three Food-Cue Conditions

Participant outlook and group size	Control cue	Incidental cue	Attended cue
Low weight-related concerns			
	222.70 (89.6)	297.57 (162.6)	203.79 (123.9)
<i>n</i>	16	12	13
High weight-related concerns			
	195.66 (115.8)	232.96 (98.5)	335.01 (145.6)
<i>n</i>	8	12	8

Note. The significant difference is between individuals with high weight-related concerns in the attended-cue condition and those in the (a) high weight-related concerns control condition and (b) low weight-related concerns attended-cue condition ( $p \leq .05$ ). The trend toward significance is between individuals with high weight-related concerns in the attended-cue condition and those in the (a) low weight-related concerns control condition ( $p \leq .06$ ) and (b) high weight-related concerns incidental-cue condition ( $p \leq .08$ ).

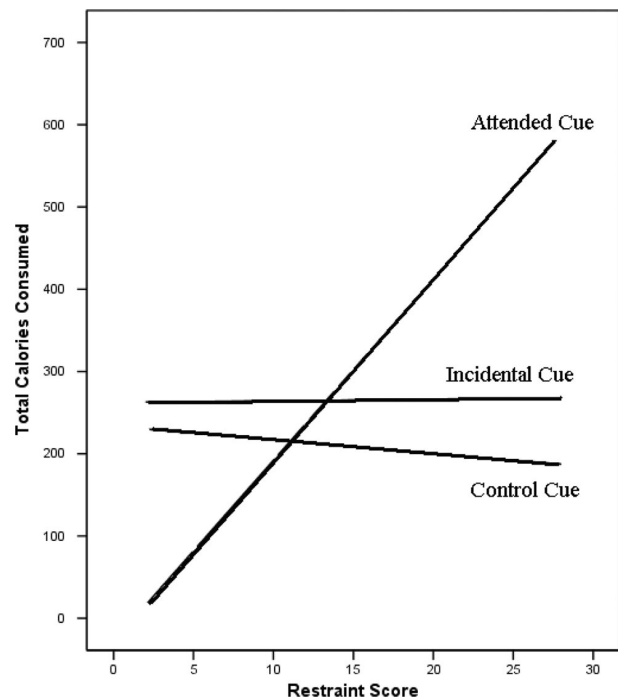


Figure 1. Relationship between scores on the Restraint Scale and total caloric intake by food-cue condition (lines depicted are lines of best fit from the scatterplot).

#### Postexposure Ratings of Hunger, Satiety, and Affect

Participants' postexposure ratings of hunger and satiety (as indicated on the items embedded in the PANAS) were analyzed with analyses of covariance, controlling for the baseline ratings of hunger and satiety as rated on the Likert scale. There was a nonsignificant main effect of food-cue condition on hunger levels,  $F(2, 64) = 3.02$ ,  $p \leq .06$ ,  $\eta^2 = .09$ , with Bonferroni-corrected pairwise comparisons indicating that individuals in the attended-cue condition exhibited more hunger ( $M = 3.4$ ,  $SD = 0.7$ ) than did those in the control condition ( $M = 2.9$ ,  $SD = 0.7$ ,  $p \leq .05$ ). The postexposure hunger levels of those in the incidental-cue condition ( $M = 3.1$ ,  $SD = 0.6$ ) did not differ from either group. A nonsignificant main effect of weight-related concerns on hunger also emerged,  $F(1, 64) = 3.4$ ,  $p \leq .08$ ,  $\eta^2 = .05$ , with those with high weight-related concerns reporting somewhat higher hunger postexposure ( $M = 3.3$ ,  $SD = 0.7$ ) than did those with low weight-related concerns ( $M = 3.0$ ,  $SD = 0.7$ ). No significant interaction between weight concerns and food-cue condition emerged,  $F(2, 64) = 0.3$ ,  $p = ns$ . There were no significant effects for postexposure satiety levels (all  $F$ s  $\leq 1$ ).

