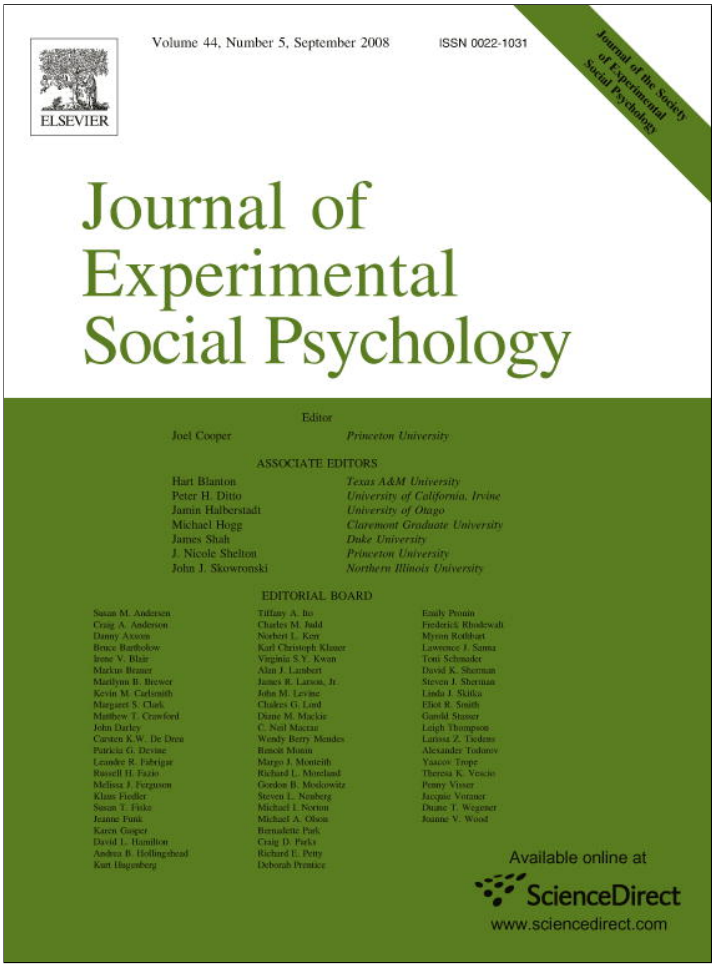

Journal of Experimental Social Psychology 44 (2008) 1283–1292

Contents lists available at ScienceDirect

Journal of Experimental Social Psychology

journal homepage: www.elsevier.com/locate/jesp

The allure of forbidden food: On the role of attention in self-regulation ☆

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ARTICLE INFO

Article history:
Received 21 December 2006
Revised 22 January 2008
Available online 6 May 2008

Keywords:
Attention
Palatable food
Hedonic
Temptation
Restrained eating
Self-regulation

ABSTRACT

The aim of the present studies was to examine the impact of food cues on restrained eaters' attention for food. Previous research has shown that restrained eaters spontaneously activate hedonic thoughts in response to palatable food cues, and that such food cues also lead them to inhibit their dieting goal. We argue that as a consequence, restrained eaters' selective attention will automatically be drawn towards hedonically relevant food items. Consistent with our expectations, the results of two studies revealed that restrained eaters, but not unrestrained eaters, displayed an attentional bias for hedonically rated food items when they had been pre-exposed to food cues. However, this attentional bias did not occur when restrained eaters were primed with the concept of dieting, thereby rendering the regulation of eating behavior more successful. These findings are discussed in the context of implicit processes in self-regulation.

Introduction

Much of human self-regulatory behavior requires ignoring the allure of short-term temptations in order to pursue other, long-term goals. For example, the attractive idea of going to a party on the night before an exam should be abandoned in favor of a good grade, the successful pursuit of a weight loss diet requires resisting the allure of a delicious chocolate cake, and the goal of saving for a new car should prevent us from spending all our money on an attractive vacation. How do individuals manage to pursue their long-term goals when they are constantly confronted with alternatives that are more attractive in the short run?

Research in the domain of self-regulation has identified a number of cognitive mechanisms and strategies that individuals use to resist short-term temptations in favor of long-term goal pursuit. In his research on delay of gratification, for example, Mischel showed that ignoring the "hot", pleasurable features of a luring temptation increases the chances that one will be able to resist it in favor of a more attractive, larger reward later (for a review, see Mischel, Shoda, & Rodriguez, 1989). More recently, Fishbach and her colleagues (Fishbach, Friedman, & Kruglanski, 2003) demonstrated that encountering an attractive short-term temptation (for example, cake) can activate the overriding, long-term goal (dieting), which increases the chances of successful pursuit of the long-term goal. In their counteractive control theory, Trope and Fishbach (2000, 2005) identified a number of more elaborate strategies that individuals employ to secure long-term outcomes in the face of short-term temptations, such as bolstering the value of the long-term goal or devising penalties for not reaching it. In the present research, we investigate the motivational dynamics of goal pursuit in one specific domain where the ability to resist temptations seems to be especially difficult for many individuals, namely the domain of dieting.

Although dieting is a very popular means of weight control, it is very difficult for most people to maintain a successful weight loss diet, and only few dieters are able to reduce their body weight in the long-term (Jeffery et al., 2000). It has been suggested that a so-called "toxic environment", which promotes unhealthy eating and activity patterns, contributes to these difficulties in weight-regulation, and to the development of obesity in Western countries (Wadden, Brownell, & Foster, 2002). In industrialized societies, highly palatable and calorically dense foods are very visible, and easily available, so that dieters are constantly confronted with temptations that threaten their long-term goal of weight control. In the present article, we investigate a mechanism by which such food temptations interfere with the dieting behavior of chronic dieters. Specifically, we examine whether the exposure to food cues leads chronic dieters automatically to direct selective attention towards attractive food items, making it more difficult for them to resist this temptation.

Restrained eating and the allure of palatable food

Earlier research examining the impact of food cues on the self-regulation of dieters has shown that chronic dieters have stronger appetitive reactions to the perception of food than non-dieters.

☆ The work in this paper was supported by grants (VIDI-grant 452-02-047 and ZONMW-grant 40160001) from The Netherlands Organization for Scientific Research, and by a grant from the Research Institute for Psychology and Health.

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doi:10.1016/j.jesp.2008.04.008

Much of this research was inspired by the concept of "restrained eating" (i.e., chronic dieting, Herman & Polivy, 1980) and the apparent inability of these individuals to keep to their diet (cf. Herman & Mack, 1975). Restrained eaters are chronically concerned with dieting and weight loss. However, they appear to be characterized by their continuous efforts at weight loss more than by their actual success, and their dieting behavior is accompanied by occasional lapses of restraint. Thus, restrained eaters have been described as very motivated, but rather unsuccessful long-term dieters (Gorman & Allison, 1995; Heatherton, Herman, Polivy, & King, 1988; Herman & Polivy, 1980, p. 223). Restrained eating is commonly assessed by the Revised Restraint Scale (Herman & Polivy, 1980), which consists of two subscales. The concern for dieting subscale assesses the chronic motivation to diet, and the weight fluctuation subscale measures participants' history of weight cycling (van Strien, Breteler, & Ouwens, 2002).

