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Research report

Eat it or beat it. The differential effects of food temptations on overweight and normal-weight restrained eaters

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ABSTRACT

Dieting is difficult to maintain in an environment where cues of attractive, high-calorie food abound. Overweight and restrained eating have been associated with failures of self-regulation in response to such food cues. A subgroup of successful restrained eaters, however, have been found to activate their dieting goal in response to tempting food cues, which helps them to pursue their dieting goal in such situations. The present research extended this finding by examining the effect of tempting food cues on wanting to eat high-calorie snacks in normal-weight and overweight restrained eaters. In an Internet experiment, normal-weight and overweight participants ($N = 284$) were unobtrusively primed with tempting food or neutral food objects. Next, wanting for high-calorie snacks was assessed with a forced-choice measure presenting pictures of high-calorie snacks and low-calorie alternatives. As predicted, exposure to attractive food cues decreased wanting for high-calorie food in normal-weight restrained eaters, but increased wanting in overweight restrained eaters. These results suggest that, in women who are successful in maintaining their weight, food temptations may trigger processes of successful self-regulation, whereas overweight restrained eaters may seem to forget about their diet goal when they are confronted with attractive food, thereby risking the chance to overeat.

As the prevalence of overweight and obesity among both children and adults is increasing in Western societies, dieting is a popular method of weight control. However, only few dieters are able to maintain their initial weight loss over an extended period of time (Elfhag & Rössner, 2005; Jeffery et al., 2000). Once they have stopped dieting, many people may even regain more weight than they initially lost (Mann et al., 2007). One of the causes of weight gain is the increased intake of high-calorie, palatable food, which is stimulated by the 'toxic environment' we are currently living in (Hill & Peters, 1998; Wadden, Brownell, & Foster, 2002). On a daily basis, people are confronted with high-calorie, palatable food that is easily available, and the presence of such food cues might be detrimental for successful weight regulation. It is crucial, therefore, to understand how exactly such food cues in our environment affect the eating behavior of people who are trying to regulate their weight. The present research examines the psychological mechanisms that translate the perception of environmental food cues into actual eating behavior. This way, we hope to improve our understanding of the difficulties that many people have in successfully regulating their body weight.

Recent research on the effects of food cues suggests that high-calorie, palatable food items are hard to resist because they have a strong motivational value. Studies on the reward-related processes triggered by attractive food cues, which have been suggested to be crucial for understanding eating behavior (e.g., Blundell & Finlayson, 2004; Lowe & Butryn, 2007; Yeomans, 1998), have shown that people have a higher 'wanting' for high-calorie snacks than for low-calorie alternatives. This is manifested in the effort they are willing to expend to obtain a high-calorie snack (e.g., Goldfield & Epstein, 2002). In addition, areas in the brain associated with reward-related behavior are activated in response to such food cues (Stoeckel, Weller, Cook, Twieg, Knowlton, & Cox, 2008). These effects have been found to be stronger in overweight and obese people compared to normal-weight people (Davis, Strachan, & Berkson, 2004; Saelens & Epstein, 1996), suggesting that it might be even more difficult for these individuals to resist such food temptations.

Numerous studies on the effects of food cues have shown that restrained eating, too, is often associated with a heightened appetitive response to palatable food cues. Restrained eaters (Herman & Polivy, 1980) are chronic dieters who are highly motivated to restrict their food intake, but also experience

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frequent lapses in their eating behavior. Indeed, being exposed to the sight or smell of palatable food, or being instructed to think about one's favorite food, triggers stronger cravings and actual overeating in restrained than in unrestrained eaters (e.g., Fedoroff, Polivy, & Herman, 1997, 2003; Jansen & Van den Hout, 1991; Papies & Hamstra, in press). In addition, the exposure to attractive food cues triggers increased visual attention for preferred food in restrained eaters. Unrestrained eaters do not show this effect (Papies, Stroebe, & Aarts, 2008a). Tempting food cues have also been shown to trigger increased salivation in restrained compared to unrestrained eaters (e.g., Brunstrom, Yates, & Witcomb, 2004; LeGoff & Spigelman, 1987).