ANOVAs were also conducted on the positive and negative affect subscales of the PANAS, with food-cue condition and weight concerns entered as independent variables. A significant main effect of condition on positive affect emerged,  $F(2, 77) = 5.04$ ,  $p \leq .01$ ,  $\eta^2 = .12$ , with Bonferroni-corrected pairwise comparisons demonstrating that individuals in the attended-cue condition had significantly lower ( $p \leq .01$ ) positive affect ( $M = 27.03$ ,  $SD = 5.22$ ) than did those in the control condition ( $M =$

30.96,  $SD = 3.96$ ). The positive affect of those in the incidental condition ( $M = 28.58$ ,  $SD = 4.73$ ) did not differ significantly from either group. A significant main effect of weight concerns on negative affect also emerged,  $F(1, 77) = 7.03$ ,  $p \leq .01$ ,  $\eta^2 = .08$ , with Bonferroni-corrected pairwise comparisons demonstrating that those with high weight-related concerns had higher levels of negative affect ( $M = 16.39$ ,  $SD = 4.64$ ) than did those with low weight-related concerns ( $M = 13.98$ ,  $SD = 4.61$ ,  $p \leq .05$ ). No other effects reached significance.

### Discussion

As predicted, individuals with high (but not low) weight-related concerns consumed more after attending to food cues, compared with individuals who were exposed to control cues and also compared with individuals with low weight-related concerns who were exposed to the attended food cue. Correlational analyses indicated that a significant relationship between scores on the Restraint Scale and intake exists for the attended-cue condition. These findings suggest that as weight-related concerns increase, so too does susceptibility to overeating after attending to a food cue. Those who attended to the food cues also reported more hunger than did participants in the control condition (though this finding was not moderated by weight concerns). Contrary to predictions, however, individuals with high weight-related concerns did not eat less after incidental food-cue exposure—there were no differences in intake between individuals with high weight-related concerns who were in the control and the incidental-cue conditions, and no significant effects emerged in correlational analyses (nor were there significant differences in hunger or satiety between those exposed to an incidental food cue and control participants). It therefore appears that highly weight-concerned individuals eat more after exposure to cues to which they direct their attention and upon which they concentrate but that incidental food-cue exposure does not lead to significant changes in their intake.

The finding that weight-concerned individuals did not decrease their intake relative to controls after incidental-cue exposure is not fully in line with the counteractive-control theory. Despite the use of the same type of food-cue exposure (i.e., a basket of fattening foods and gourmet food magazines), exposure to a temptation did not lead to changes in behavior, in accordance with dieting goals. However, in contrast to the approach used by Fishbach and colleagues (2003), who studied food choice and self-reported behavioral intentions, the current study included a continuous measure of food intake. Given that goal activations were not directly measured, and because weight-concerned individuals did not eat significantly more in the incidental-cue condition compared with those in the control condition, we cannot exclude the possibility that the incidental cue activated dieting goals. Yet, with a mean intake of over 200 calories, those with high weight-related concerns who were exposed to the incidental cue were not really eating minimally but in fact were having a snack (albeit somewhat smaller than the one eaten by those in the attended-cue condition). Therefore it appears that dieting goals were not sufficiently activated to influence eating behavior.

It is possible that, as an alternative explanation, counteractive control fails when individuals are presented with only fattening foods. It may be that exposure to incidental food-related cues activates dieting goals and leads to behavioral choices in accor-

dance with these goals (as in Fishbach et al., 2003) when a choice between a healthy and a fattening snack is available, but once the choice of a healthy item is removed and an individual is confronted with heaping plates of high-caloric foods, the activation of the dieting goal is insufficient to overcome the motivation to try these foods. In other words, incidental food cues may activate dieting goals and good intentions to avoid fattening foods, and these intentions may stay intact provided that healthier choices are available. However, under conditions of confrontation with large amounts of fattening foods and no healthier options, it is possible that the activation of dieting-related goals breaks down and does not translate into a reduced intake of fattening foods. In the current study, the assessment of the activation of dieting goals by means of a lexical decision task was not performed, as our focus was on behavioral measures. Inclusion of this measure and the offering of healthy foods, in conjunction with measuring state changes in hunger or food craving, which may correspond with changes in dieting goals, may help further elucidate the mechanisms underlying behavioral responses to incidental food cues.

In this future research on incidental food cues, it will also be important to disentangle the potential underlying mechanisms—for although activation of dieting-related goals represents one possible mechanism, which has been supported by previous research (Fishbach et al., 2003), it is also possible that participants distract themselves from incidental food cues, which in turn allows them to maintain their dieting goals. In the current study, the incidental food cue involved exposure to a basket of fattening foods and gourmet food magazines, in addition to a writing task about a neutral perceptual experience (used as a control for the food-related writing task in the attended-cue condition). It may be that those with high weight-related concerns used the writing task to distract themselves from the food cues, in order to avoid a threat to their dieting goals. A manipulation check probing for awareness of the control and incidental cues was not included in the study because of the problems associated with retrospective questioning—that is, if participants reported that they were not aware of the basket of food, it would be unclear whether this was because of distraction or a genuine lack of awareness. In order to ensure that all participants looked at the cues in the room, the experimenter initially placed the food for the taste test directly beside the basket and magazines and began to provide the instructions for the taste test from this location before placing the food directly in front of the participants.