Numerous studies were conducted to scrutinize the overeating of restrained eaters, finding for example that restrained eaters respond with higher levels of salivation to the presence of palatable food (Brunstrom, Yates, & Witcomb, 2004; Klajner, Herman, Polivy, & Chhabra, 1981; Tepper, 1992) and to the smell of food (LeGoff & Spigelman, 1987). Moreover, olfactory and cognitive food cues were shown to elicit stronger urges to eat this food in restrained than in unrestrained eaters (Fedoroff, Polivy, & Herman, 1997, 2003; Harvey, Kemps, & Tiggemann, 2005). Food cues also exert a strong impact on restrained eaters' actual eating behavior, as they eat more than unrestrained eaters after having been primed with the sight, the smell, or with thoughts about palatable food (Collins, 1978; Fedoroff et al., 1997; Jansen & Van den Hout, 1991; Rogers & Hill, 1989). In sum, these studies have shown that following exposure to palatable food, restrained eaters' cognition and behavior is influenced more by the pleasure that can be gained from food rather than by their dieting goal. We suggest that there is a common mechanism underlying these findings, namely that palatable food cues elicit in restrained eaters pleasure-oriented, hedonic thoughts about food which then guide their behavior and lead to overeating, despite their chronic dieting goal (Papies, Stroebe, & Aarts, 2007).

To account for the difficulties which restrained eaters experience in resisting palatable food, Stroebe and colleagues (Stroebe, Mensink, Aarts, Schut, & Kruglanski, 2008) recently developed a Goal Conflict Model of Eating that specifies the psychological processes underlying restrained eaters' eating regulation. According to this theory, restrained eaters are especially sensitive to the hedonic aspects of food, so that perceiving palatable food easily triggers in them the goal of eating that food (Papies et al., 2007). However, this could lead to overconsumption of palatable, high-calorie food, and eventually to weight gain. As our society favors a rather slim physique, weight gain will sooner or later trigger the motivation to diet in order to control one's body weight. The goal conflict theory suggests that as a result of this process, restrained eaters are dieters who hold two incompatible goals with regard to food and eating, namely the hedonic goal of eating good food, which is based on their increased sensitivity to palatable food, and the goal of dieting and weight control, which has emerged in order to control the potential weight gain. Unrestrained eaters, on the other hand, are less sensitive to the hedonic aspects of food and therefore need to be less concerned with their body weight, so that they do not experience the same goal conflict as restrained eaters.

The goal conflict theory suggests that normally, restrained eaters' weight control goal curbs their hedonic thoughts about food, so that they are able to resist the temptation of high-fat, palatable food and refrain from eating it. However, this fragile balance between hedonic thoughts about food and the goal of weight control can easily be disturbed by cues that activate hedonic thoughts in restrained eaters, such as the sight or smell of palatable food. If hedonic thoughts are activated, the mental representation of the conflicting goal of weight control will become less accessible (Shah, Friedman, & Kruglanski, 2002). The hedonic thoughts are then highly active, whereas the weight control goal is temporarily less accessible in mind. As a result of this process, restrained eaters' subsequent cognition and behavior will be dominated more by a hedonic orientation towards food than by the goal of weight control.

Experimental tests of the processes proposed by this goal conflict model confirmed the idea that restrained eaters react to palatable food cues with hedonic thoughts about food (Papies et al., 2007). In two studies, which used the concern for dieting scale to identify chronically restrained eaters, restrained and unrestrained participants read behavior descriptions involving either palatable food or neutral food. After each behavior description, participants were probed unobtrusively for the mental accessibility of hedonic thoughts about food. Results indicated that for restrained eaters, hedonic thoughts about food were more accessible, but only after behavior descriptions that involved palatable food and not neutral food. These findings show that restrained eaters are readily triggered to think hedonically about food, which is in conflict with the goal of dieting.

Indeed, recent evidence shows that the perception of palatable food not only triggers restrained eaters to think hedonically about food, but also leads them to inhibit the conflicting dieting goal. In two sequential priming studies, Stroebe et al. (2008) primed restrained and unrestrained participants briefly with palatable food words or control words and examined the accessibility of the mental representation of the dieting goal with a lexical decision task. Restrained eaters who were primed with palatable food words showed decreased access to diet-related words compared to restrained eaters who were primed with control words. Unrestrained eaters' access to diet words was not influenced by the nature of the prime. This suggests that the subtle exposure to palatable food cues caused restrained eaters to temporarily inhibit their dieting goal, as this is incompatible with their hedonic thoughts about food.

As these findings show, the exposure to palatable food cues seems to lead to a twofold cognitive reaction in restrained eaters: it triggers hedonic thoughts about food (Papies et al., 2007), and it inhibits the mental representation of the dieting goal (Stroebe et al., 2008). We propose that this twofold reaction will influence restrained eaters' subsequent processing of food cues, as this will be guided by the highly accessible hedonic thoughts rather than by their dieting goal. Thus, the allocation of selective attention will be influenced by hedonic thoughts about food, leading to increased attention for food items that match the current hedonic orientation (Lang, Bradley, & Cuthbert, 1997). In the present studies, therefore, we hypothesized that the exposure to palatable food cues triggers hedonic food thoughts in restrained eaters and therefore leads restrained eaters to allocate increased selective attention to hedonically relevant food. Furthermore, we test the assumption that the accessibility of the dieting goal plays a pivotal role in this process.

Selective attention to palatable food

Previous research on the role of eating restraint in directing selective attention towards food has led to equivocal results. While some studies found restrained eaters displaying greater Stroop interference on food words than unrestrained eaters (Francis, Stewart, & Hounsell, 1997; Stewart & Samoluk, 1997), other studies found no evidence of selective attention for food stimuli in dietary restraint (Boon, Vogelzang, & Jansen, 2000; for a review, see Dobson & Dozois, 2004; Sackville, Schotte, Touyz, Griffiths, & Beumont, 1998). There are two possible reasons for these conflicting results, namely (1) the influence of restrained eaters' dieting concern on

attentional processes, and (2) the type of measures traditionally used to examine these processes.

The first reason may be found in the interference of restrained eaters' dieting goal during the assessment of attention for food. Since restrained eaters chronically try to reduce their weight by dieting, the mental representation of the dieting goal has enhanced mental accessibility for them (Stroebe et al., 2008) and could prevent increased attention for high-calorie food items. Due to the high cognitive accessibility of dieting thoughts, restrained eaters might initially direct no selective attention towards tempting food stimuli which constitute a potential threat to their diet (cf. Boon et al., 2000). Only when repeated exposure to palatable food cues has triggered hedonic thoughts about food and at the same time, made the chronic dieting goal less accessible, will restrained eaters display increased selective attention for relevant food items. We therefore designed two experiments to examine restrained eaters' selective attention for hedonically relevant food, not as a general phenomenon, but as a function of the pre-exposure to food cues and the resulting hedonic orientation towards food (Papies et al., 2007).