Other studies, however, have qualified these effects and shown, for example, that restrained eaters overeat only when they are also impulsive (Jansen et al., 2009), or when they are placed under cognitive load (Ward & Mann, 2000). Thus, some restrained eaters seem to be able to control their eating behavior when confronted with tempting food and thus control their weight on the long term, while others fail. For research in this area, it is therefore crucial to understand which factors and psychological mechanisms contribute to this differential effect of food cues.

Recently, a number of studies have examined the nonconscious psychological mechanisms that could be underlying the effects of food cues on restrained eaters, without further differentiating, for example, between impulsive and less impulsive participants. One set of studies (Papies, Stroebe, & Aarts, 2007) examined the nonconscious activation of hedonic thoughts about food in restrained eaters. These studies showed that when they were unobtrusively confronted with palatable food words while reading behavior descriptions that involved palatable food (e.g., "Peter is taking a big piece of apple pie."), restrained eaters spontaneously activated thoughts about the rewarding properties of food ("tasty", "delicious", "yummy", etc.). Unrestrained eaters did not show this effect. Such hedonic thoughts could be the cognitive underpinnings of restrained eaters' increased motivation to eat when they are confronted with palatable food (see Aarts, Custers, & Marien, 2008).

A related study addressed the effect that food cues have on restrained eaters' goal of dieting (Papies, Stroebe, & Aarts, 2008b). Here, participants were presented very briefly with attractive food items (e.g., pizza, chips, chocolate), before the cognitive accessibility of the goal of dieting was assessed. The results of this study showed an interesting difference between successful and unsuccessful restrained eaters, as measured by a self-report scale (Fishbach, Friedman, & Kruglanski, 2003). For unsuccessful restrained eaters, the goal of dieting was less accessible after the presentation of an attractive food item than at baseline, indicating that they had inhibited their dieting goal in response to the food cue. This could explain why unsuccessful restrained eaters "forget" about their dieting goal and overeat when confronted with attractive food. The opposite effect, however, occurred for successful restrained eaters. For this group, the dieting goal was more accessible after the food cues than after no food cues. This suggests that successful restrained eaters activate their dieting goal when they encounter food temptations. This makes it easier for this group of restrained eaters to pursue the dieting goal when they are confronted with attractive food, i.e., to refrain from eating that food.

A second study confirmed that successful restrained eaters are indeed better able than unsuccessful restrained eaters to translate their intentions into actual behavior (Papies et al., 2008b). Interestingly, even in a sample of relatively normal-weight students, the measure of dieting success (Fishbach et al., 2003) was negatively associated with participants' BMI ($r = -.48$), suggesting that self-reported successful restrained eaters are indeed better able to regulate their body weight on the long term (Papies et al., 2008b). Thus, activating, rather than inhibiting, one's dieting goal in response to food temptations seems to be an important mechanism that can help restrained eaters to refrain from eating high-calorie food and to maintain a normal body weight.

The work discussed above shows that unsuccessful restrained eating is associated with a higher body weight and with the inhibition and decreased pursuit of the dieting goal in the presence of attractive food cues. Successful restrained eating, on the other hand, is associated with a lower body weight, and with the activation and pursuit of the dieting goal in response to food cues. In the current research, we combined these two lines of research in order to examine the effect of attractive food cues on overweight and normal-weight restrained eaters. This novel combination of predictors allows us to examine whether normal-weight restrained eaters show the same pattern of behavior as successful restrained eaters, and overweight as unsuccessful restrained eaters. In addition, we measured effects on wanting to eat high-calorie food, rather than on cognitive accessibility of the dieting goal, which is an important extension of earlier findings.

We exposed participants to tempting or neutral food cues by means of the behavior descriptions used in Papies et al. (2007). We then assessed participants' wanting by a forced choice method (Finlayson, King, & Blundell, 2007) in which the participants had to choose between a high-calorie food and a low-calorie alternative on several trials. Since wanting is the directed impulse towards a desired stimulus, this process will play a key role in each directional choice for a food item from a given pair (Finlayson et al., 2007). We predicted that overweight restrained eaters would show increased wanting for high-calorie food when they have been exposed to attractive food cues. This would parallel the finding that unsuccessful restrained eaters inhibit their dieting goal in response to attractive food cues (Papies et al., 2008b). Restrained eaters with a lower body-weight, on the other hand, might show decreased wanting for high-calorie food after the exposure to attractive food cues. This in turn would parallel the finding that successful restrained eaters activate and pursue their dieting goal in response to attractive food cues.