The method of food-cue presentation represents a potential explanation for the different direction of findings across the studies (i.e., the increased intake of individuals with high scores on the Restraint Scale demonstrated by Fedoroff et al., 1997, 2003, and the healthy food choice and intentions to avoid fattening foods demonstrated by Fishbach et al. 2003). The results of the current study fit with this interpretation; however, not all previous data correspond perfectly with this explanation. Focusing specifically on previous studies that investigated food intake in response to a single, acute exposure to a food-related cue, Nederkoorn and Jansen (2002) reported that attending to food cues did not increase intake in individuals, regardless of whether they had low or high scores on the Restraint Scale. These results are at odds with the findings of the current study, despite the fact that the cue exposure was similar to that of our attended-cue condition. Perhaps the

inclusion of physiological measurements (i.e., skin conductance, heart rate) during cue exposure influenced cue reactivity.

However, further discrepancies across studies arise when examining the effects of attending to food cues on the eating behavior of those with low scores on the Restraint Scale or TFEQ. Rogers and Hill (1989) reported a significant decrease in the intake after food-cue exposure, while Fedoroff et al. (1997, 2003) reported that the intake of cue-exposed individuals with low scores on the Restraint Scale was not significantly different from that of controls. Other studies (which did not assess participants' dietary restraint scores but selected only participants who were not dieting or trying to lose weight) have demonstrated either increased intake after cue exposure (Cornell, Rodin, & Weingarten, 1989) or no differences in intake between cue-exposed participants and controls (Lambert, Neal, Noyes, Parker, & Worrel, 1991). Part of the discrepancies may be attributed to either relatively small sample sizes or methodological differences across studies. For example, the priming manipulation employed by Cornell et al. (1989) did not differ substantially from the instructions typically used during "taste tests." Participants in the study by Cornell et al. were instructed to take one bite of the food and rate its sensory qualities and were then invited to help themselves if they wanted more of the food. In contrast to this manipulation involving brief taste, typically there is a food-cue exposure phase that occurs prior to the opportunity to eat food and the participants are instructed to concentrate on the smell of the food (as in Jansen & van den Hout, 1991) or to imagine eating the food (as in Rogers & Hill, 1989).

These discrepancies across studies suggest that there may be a somewhat tenuous effect of food-cue exposure on food intake, particularly for those with low weight-related concerns, as the majority of the inconsistencies across studies appear to occur with the eating behavior of those who have low weight-related concerns (those with high concerns appear to fairly consistently eat more after attending to a food cue, with the exception of those in the study by Nederkoorn & Jansen, 2002). Our main objective for the current study was to investigate the eating behavior of individuals with high weight-related concerns in particular, given that both the cue-reactivity model and counteractive-control model predict exaggerated reactivity to cue exposure only in this group. It is therefore difficult to draw conclusions about the underlying mechanism for inconsistencies across studies in the eating behavior of those with low weight-related concerns. However, future research on the effects of the manner of food-cue presentation may help elucidate some of these inconsistencies. When considering the effects of the manner of food-cue presentation, one may find it prudent to consider the issue of cue salience. Fishbach and colleagues (2003) raised the issue that the saliency of temptations may influence whether dieting-related goals are activated or inhibited; however, salience of food cues is not well defined in the literature. Previous researchers (e.g., Staiger & White, 1991) have suggested that the sight, smell, and taste of a cue are more salient than just the sight and smell of the cue. However, they pointed out that it is not clear whether one element of a cue (e.g., taste) constitutes a "stronger" element; they are merely able to conclude that exposing individuals to both the sight and smell of a drink cue led to stronger physiological and psychological responses. Using another approach, Ross (1974) manipulated cue salience by manipulating both visibility (i.e., bright vs. dimly lit food) and attention to food (i.e., thinking about the food vs. thinking about

marbles), while Kozlowski and Schachter (1975) manipulated whether a cue was prominent versus remote (i.e., the only cue provided in the room vs. a cue present while participants focused attention on another task). Furthermore, cue salience is inherently somewhat subjective—an individual who is chronically dieting and has been trying to restrict a particular food (such as chocolate) may find that food to be highly salient if it is in the room, even if the room is dimly lit. Without establishing a clear definition of *cue salience*, it is difficult to determine how to best measure and discuss the magnitude of this construct (although an attended cue is likely to be of higher relative salience than is an incidental cue for most participants).