The measures generally used to assess attentional processes might be the second reason why to date, we have no complete understanding of the pattern of restrained eaters' attention for food. Most studies investigating this issue have made use of the Stroop color-naming paradigm. However, reaction time differences that are found with the Stroop paradigm could also be due to increased concern with certain stimuli (Francis et al., 1997), as Stroop effects have also been observed for threatening stimuli, for example in phobias or anxiety (e.g., Mattia, Heimberg, & Hope, 1993; Mogg, Bradley, Williams, & Mathews, 1993). Thus, when individuals are confronted with cues which are related to a chronic concern, they display increased color-naming latencies for these cues. Since restrained eaters typically experience concern about high-fat, palatable food, Stroop effects for such food stimuli cannot distinguish between an attentional bias that is driven by the goal to avoid this food or by a hedonic orientation towards it.

We suggest that the visual probe paradigm (MacLeod, Mathews, & Tata, 1986), might be more suited to measuring a hedonically motivated attentional bias, since it assesses shifts of selective attention towards relevant cues. In this task, participants are confronted with two stimuli presented simultaneously, one of which is the critical cue. Subsequently, a probe is presented in the same location as one of the two stimuli, and participants are required to press a key as quickly as possible in response to the probe. This response is facilitated if the probe appears in the same location as the critical cue, since this attracts increased attention from the participants. The visual probe task thus directly measures the allocation of attention between two competing stimuli (Ehrman et al., 2002). In recent years, the visual probe task has successfully been used to demonstrate an attentional bias for drug-related cues among, for example, smokers, alcoholics, and users of heroin or cannabis (e.g., Ehrman et al., 2002; Field, Mogg, & Bradley, 2004; Lubman, Peters, Mogg, Bradley, & Deakin, 2000; Townshend & Duka, 2001). In the present research, we used this experimental paradigm to examine the effects of palatable food cues on the shifting of attention of restrained eaters towards these food cues.

The present research

We conducted two experiments to examine the hypothesis that palatable food cues will attract the attention of restrained eaters, but only if hedonic food thoughts have been activated and the dieting goal has been inhibited in mind (cf. Papies et al., 2007; Stroebe et al., 2008). In the present studies, a food pre-exposure manipulation was used to initiate this hedonic orientation towards food. This pre-exposure was implemented as a lexical decision task which contained either palatable food words or food-unrelated words and was presented to participants before the selective attention task.

The hedonic thoughts that are triggered by this pre-exposure to food cues will subsequently direct restrained eaters' attention towards items with high perceived hedonic quality. Therefore, in Experiment 1 it was hypothesized that after the pre-exposure to food cues, restrained eaters would display increased selective attention towards palatable food as a function of their hedonic ratings of this food. We expected this effect to occur not for food in general, but only for palatable food, since only palatable food is likely to trigger hedonic thoughts in the first place. Therefore, we included both palatable and control food words as items in the visual probe task. The control food words refer to neutral food that is neither liked nor disliked by participants (e.g., carrots, oatmeal) and which is therefore not relevant as a target of hedonic food thoughts. The palatable food words, on the other hand, will attract increased attention from restrained eaters, depending on their subjective hedonic quality.

In Experiment 2, we additionally examined the role of the accessibility of the concept of dieting in restrained eaters' attention for food by priming participants subliminally with diet-related words after the pre-exposure to food cues. If repeated exposure to palatable food items triggers hedonic thoughts about this food, resulting in the inhibition of the dieting goal (Stroebe et al., 2008) and in selective attention being directed towards hedonically relevant food, then priming the dieting goal should curb the hedonic thoughts and prevent the allocation of hedonically motivated attention. In line with previous work on goal priming and goal pursuit (e.g., Bargh, Gollwitzer, Lee Chai, Barndollar, & Troetschel, 2001), we therefore expected that priming the concept of dieting would reactivate the dieting goal in restrained eaters and as a consequence prevent their attentional bias for hedonically relevant food after food cue exposure. Although this constitutes only an indirect test of our hypothesis that the attentional bias is contingent on the inhibition of the dieting goal, it might provide us with a first indication that changes in accessibility of the dieting goal play a pivotal role in the cognitive regulation of restrained eaters' attention and behavior.

Experiment 1

Experiment 1 was designed to test the hypothesis that the pre-exposure to food cues elicits in restrained, but not unrestrained eaters, an attentional bias for palatable, hedonically relevant food. Participants' hedonic ratings of the food items were used to test the hypothesis that food cue exposure triggers restrained eaters to shift their attention towards palatable food items to the degree that they subjectively experience them to be enjoyable.

A visual probe task was employed to examine attention for palatable and control food words compared to non-food words. A facilitated response for probes that appear in the same location as relevant cues is interpreted as increased attention for such cues. In the present experiment, participants were required to respond by indicating the type of probe rather than the location of the probe, since this version of the visual probe task more directly encourages participants to monitor both sides of the screen equally (Bradley, Mogg, Wright, & Field, 2003).

Method

Participants and design

One hundred and four students (25 men, 79 women) of Utrecht University participated in the study for course credit or € 2,50. The design of the study was a 2 (pre-exposure: food cue vs. non-food

cue) × 2 (restraint: restrained vs. unrestrained) × 2 (type of food: palatable vs. control) × 2 (probe location: congruent vs. incongruent), with the first two factors varying between participants and the latter two factors within participants. In addition, hedonic ratings of all food items were obtained from participants.

Materials

In the lexical decision task, participants were presented with 40 words and 40 pronounceable non-words. In the food pre-exposure condition, half of the words were food items, namely 10 palatable food items (e.g., pizza, chocolate, cake), and 10 control food items (e.g., radish, oatmeal, raisins). The categorization of food items was based on a pilot study ($N = 51$). In the non-food pre-exposure condition, only food-unrelated words were presented in the lexical decision task.

In the visual probe task, the same food words were used as in the food pre-exposure condition of the lexical decision task. Each food word was matched with an office-related word of equal length (e.g., book, pencil, desk) to be presented simultaneously. In addition, words from two food-unrelated categories were used in filler trials.

Procedure

Upon arrival at the laboratory, participants were seated in individual cubicles containing a desktop computer. Participants were randomly assigned to the food pre-exposure or the non-food pre-exposure condition. All materials and instructions were presented on the computer. Participants were informed that the experiment consisted of several different tasks.

Lexical decision task. First, the lexical decision task was introduced, asking participants to indicate as quickly and accurately as possible whether the presented word was an existing Dutch word or not. All words were preceded by a fixation cross for 500 ms and remained on the screen until the participant had responded by pressing the "yes"-button or the "no"-button marked on the keyboard. There was an inter-trial interval of 1 s. The lexical decision task consisted of 80 trials. For the participants in the food pre-exposure condition, these were the 20 food words described above, 20 office words, and 40 non-words. Participants in the non-food pre-exposure condition were presented with 40 nature-related words and 40 non-words. All trials were presented in random order. Both groups of participants first completed 10 practice trials with unrelated words to familiarize themselves with the task.