In a previous study on the effect of food cues on wanting (Ouwehand & De Ridder, 2008), we found some initial evidence that, when confronted with palatable food cues, diet-concerned women who were successful in maintaining a normal, healthy weight showed less wanting for their favorite snack in comparison to a healthy alternative. Interestingly, this effect was not present among overweight women. However, the opposite effect, as hypothesized in the present study, was not observed either. An important limitation of this study (Ouwehand & De Ridder, 2008) was that it included only young, female college students, with a relatively small range in body weight and a generally low BMI. We decided to examine our present hypotheses in a sample with a wider variance in body weight and age. We recruited adult participants for an online experiment that could easily be done on the participants' own computers. This unobtrusive procedure might also reduce problems with socially desirable responding, which could play a role, especially in overweight and dieting individuals.

Method

Participants

Participants were recruited via the digital newsletter of the Netherlands Nutrition Centre, with the question "to fill out a web questionnaire regarding their opinion on snacks". Participants had to finish the experiment within one session. Of the 605 normal-weight and overweight individuals with a body mass index (BMI = kg/m^2) between 18 and 30 who completed the full experiment, relatively few were male ($n = 45$). Therefore, we decided to only focus on women in this study. Other exclusion

criteria were not being aged between 18 and 70 ($n = 27$), having a physical condition that may influence food preferences (being pregnant ($n = 5$)), currently suffering from or having a history of eating disorders ($n = 71$) measured by means of the Eating Disorders Diagnostic Scale (EDDS; Stice, Telch, & Rizvi, 2000), or being allergic to one or more food items used in the wanting measure ($n = 82$), and not following any dietary restrictions because of a medical condition ($n = 91$), such as high cholesterol levels or diabetics. This combination of exclusion criteria resulted in a final sample consisting of 284 women with a mean age of 42.3 years ($SD = 12.3$) and a mean BMI of 23.7 ($SD = 2.8$).

Procedure

The web experiment was designed in software program Netquestionnaires. Participants were randomly assigned to one of the two conditions (temptation vs. control). In each condition, they were asked to complete a Scrambled Sentence Task (Srull & Wyer, 1979), which is widely used and has been shown to be an adequate, supraliminal, yet unobtrusive priming technique (for more recent research, see e.g., Smeesters, Warlop, Van Avermaet, Corneille, & Yzerbyt, 2003). This part of the questionnaire was presented to the participants as an unrelated word puzzle task. The scrambled sentence task used in this experiment consisted of ten items, with each item consisting of a number of words presented in random order. Participants were asked to form grammatically correct sentences, while leaving out one of the words. For example, the item "eating, is, everywhere, chips, some, movie, the, during, John" would result in the sentence "John is eating some chips during the movie". Five of the 10 items included food words. In the temptation condition, these were high-calorie food items, such as chocolate, fries, and cookies. In the control condition, these were replaced by neutral (staple) food, such as carrots, rice, and currants. The material for this puzzle task was taken from the study by Papies et al. (2007). By means of this puzzle task, participants were unobtrusively primed with high-calorie food, or with neutral food items.

After the puzzle task, the wanting task was administered, followed by a number of questions about the participant's restraint status, height (cm) and weight (kg), and the food and drinks most recently consumed. Afterwards, participants were thanked for their participation. On average, the duration of the experiment was 30 min.

Measures

Wanting

In order to measure participants' wanting to eat high-calorie snacks over low-calorie alternatives, we used the method introduced by Finlayson et al. (2007). Participants were confronted with photographic food stimuli that varied along two dimensions, namely calorie content (high and low) and taste (sweet and savory) resulting in four separate categories: high-calorie sweet (HFSW); low-calorie sweet (LFSW); high-calorie savory (HFSA); and low-calorie savory (LFSA). In our experiment, each category was represented by four different food stimuli that were adapted to the general taste of the Dutch population and that represented snack foods in eatable portion sizes (see Table 1). Web-ready, digital color photographs of these 16 food stimuli were automatically presented on participants' computer screen, were presented in pairs, and measured 200 × 150 pixels.