It is noteworthy that the positive affect of those in the attended-cue condition was lower than that of controls, as this suggests that there may be some aversive qualities to concentrating on high-caloric foods. This finding provides partial support for our hypothesis that affective state would be influenced by food-cue exposure (contrary to our hypotheses, only positive, but not negative, affect was influenced by attendance to a food cue, and there was no interaction with weight concerns). Numerous studies (e.g., Heatherton et al., 1991; Heatherton, Strieppe, & Wittenberg, 1998) have demonstrated that individuals with high weight-related concerns increase their intake after negative mood inductions. However, it is unlikely that affect mediated the pattern of results for weight-concerned individuals in the current study, as conducting further analyses that controlled for positive affect in the ANOVA on food intake did not change the pattern of results. Review of the free responses that participants wrote during the cue exposure indicated that several participants indicated they would like to try at least some of the foods presented to them, yet this had been expressly prohibited by the experimenter. Therefore, perhaps the lower affect in those who attended to a food cue related to the fact that the food appeared to be palatable and tasty, yet they were not able to try it (and were not yet aware that they would later have the opportunity to do so), and perhaps frustration arose as a result of this prohibition. However, any frustration that may have arisen likely dissipated within minutes when the experimenter presented the foods to the participants immediately after they completed the PANAS. Further research is necessary in order to disentangle the experimental effects of food-cue exposure on affect and to elucidate whether decreases in positive affect are an artifact of a desire to eat the foods being presented at that moment. The precise food-cue exposure employed in the current study is unlikely to arise in real-world situations; however, it is conceivable that someone may be exposed to a tasty food and reflect on the smell and taste of this food yet not be able to eat it (e.g., while sitting on a train and watching a fellow passenger eating an aromatic snack). In fact, individuals are constantly exposed to food cues throughout each day (Blundell et al., 2005) and are not able to eat upon each exposure. Therefore, investigations into corresponding changes in behavior and affect as a result of this type of food-cue presentation are warranted.

The results of the current study suggest that predictions of the cue-reactivity model and the counteractive-control model are not in fact contradictory but rather that the manner of food-cue presentation may moderate which process is activated in individuals with high weight-related concerns who are exposed to a food cue. Attending to direct food-related cues led to disinhibited eating in weight-concerned individuals, whereas the presence of subtle, or

incidental, food cues in the environment apparently did not disinhibit their eating (and may have activated dieting-related goals). The null findings for the effects of the incidental food cue are, however, limited by the relatively small sample size of the current study (particularly for individuals with high weight-related concerns). The fact that those with high weight-related concerns demonstrated a significant difference in intake between the attended- and control-cue conditions (despite the small sample size) suggests that this manipulation is relatively powerful, yet perhaps a larger sample size is needed in order to detect the effects of incidental food cues on intake. A further limitation to the current study is the fact that in the attended-cue condition, two factors were changed relative to the incidental-cue condition (i.e., the nature of the cue, by adding the bowls of food, as well as the attention to the cue with the writing task). These two changes were made in order to optimize the attended-cue condition and to make the attended cue similar to that used in other studies supportive of the cue-reactivity model (i.e., Fedoroff et al., 2003; Jansen & van den Hout, 1991) and the incidental cue similar to that used by Fishbach and colleagues (2003). However, these two changes limit our ability to determine which factor in particular leads to increased intake or whether both factors are in fact necessary to influence eating behavior.

The current support for the cue-reactivity model suggests that learning mechanisms may play a role in the overeating exhibited by individuals with high weight-related concerns. There has been some limited use of cue exposure and response prevention (i.e., inhibition of food consumption) in the treatment of bulimia nervosa (see, e.g., Jansen, 1998), though some researchers have suggested that exposure and response prevention is a complicated addition to treatment that does not offer significant benefits over traditional cognitive-behavioral therapy (Bulik, Sullivan, Carter, McIntosh, & Joyce, 1998). Given that individuals with high weight-related concerns are triggered to overeat by attending to food cues (just as those with bulimia can be triggered to binge), perhaps exposure and response prevention could serve as a useful tool to aid weight loss in overweight dieters. Future research that teases apart the underlying mechanisms of food-cue exposure and further investigation into the possible clinical applications of food-cue exposure in conjunction with response prevention are warranted.

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