Probe classification task. After participants had completed the lexical decision task, the probe classification task was introduced. In this task, two words were presented simultaneously on the screen, followed by a small arrow pointing either upwards or downwards. On half of the critical trials, the probe appeared in the same location as the food word (congruent trials), and in the other trials, the probe appeared in the location of the control word (incongruent trials). Participants were instructed to indicate as fast and as accurately as possible whether the arrow was pointing upwards or downwards, using the "2" and "8" keys on the numerical part of the keyboard. Each trial started with a fixation cross for 500 ms, followed by the word pair for 200 ms and then by the probe that remained on the screen until a response was given. The words were approximately 6 mm high and presented next to each other with a distance of approximately 4 cm between their inner edges. Probes were 1 cm in height. In the probe classification task, 20 food-office word pairs and 20 filler word pairs were each presented four times: twice on each side of the screen, and twice in each congruence condition.

Thus, the probe classification task consisted of 160 trials, which were presented in random order. In the beginning of the task, 20 unrelated practice trials were presented to participants. After 80 trials, there was a break of 1 min.

Restrained eating scale. After the probe classification task, a filler task followed after which participants were asked to fill out the Dutch version of the Revised Restraint Scale (Herman & Polivy, 1980). In line with earlier studies on the cognitive processes in restrained eating, we used the Concern for Dieting subscale (see Appendix), which has been recommended to assess participants' chronic motivation to control their weight by dieting (Stroebe et al., 2008; van Strien et al., 2002).

Perceived palatability. Subsequently, participants rated the hedonic quality of the twenty food items that were presented in the previous tasks. Ratings were given on a nine-point scale from "not tasty at all" to "very tasty". After they had completed the ratings, participants were debriefed, paid, and thanked.

Results

Lexical decision task

The lexical decision task allowed us to examine if there were baseline differences in the mental accessibility of palatable and control food words between restrained and unrestrained eaters in the food pre-exposure condition. The reaction times for these words in the lexical decision task were analyzed with restraint scores, hedonic ratings, and their interaction as predictors. In order to reduce multicollinearity, predictor variables were transformed to standardized scores before computing cross-product terms (Dunlap & Kemery, 1987). Regression analyses revealed no significant effects of restraint scores, hedonic ratings, or their interaction (all $t < .6$).

Probe classification task

The main dependent variable was the time it took participants to classify the arrow as pointing upwards or downwards as a measure of selective attention in the probe classification task. Reaction times on trials with errors and reaction times shorter than 100 ms or longer than 1500 ms were excluded from analyses (3.8%; Townshend & Duka, 2001). The data of one participant were discarded because of an exceptionally high error rate (21%). Attentional bias scores were obtained by subtracting reaction times on congruent trials from reaction times on incongruent trials. Higher scores then indicate faster reactions on probes replacing food words compared to probes replacing control words, i.e., an attentional bias for food words. These difference scores were computed separately for palatable food words and control food words for each participant.

Palatable food words

An initial test in the general linear model was conducted to examine the effect of eating restraint and hedonic ratings on attentional bias for palatable food words in both pre-exposure conditions. This analysis revealed an interaction between restraint scores and hedonic ratings of the these food words, $F(1,96) = 4.71$, $p = .03$, $\eta^2 = .05$. This two-way interaction was qualified by a three-way interaction between restraint scores, hedonic ratings and pre-exposure condition, $F(1,96) = 4.15$, $p = .04$, $\eta^2 = .04$. In order to examine the nature of this interaction and test our specific hypothesis, the effects of restraint scores and hedonic ratings on attention for palatable food were tested in the food pre-exposure and the non-food pre-exposure conditions separately.[1]

[1] Note that in both Experiments 1 and 2, pre-exposure condition did not affect restrained and unrestrained eaters' hedonic ratings of the food items, as the main effect of pre-exposure and the interaction with restraint scores on hedonic ratings were not significant (all $p > .16$). Only in Experiment 2 there was a main effect of restraint, such that restrained eaters indicated to like the palatable food items less than unrestrained eaters, $F(1,132) = 5.73$, $p = .02$.

In the food pre-exposure condition, a regression analysis using restraint scores, hedonic ratings, and their interaction as predictors revealed a significant interaction of restraint with hedonic ratings, $\beta = .38$, $t(46) = 2.92$, $p = .005$, while none of the main effects were significant. To examine the nature of this interaction, we computed simple slopes for the regression of the attentional bias scores on hedonic ratings for unrestrained eaters (one standard deviation below the mean restraint score) and restrained eaters (one standard deviation above the mean; see Aiken & West, 1991; see Fig. 1). A significant relation between hedonic ratings and attentional bias for palatable food words was observed for restrained eaters, $\beta = .54$, $t(46) = 2.95$, $p = .005$, but not for unrestrained eaters, $\beta = -20$, $t(46) = -1.12$, $p = .27$. These results indicate that for restrained eaters, attention for palatable food words increased as a function of the perceived hedonic quality of the presented food. For unrestrained eaters, hedonic ratings of the food did not influence their attentional bias scores.

In the non-food pre-exposure condition, the interaction of restraint scores and hedonic ratings was not significant, $\beta = .02$, $t(50) = .10$, $p = .92$. This pattern of results suggests that only after food pre-exposure, restrained eaters have an attentional bias for palatable food words that is dependent on the perceived hedonic quality of these food items. For unrestrained eaters, there is no association between hedonic ratings and attention for palatable food words in either pre-exposure condition.[2]

Control food words

With regard to control food items, the same analyses did not reveal the interaction of eating restraint, hedonic ratings of the control food words, and pre-exposure condition, or any significant main effects.

Error rates. An analysis of variance on the proportion of errors on the trials with palatable food words revealed a significant Restraint $\times$ Hedonic ratings interaction, $F(1,96) = 4.30$, $p = .04$, $\eta^2 = .04$, such that restrained eaters' accuracy on congruent trials increased with the perceived hedonic quality of the presented food items. The same interaction effect was found for errors on control food trials, $F(1,96) = 4.28$, $p = .04$, $\eta^2 = .04$. No other effects were significant. This suggests that restrained eaters' faster reactions on congruent trials with palatable food items were not made at the cost of accuracy.

Discussion

The present experiment revealed the expected pattern of selective attention for food: the pre-exposure to food cues elicited in restrained eaters an attentional bias for palatable food such that higher hedonic ratings of palatable food were associated with increased selective attention for these food items. For unrestrained eaters, no shifts in selective attention were observed. Moreover, both groups did not display selective attention for control food words. These results could not be attributed to differences either in the baseline accessibility of food words or the priming of items per se, since reaction times in the lexical decision task were not associated with restraint scores or hedonic ratings, and pre-exposure did not lead to a main effect on selective attention. Thus, while our priming manipulation did not show differences in semantic accessibility of the specific food items in memory, it did influence the allocation of restrained eaters' visual attention to these stimuli as a function of their hedonic value.