Wanting was measured by a forced choice methodology, in which each food stimulus from the high-calorie category was matched with each stimulus from the low-calorie category, resulting in 64 trials in which the participant was asked "if you had to make a choice, which food would you most want to eat now?" For the purpose of this article, the relative wanting for high-calorie snacks in comparison to low-calorie alternatives was determined by counting the frequency of selections made for that first category.

Table 1
Photographic snack stimuli used in the wanting measure.

HFSW	LFSW	HFSA	LFSA
Chocolate	Green grapes	Salted crisps	Savory biscuits
Wedge of apple pie	Fruit biscuits	French fries	Carrots
Treacle waffle	Strawberries	Cheese cubes	Cherry tomatoes
Bonbon bloc®	Apple	Mini pizza	Slices of cucumber

Note. HFSW = high-calorie sweet; LFSW = low-calorie sweet; HFSA = high-calorie savory; LFSA = low-calorie savory.

Restrained eating

Participants filled out the Dutch version of the Concern for Diet subscale of the Revised Restraint Scale (Herman & Polivy, 1980; Jansen, Oosterlaan, Merckelbach, & Van den Hout, 1988). This scale consists of six items that assess participants' chronic motivation to control their weight by dieting. Sample items are "How often are you dieting?" and "How conscious are you of what you are eating?"

Hunger

Ratings of hunger were measured before and after manipulation by asking the participants to answer the question "At this moment, how hungry are you?" on a five-point Likert scale (1 = not at all, 3 = neutral, 5 = very much)

Date and time

Netquestionnaires automatically recorded the date and time of the day the participants completed the web experiment

Statistical analyses

Linear regression analysis was employed to examine the effects of experimental condition (temptation vs. control), BMI and restrained eating as well as their interactions on the wanting for high-calorie snacks over low-calorie alternatives. In order to reduce multicollinearity, restraint scores and BMI were transformed to standardized scores before computing cross-product terms (Dunlap & Kemery, 1987). Experimental condition was contrast coded as −1 (control) and 1 (temptation). In order to avoid a median split on restraint and BMI scores and to retain the continuous character of these variables, we conducted regression analyses.

Results

Table 2 shows the baseline characteristics of the participants in the two experimental conditions. No significant differences were found for any of these variables (all $ps > .10$). Many participants completed the web experiment between 3 p.m. and 4 p.m., which is often a favorite time of the day to eat a snack.

Table 2
Statistics of the baseline variables for the temptation group and the control group separately ($N = 284$).

	Range	Temptation		Control	
		M	*SD*	*M*	*SD*
N		132		152	
Age (years)	18–70	43.6	13.0	41.2	11.9
Educational level	1–6	4.2	1.1	4.1	1.1
BMI (kg/m^2)	18–30	23.6	2.8	23.8	2.9
BMI 20–25/BMI > 25 (%)		73/27		72/28	
Restrained eating	1–19	7.0	2.7	7.9	2.8
Baseline hunger	1–5	1.5	0.8	1.6	0.8
Posttest hunger	1–5	1.6	0.9	1.7	0.9
Time of day	0–24	15.4	4.5	15.5	4.4

An initial regression analysis with restraint scores, BMI and experimental condition as predictors of wanting revealed a marginally significant main effect of restraint scores, $\beta = .12$, $t(276) = 1.81$, $p = .07$, and a marginally significant main effect of BMI, $\beta = .11$, $t(276) = 1.73$, $p = .09$, indicating that both higher restraint scores and a higher BMI were associated with a stronger wanting for high-calorie snacks over low-calorie alternatives. As predicted, these effects were qualified by a significant interaction of restraint, BMI and experimental condition, $\beta = .20$, $t(276) = 2.85$, $p = .005$.

In order to further examine this three-way interaction and to test our specific hypotheses, the effect of BMI and experimental condition was examined for participants with high restraint scores (one standard deviation above the mean of the scale; see Aiken & West, 1991) and participants with low restraint scores (one standard deviation below the mean). This allows us to test the two-way interaction and the simple main effects, within the three-way interaction. For clarity reasons, we will label these two groups restrained eaters and unrestrained eaters respectively.