Taken together, the present findings offer preliminary support for our contention that the exposure to food cues leads restrained eaters to direct their attention towards food cues which are hedonically relevant.

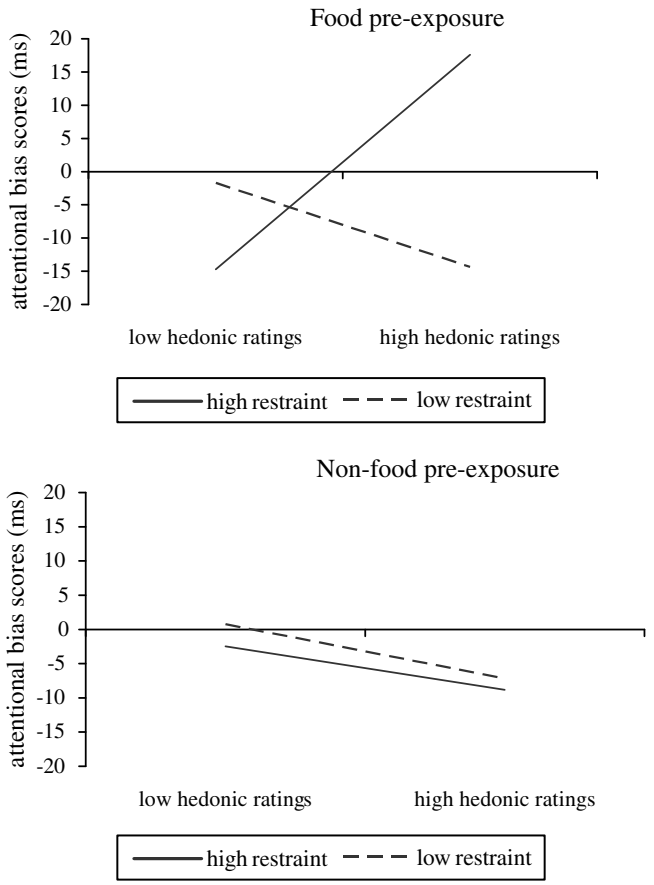

Fig. 1. Predicted attentional bias scores for palatable food words as a function of restraint scores and hedonic ratings in the food pre-exposure and non-food pre-exposure conditions. *High* and *low* values represent plus or minus one standard deviation from the respective means.

Experiment 2

The results of Experiment 1 showed that after exposure to food cues, restrained eaters allocate selective attention towards hedonically rated food. Based on the results of Papies et al. (2007), we suggest that the exposure to food cues activates hedonic thoughts in restrained eaters, which then guide their attention towards such food stimuli which match this hedonic orientation. In Experiment 2, we explore in more detail this process that might underlie restrained eaters' shifts in selective attention.

Based on previous research (Stroebe et al., 2008), we propose that the exposure to food cues disturbs the fragile balance between hedonic food thoughts and the goal of weight control that normally allows restrained eaters to regulate their eating behavior. The perception of palatable food activates restrained eaters' hedonic thoughts about food, and as a consequence, the mental representation of the conflicting dieting goal is inhibited (Stroebe et al., 2008). As a result, this goal can no longer curb the influence of the hedonic

[2] Additional analyses revealed that the predicted three-way interaction between restraint scores, hedonic ratings and pre-exposure condition was qualified by a four-way interaction with gender, $F(1,88) = 8.47$, $p < .01$, $\eta^2 = .09$. Analyses conducted separately for men and women showed that the three-way interaction between restraint scores, hedonic ratings, and pre-exposure condition was highly significant for men, $F(1,17) = 8.53$, $p = .01$, $\eta^2 = .33$, while it did not reach significance for women, $F(1, 71) = 2.03$, $p = .16$, $\eta^2 = .03$. However, consistent with our prediction, the second-order interaction between restraint scores and hedonic ratings was significant for both men and women within the food pre-exposure condition, and not in the neutral pre-exposure condition.

thoughts, and the subsequent processing of food cues is guided by hedonic thoughts rather than by the goal of dieting. We suggest that this cognitive reaction to food cues is the underlying mechanism that leads restrained eaters to allocate their attention towards such food stimuli which match their current hedonic orientation.

In order to further examine this proposed cognitive mechanism underlying restrained eaters' attention for palatable food, we set up a second study which included a priming manipulation after the pre-exposure to food cues in order to enhance the accessibility of the dieting goal and assesses its influence on restrained eaters' selective attention. If selective attention for certain food stimuli is the result of hedonic thoughts that are activated by the pre-exposure to food cues and that inhibit the dieting goal, then priming this dieting goal after the food pre-exposure should restore its effect and prevent the shifting of selective attention towards palatable food.

In this experiment, half of the participants in the food pre-exposure condition received a version of the visual probe task in which diet-related words were presented before the word pairs in order to prime the goal of dieting. The other participants were presented with control primes in the visual probe task. We reasoned that a diet prime would reinstate the dieting goal, which should then again curb the hedonic thoughts about food and preclude their influence on attentional processes (cf. Bargh et al., 2001). Therefore, in the condition where the food pre-exposure was followed by a diet prime, we expected restrained eaters to display no attentional bias for palatable food stimuli, as in the non-food pre-exposure condition. Because we were especially interested to see whether restrained eaters' self-regulatory mechanisms can be triggered nonconsciously, the diet primes were presented subliminally to prevent conscious processing. In addition, we wanted to preclude that restrained eaters become aware of the goal of the study and actively avoid the food words because of demand characteristics. Therefore, although supraliminal reminders of one's dieting goal might be effective in other situations, using a subliminal presentation technique seemed most appropriate in the context of our study.

With this extension, Experiment 2 served two main goals. Firstly, it was designed to replicate the results of Experiment 1 and confirm their robustness. Secondly, the addition of a diet prime in Experiment 2 allows us to investigate the potential for restoring the balance between hedonic thoughts and the weight control goal in chronic dieters. If, as we hypothesize, the diet prime serves to prevent the attentional bias despite the prior food pre-exposure, we have some important evidence that nonconsciously reinstating one's dieting goal might preclude the influence of hedonic thoughts on attentional processes in restrained eaters and curb the motivation to eat tempting food.

Method

Participants and design

One hundred and thirty-eight students (40 men, 98 women) of Utrecht University participated in the study for course credit or € 3. Participants were randomly assigned to one of three conditions: non-food pre-exposure, food pre-exposure, or food pre-exposure plus diet prime. Apart from this, the experimental design was the same as in Experiment 1. This resulted in a 3 (condition: non-food pre-exposure vs. food pre-exposure vs. food pre-exposure plus diet prime) × 2 (restraint: restrained vs. unrestrained) × 2 (food type: palatable vs. control) × 2 (probe location: congruent vs. incongruent) design, with the first two factors varying between participants, and the latter two factors within participants. Moreover, as in Study 1, hedonic ratings of the food items were obtained from all participants. Gender did not have a main effect, nor did it interact with the other factors. Therefore, it is not discussed any further.

Materials

The same materials were used as in Experiment 1. In addition, five words that reflect the concept of eating restraint (dieting, weight, slim, diet, losing weight) were used to prime participants in the food pre-exposure plus diet prime condition.

Procedure

Upon arrival at the laboratory, participants were seated in individual cubicles containing a desktop computer. All materials and instructions were presented on the computer. Participants were informed that the experiment consisted of several different tasks.

Lexical decision task. First, the lexical decision task was introduced, which was the same as in Experiment 1.

Probe classification task. After participants had completed the lexical decision task, the probe classification task was introduced. This task was identical to the probe task in Study 1, except that the fixation cross used in Study 1 was replaced by random letter strings in which a prime was inserted. Each trial started with a letter string that served as a fixation for 250 ms. Then, a prime was presented for 30 ms (see for a similar priming method, Aarts et al., 2005; Shah et al., 2002). In the non-food pre-exposure and food pre-exposure condition, these primes were non-word letter strings, and in the food pre-exposure plus diet prime condition, the primes were five words related to dieting. The prime was followed by a postmask letter string for 350 ms, and then by the word pair for 200 ms. After the word pair, the probe appeared and remained on the screen until participants had classified it according to its direction. The size and location of the stimuli and the number and organization of trials was the same as in Experiment 1.

After the probe classification task and a filler task, participants completed the Restraint Scale and the hedonic ratings as in Experiment 1. Participants were debriefed and probed for awareness of the primes by using a procedure similar to that suggested by Bargh and Chartrand (2000). None of the participants indicated to have noticed the appearance of words between the random letter strings. Finally, participants were paid, and thanked for their participation.

Results

Lexical decision task

In order to assess the accessibility of the palatable and neutral food words for restrained and unrestrained eaters in the food pre-exposure conditions, the reaction times for these words in the lexical decision task were analyzed with restraint scores, hedonic ratings, and their interaction as predictors. Again, all predictor variables were transformed to standardized scores before computing cross-product terms. Reaction times of incorrect responses and reaction times longer than 2000 ms were excluded from these analyses. Regression analyses revealed no significant effects (all $t < 1.2$).

Probe classification task

The main dependent variable was the time it took participants to classify the arrow as pointing upwards or downwards. Reaction times on trials with errors and reaction times shorter than 100 ms or longer than 1500 ms were excluded from analyses (3.1%). Difference scores were obtained by subtracting reaction times on congruent trials from reaction times on incongruent trials. Higher difference scores then indicate faster reactions on probes replacing food words compared to probes replacing office words, i.e., an

attentional bias for food words. These difference scores were computed separately for palatable food words and for control food words for each participant.

Palatable food words

An initial test in the general linear model was conducted to examine the effect of eating restraint and hedonic ratings of the palatable food on attentional bias scores for palatable food words in the three experimental conditions. This analysis revealed a three-way interaction between restraint scores, hedonic ratings and condition, $F(2,126) = 4.08$, $p = .02$, $\eta^2 = .06$. In order to examine this interaction effect and test our specific hypotheses, the effects of restraint scores and hedonic ratings of palatable food on attention for palatable food words were tested in the non-food pre-exposure, the food pre-exposure, and the food pre-exposure plus diet prime conditions separately.

In the food pre-exposure condition, this analysis revealed a significant interaction of restraint scores with hedonic ratings, $\beta = .39$, $t(43) = 2.71$, $p = .009$. To examine the nature of this interaction, we computed simple slopes for the regression of attentional bias scores on hedonic ratings for unrestrained eaters (one standard deviation below the mean restraint score) and restrained eaters (one standard deviation above the mean; see Aiken & West, 1991). As in Experiment 1, a significant relation between hedonic ratings and attentional bias for palatable food was observed for restrained eaters, $\beta = .67$, $t(43) = 2.68$, $p = .01$, but not for unrestrained eaters, $\beta = -32$, $t(43) = -1.48$, $p = .15$. These results show that only for restrained eaters, attention for palatable food increased as a function of the perceived hedonic quality of this food, thereby replicating the pattern of results obtained in Experiment 1. For unrestrained eaters, attention for food words was not related to hedonic ratings.

In the non-food pre-exposure condition, the interaction of restraint scores and hedonic ratings was not significant, $\beta = .17$, $t(43) = 1.01$, $p = .32$. In the food pre-exposure plus diet prime condition, this effect was also not significant, $\beta = -23$, $t(40) = -1.41$, $p = .16$. None of the main effects were significant (all $t < 1.5$). This suggests that the diet prime which was presented in the pre-exposure plus diet prime condition served to reinstate the dieting goal and thus to prevent the hedonically motivated shift of attention towards palatable food.

These results are displayed in Fig. 2. Following the suggestions of Aiken and West (1991), we present the attentional bias scores at one standard deviation below and one standard deviation above the respective means of the restraint scores and hedonic ratings.

Control food words

For the control food words, analyses did not reveal the interaction of eating restraint, hedonic ratings of the control food words and pre-exposure condition, or any significant main effects.

Error rates. In an analysis of variance on the proportion of errors on the trials with palatable food words, a significant Condition × Restraint interaction was found, $F(2,126) = 4.30$, $p = .02$, $\eta^2 = .06$, such that higher restraint scores were associated with higher accuracy on congruent trials only in the non-food pre-exposure condition, $\beta = -32$, $t(45) = -2.27$, $p = .03$, but not in the food pre-exposure and the food pre-exposure plus diet prime conditions. No significant effects were found on error rates on trials with control food words.

Discussion

Experiment 2 revealed the predicted pattern of attention for food cues among restrained and unrestrained eaters. First of all, the results of Experiment 1 were replicated by showing that the food pre-exposure triggers in restrained eaters an attentional bias for palatable food items that increases with the perceived hedonic quality of these items. When participants were not pre-exposed to food cues, restrained eaters did not differ from unrestrained eaters in the attention they allocated to food. These results are in line with our reasoning that the hedonic thoughts which palatable food elicits in restrained eaters (Papies et al., 2007) serve to guide subsequent attention towards hedonically relevant cues.