For unrestrained eaters, the analysis regressing wanting scores on BMI, experimental condition, and their interaction revealed only a significant effect of condition, $\beta = -.17$, $t(276) = 2.02$, $p = .04$, such that participants in the temptation condition had a higher wanting for low-calorie food items than participants in the control condition. For restrained eaters, the same analysis revealed a significant effect of BMI, $\beta = .22$, $t(276) = 2.04$, $p = .04$, such that a higher BMI was associated with more wanting for high-calorie snacks. This effect was qualified by the predicted two-way interaction of BMI with experimental condition, $\beta = .32$, $t(276) = 2.84$, $p < .01$. As Fig. 1 shows, for restrained eaters with a low BMI (one SD below the mean BMI i.e., a BMI of ca. 20.85), there was an effect of experimental condition, such that participants in the temptation condition had a decreased wanting for high-calorie snacks compared to participants in the control condition, $F(1, 276) = 5.29$, $p = .02$. Among restrained eaters with a high BMI (one SD above the mean BMI i.e., a BMI of ca. 26.54), the temptation manipulation had the opposite effect, such that participants in the temptation condition showed an increase in wanting for high-calorie snacks compared to participants in the control condition, $F(1, 276) = 5.83$, $p = .02$.

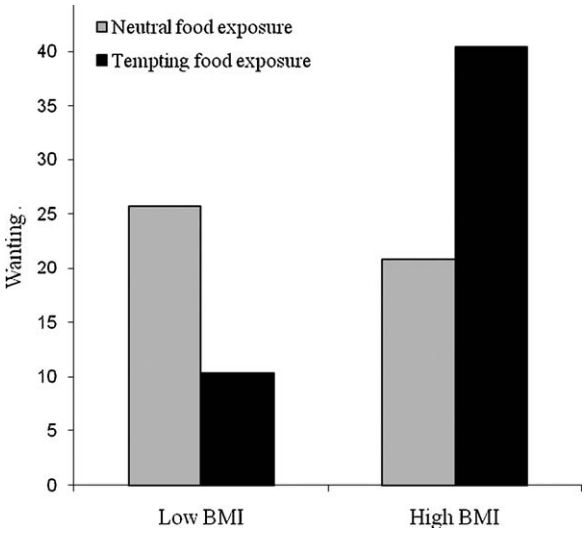

Fig. 1. Wanting for high-calorie snacks over low-calorie alternatives of restrained eaters (one standard deviation above the scale mean) as a function of experimental condition and body mass index (BMI). High and low values of BMI represent one standard deviation above vs. below the mean BMI (see Aiken & West, 1991, for this procedure).

The three-way interaction of restraint, BMI and experimental condition on wanting remained significant when we statistically corrected for participants' self-reported hunger at the beginning of the experiment, $\beta = .24$, $t(276) = 4.20$, $p < .001$, and the time of the day they participated in the experiment, $\beta = .19$, $t(276) = 2.85$, $p < .01$.

Discussion

The current research addressed the question whether the confrontation with attractive food cues differentially affects wanting for high-calorie snacks in normal-weight and overweight restrained eaters. Our results confirmed that restrained eaters who are able to successfully maintain a low body weight displayed less wanting for high-calorie food after exposure to attractive food cues, while overweight restrained eaters displayed an increased wanting for high-calorie food after tempting food cues. These findings are in line with earlier research showing that successful restrained eaters activate their dieting goal after having been confronted with an attractive food item, whereas unsuccessful restrained eaters inhibit their dieting goal (Papies et al., 2008b). The current findings confirm and extend this earlier research by showing that tempting food cues trigger processes of successful self-regulation in restrained eaters with a lower body weight, leading them to make healthier choices (for related findings, see Fishbach et al., 2003; Fishbach & Shah, 2006). In overweight restrained eaters, however, tempting food cues trigger increased wanting for high-calorie food, which could be based on the cognitive inhibition of the dieting goal (Papies et al., 2008b) and leads to less successful self-regulation and to the maintenance of the higher body weight.