In addition, however, Experiment 2 revealed another interesting finding about attentional processes in restrained eating. The study demonstrated that restrained eaters' attentional bias for palatable food did not emerge when they were exposed to subliminally presented diet words after the pre-exposure to food cues. Although

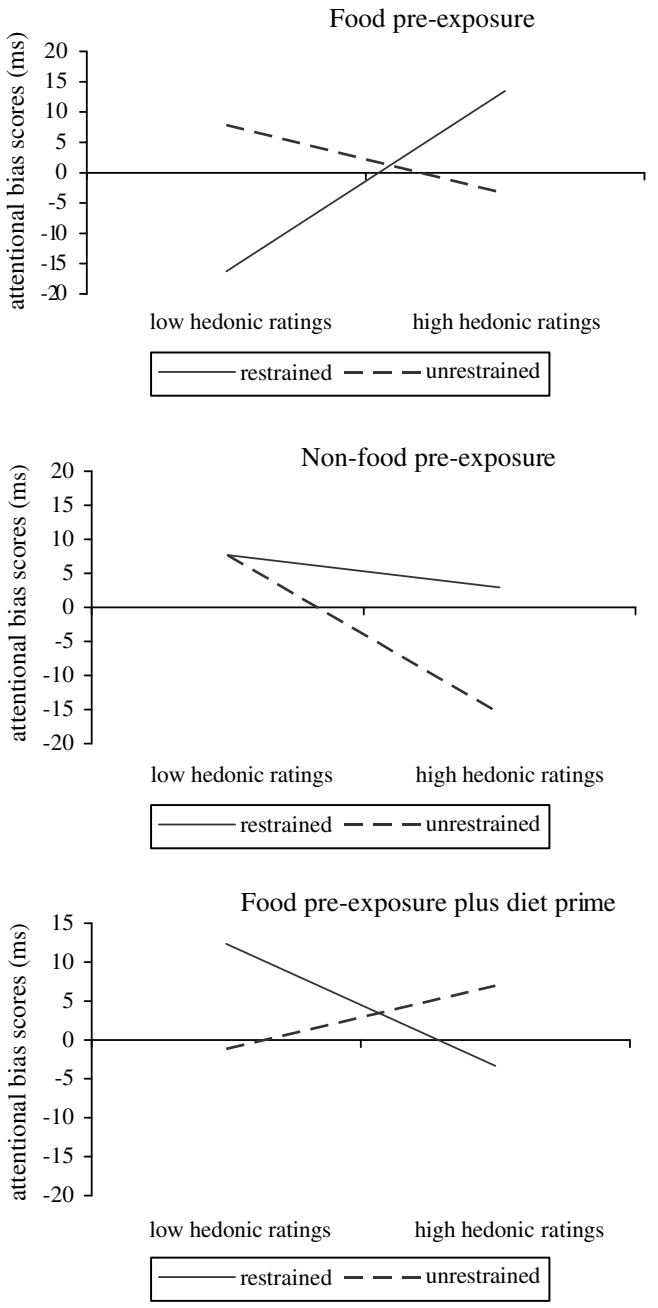

Fig. 2. Predicted attentional bias scores for palatable food words as a function of restraint scores and hedonic ratings in the food pre-exposure, non-food pre-exposure, and food pre-exposure plus diet prime conditions. *High* and *low* values represent plus or minus one standard deviation from the respective means.

the accessibility of the dieting goal was not measured directly, these findings might indicate that our priming manipulation served to reinstate restrained eaters' dieting goal and thus to reinstall the subtle balance between their hedonic thoughts and their goal of dieting, with the result that selective attention was no longer directed towards tempting food items. Taken together, the results of Experiment 2 illustrate the implicit interplay of the weight control goal and a hedonic orientation towards palatable food in the self-regulation of restrained eaters.

General discussion

The present studies examined the dynamics of restrained eaters' attention for palatable food as a function of the exposure to food cues. This way, our work extends previous research on the self-regulation of restrained eaters by focusing on the cognitive processes that potentially lead to overeating in response to tempting food cues. Taken together, our findings are consistent with the notion that restrained eaters hold two conflicting goals with respect to food, namely the goal of weight control, and the hedonic goal of eating good food (Stroebe et al., 2008). While their weight control goal in principle serves to protect restrained eaters against the lure of tempting food, this self-regulatory balance is easily disturbed by the exposure to palatable food cues, as this causes in restrained eaters enhanced accessibility of hedonic thoughts, and decreased accessibility of the conflicting weight control goal. As a result, restrained eaters' visual attention is directed towards food items which are relevant for their current hedonic orientation. However, when the conflicting dieting goal is reactivated by dieting cues, the balance between hedonic thoughts and the weight control goal is reinstalled and the hedonically motivated attentional bias disappears. The present studies illustrate how external cues can influence restrained eaters' attentional processes with regard to food stimuli, and together with previous findings which demonstrated that the perception of attractive food can lead to the inhibition of the dieting goal (Stroebe et al., 2008), offers converging evidence for the role of the accessibility of the dieting goal in restrained eaters' responses to food cues. However, in the present studies, the effects of food-related goals were assessed only indirectly by examining their impact on subsequent cognitive-motivational processes. Future studies could use more direct measures of goal activation to confirm these results.

One of the most intriguing issues that research on restrained eating is dealing with pertains to the fact that the confrontation with palatable food can easily entice restrained eaters into overeating on palatable, high-calorie foods, despite their chronic dieting goal (e.g., Fedoroff et al., 1997). The results of the present studies suggest that the exposure to food cues could influence restrained eaters by triggering an attentional bias for hedonically relevant food cues. Once such an attentional bias is triggered, it will result in the maintenance of hedonic thoughts about food since further hedonic food cues will be processed preferentially, while competing stimuli are less likely to draw attention (Franken, 2003; Lang et al., 1997). This focus on attractive, pleasurable food cues is likely to influence subsequent ingestive behavior (Mischel, Cantor, & Feldman, 1996), rendering overeating more likely. As such, the present studies could help us understand the mechanism by which external food cues can trigger restrained eaters to indulge in high-calorie, palatable food despite their chronic dieting goal.

To be sure, our studies assessed these processes in a design which was necessarily partly correlational, thus raising the question of potential covariates of restrained eating that could influence attentional processes for food. Restrained eating has not been found to be associated with more positive evaluations of food (Roefs, Herman, MacLeod, Smulders, & Jansen, 2005; Stroebe et al., 2008), so that the reported effects on attentional processes in attention are most likely not due to differences in liking. However, restrained eaters have repeatedly been found to be heavier than unrestrained eaters, even though the correlations between restraint scores and body mass index tend to be low to moderate (see Gorman & Allison (1995), for an overview). However, overweight is not associated with a hedonic motivation towards food (e.g., Roefs & Jansen, 2002). Moreover, we argue that overweight per se is unlikely to lead to the cognitive processes addressed here without implying the dieting goal as a mechanism. This is especially true for Study 2, where diet primes triggered processes of successful self-regulation in restrained eaters. Further studies should disentangle the effects of weight status and dieting concerns on attentional processes.

In other domains of health behavior, attentional biases for tempting stimuli have been used to assess individual differences in motivation, for example with respect to cigarettes, alcohol, and other addictive substances (for an overview, see Franken, 2003). Regular users of these substances have been found to allocate increased selective attention towards drug-related cues, especially when they are experiencing abstinence or cravings and are thus especially motivated to use the drug (Field et al., 2004; Mogg & Bradley, 2002; Townshend & Duka, 2001). Thus, biases in selective attention seem to reflect individual differences in motivation to obtain or consume a certain stimulus (cf. Robinson & Berridge, 2000). Similarly, in the domain of personality research, attentional biases for stimuli of immediate relevance have been studied in relation to individual differences in temperament, such as impulsivity, sensitivity to reward or extraversion. For example, individuals high in sensitivity to reward have been shown to allocate enhanced attention to cues signaling reward rather than punishment (Derryberry & Reed, 1994). Taken together, these findings support the notion that shifts in attention toward stimuli of immediate relevance reflect motivational processes stemming from rather stable individual differences, as well as in temporary differences in motivation, as individuals direct their attention automatically towards those stimuli that are relevant given their current motivational state (Lang et al., 1997).

In light of this, the current findings on attentional processes in restrained eating might reflect not only purely cognitive, but also rather implicit motivational differences with respect to palatable food, such that the exposure to food cues triggers in restrained eaters an increased motivation to consume certain palatable food items. This notion is corroborated by previous experimental evidence showing that the exposure to attractive food cues instigates in restrained eaters stronger anticipatory salivation (e.g., Brunstrom et al., 2004) and stronger urges to eat the cued food (Fedoroff, Polivy, & Herman, 2003; Harvey et al., 2005). In our reading of the present findings, the exposure to food cues triggers in restrained eaters a motivational response towards food items with a high hedonic quality, which might manifest itself as a craving to eat this food and as such have a strong impact on actual eating behavior.

As discussed so far, the present research suggests a possible mechanism underlying restrained eaters' appetitive reactions to food cues, and as such, it is instructive about the failure of self-regulation in chronic dieting behavior. However, the current findings also point out a promising avenue towards more successful dieting behavior. By confronting restrained eaters with their dieting goal, we were able to prevent the occurrence of an attentional bias for food in Experiment 2. Thus, although external food cues can have a strong impact on restrained eaters' cognitions and potentially interfere with the pursuit of their dieting goal, external cues can similarly contribute to successful self-regulation by reinstating the dieting goal, even nonconsciously, which can then keep in check the pleasure-oriented motivation to indulge in high-fat, palatable food.

A similar perspective has been proposed in recent research exploring the role of automatic processes in the regulation of eating behavior. Fishbach et al. (2003) showed that successful dieters automatically activate their dieting goal when they encounter temptations that could potentially interfere with this goal, which is a functional self-regulation mechanism. In the current studies, restrained eaters needed an external reminder of their dieting goal in order to prevent appetitive reactions to the palatable food items, possibly because the majority of restrained eaters are rather unsuccessful dieters (Gorman & Allison, 1995; Herman & Polivy, 1984). Moreover, participants in the present studies were exposed to palatable food cues repeatedly in the first phase of the experiment, which may have overruled the activation of the dieting goal even in successful dieters. This may explain why unlike the Fishbach et al. studies, the present studies showed no evidence of dieting goal activation in response to the food cue exposure. Nevertheless, when participants were primed with dieting, nonconscious self-regulation was successful.

Traditionally, the overeating of restrained eaters has mostly been explained in terms of conscious, deliberative processes, such as the "what-the-hell-cognitions" about overeating suggested by Herman and Polivy (1984), in which restrained eaters are argued to deliberately abandon their diet when they have eaten high-calorie food. In more recent research, evidence is accumulating that automatic self-regulation in the domain of restrained eating is possible, too. At the same time, there is a growing consensus that environmental cues may be of considerable influence on the eating behavior of restrained and obese individuals (Mela, 2006; Wadden et al., 2002; see also Schachter, 1968). Individuals differ with respect to the sensitivity to external cues representing palatable food (cf. Mela, 2006) and in their sensitivity to rewards in general, which might increase one's susceptibility to overweight (Franken & Muris, 2005). The present studies contribute to this new direction in eating research by examining the interplay of environmental food cues with personal goals and preferences and their influence on automatic processes that guide eating behavior.

However, the present studies are also instructive for research on the more general problem of dealing with temptations that can endanger goal pursuit, and for the recent debate about situational vs. personal control over behavior (Bargh & Chartrand, 1999; Fishbach et al., 2003; Trope & Fishbach, 2005). Our findings suggest that while the accessibility of individuals' long-term goals may in the first place equip them to ignore the presence of attractive temptations, the repeated exposure to temptation cues in the environment can trigger an attentional bias for short-term rewards at the cost of the conflicting long-term goal.

Once such a shift in attention is triggered, it becomes increasingly difficult to disengage from the attractive cues. For example, one's attempts to quit smoking might be undermined by the presence of an ashtray on a restaurant table: the perception of such a smoking cue can trigger cravings for a cigarette, which in turn can lead to increased selective attention for further smoking cues in the environment and thus to a perseverance of one's cravings and the motivation to smoke (Ehrman et al., 2002; Franken, 2003). In the case of restrained eaters, once an attentional bias for palatable food has been triggered, this will serve to continuously stimulate hedonic thoughts about food, which in turn will maintain biases in selective attention for tempting food. Thus, attentional biases in self-regulation are not only a reflection of increased motivation to gain access to a certain stimulus, they also function to reinforce this motivation by triggering a cognitive focus on the temptations that are in conflict with one's long-term goal. This way, temptation cues in a given situation can interfere with the personal control over one's goal strivings by directing attention and motivation away from one's long-term goals. Although we would like to suggest that such processes of motivated attention are likely to have a strong impact on temptation-related behavior, the present studies did not measure the behavioral effects of attentional biases. Future studies should attempt to establish direct causal links between these cognitive processes in self-regulation and behavioral outcomes.

While our discussion so far outlines a rather bleak picture for our attempts at self-control, there are also indications that situational cues can help us to resist the temptations that we may encounter during goal pursuit. In the studies presented here, the subliminal presentation of diet-related words served to reinstate restrained eaters' dieting goal despite the presence of attractive food cues, and this overriding goal prevented the shift of selective attention towards the conflicting temptations. This result is consistent with recent research on automatic self-regulatory processes showing that goal primes inhibit alternative goals and temptations (Aarts, Custers, & Holland, 2007; Fishbach et al., 2003, Study 2; Shah et al., 2002), a mechanism that has been termed goal shielding (Shah et al., 2002). While earlier studies have provided evidence for goal shielding by showing that the activation of a focal goal causes alternative goals to become less accessible in memory, our findings corroborate this mechanism by showing that alternative, short-term goals cease to trigger hedonically motivated processes when a conflicting long-term goal has been primed. In conclusion, the present experiments serve to advance our understanding of the processes by which the abundance of luring temptations in our environment threaten to pull us off our path of successful self-regulation, and how we can shield our long-term goals in order to prevent this.

Appendix

Concern for Dieting Subscale of the Revised Restraint Scale (Herman & Polivy, 1980). For the present studies, a Dutch translation of this scale was used (Jansen, Oosterlaan, Merckelbach, & van den Hout, 1988).

1. How often are you dieting?
2. Do you have feelings of guilt after overeating?
3. Do you eat sensibly in front of others and splurge alone?
4. Do you give too much time and thought to food?
5. Would a weight fluctuation of 5 lb affect the way you live your life?
6. How conscious are you of what you are eating?

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