An important strength of the present study was that we used data from a sample of the population which varied rather widely in age, educational level, and BMI. We recruited participants who were already interested in dieting and healthy eating, which somewhat limits the generalizability of our findings. However, the sample we obtained is considerably more diverse than samples of most experimental studies regarding restrained eating behavior, which focus on homogeneous groups of highly educated college students. A limitation of our study, however, is the fact that we were only able to investigate our hypotheses in women, since relatively few men participated in the web experiment. It would be interesting to examine whether the same results are found when comparing normal-weight and overweight men.

In addition, a few remarks should be made regarding the wanting measure. It is clear that this instrument has several strengths: it is easy to understand for the participant, easy to administer, especially in an Internet setting, and conceptually interesting, since it resembles a real-life situation in which people have to choose between two alternatives. However, the concept of wanting may also imply the aspect of effort i.e., the amount of work a person is willing to invest to obtain a certain food (Epstein & Leddy, 2006). Although the forced-choice task might have assessed this indirectly, other instruments have been developed that address this aspect more explicitly, for example, by letting participants earn points for snack food versus alternatives in a slot-machine-like task (e.g., Saelens & Epstein, 1996). It could be interesting to replicate the current findings with such a measure in future research.

An important question that arises from the current findings is what the underlying processes are that lead to the reported differences in reward-related behavior. As has been suggested earlier (Fishbach et al., 2003; Papies et al., 2008b), successful restrained eaters may have learned to activate their dieting goal in response to tempting food cues by repeatedly and successfully pursuing this goal in tempting situations. This way, the mental representation of the goal becomes associated with the presence of attractive food, which facilitates successful restraint in the future.

Although we did not test this underlying mechanism directly, we would like to suggest that a similar process might play a role for the self-regulatory behavior of the group of normal-weight restrained eaters in the current study. Such processes might be more difficult to achieve, however, for overweight dieters, as overweight is associated with increased reward-related responses to high-calorie food (e.g., Davis et al., 2004; Saelens & Epstein, 1996). Their increased sensitivity to the motivational value of such food items might make it more difficult for overweight restrained eaters to overrule their initial hedonic reaction and activate and pursue their dieting goal in the presence of an attractive food temptation. Indeed, this reasoning is also in line with findings showing that impulsive restrained eaters are particularly likely to overeat (Jansen et al., 2009), and that obese individuals are more impulsive than normal-weight individuals (e.g., Nederkoorn, Smulders, Havermans, Roefs, & Jansen, 2006). Impulsivity may be related to an increased sensitivity for food rewards and thus make it more difficult to activate the dieting goal in tempting situations. Future studies could include measures of impulsivity and also examine the activation of the dieting goal in response to food cues.

The reasoning that the cognitive availability of the dieting goal is crucial for overruling the motivational power of attractive food is also in line with a recent study examining wanting for high-calorie snack foods in restrained eaters who were currently dieting, who were not currently dieting, and unrestrained eaters (Giesen, Havermans, Nederkoorn, Strafaci, & Jansen, 2009). This study demonstrated that compared to unrestrained eaters, those restrained eaters who were currently on a diet displayed less wanting for snack food in a concurrent schedules task, whereas restrained eaters not currently on a diet displayed more wanting for snacks. For restrained eaters who are currently pursuing a concrete weight-loss diet, the dieting goal may be more accessible on a cognitive level, and therefore more likely to guide behavior in relevant situations. As such, the behavior of restrained eaters who are currently on a diet resembles that of successful and normal-weight restrained eaters and may be based on the activation of the dieting goal in response to tempting food cues.

To conclude, the present research gives us a better understanding of the dynamic effects of environmental food cues and individual-level characteristics on motivational food choices. Tempting food cues affect normal-weight and overweight restrained eaters differently and are especially likely to trigger overeating in overweight restrained eaters, for whom the motivational power of palatable food is stronger. Recent evidence, however, also suggests that the hedonic pull of palatable food can be overruled by activating the dieting goal via cognitive mechanisms or by subtle primes from the environment (e.g., Fishbach et al., 2003; Giesen et al., 2009; Papies & Hamstra, in press; Papies et al., 2008a, 2008b), which has important implications for facilitating successful dieting behavior. Since it is not always possible to integrate diet-related cues in our environment, it might be crucial to develop techniques to activate this goal via cognitive mechanisms. This may eventually protect restrained eaters against the undermining consequences of the food temptations that they are continuously confronted with in our food-rich environment.

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