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## Through the eyes of dieters: Biased size perception of food following tempting food primes

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## ABSTRACT

Why do some dieters succeed in controlling their diet while others do not? This research focused on a perceptual process—size perception of food objects—that may moderate the success of dieters in self-control dilemmas. We assessed successful and unsuccessful dieters' size perception of palatable food (Study 1) and diet-food (Study 2) after pre-exposing them to tempting food primes. Dieters perceived palatable food as bigger when primed with tempting food (vs. control prime), regardless of self-regulatory success in dieting (Study 1). Palatable food thus looms larger for both unsuccessful and successful dieters when in a “hot” state. In contrast, the perceived size of diet-food was increased by a tempting food prime only for successful dieters, but decreased for unsuccessful dieters (Study 2). These results are interpreted in terms of differences in the mental accessibility of competing goals (eating enjoyment vs. dieting) in successful vs. unsuccessful dieters. Indeed, when the dieting goal was made accessible for all dieters by a diet prime, even unsuccessful dieters perceived diet-food as bigger (Study 2). This research provides insight into a perceptual process that may be detrimental or beneficial in resolving self-control conflicts in the domain of eating and dieting behavior—and probably other domains of self-control as well.

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Tempting alternatives promising immediate satisfaction often challenge people's striving for higher-order goals that offer long-term benefits. Resolving this conflict in favor of the long-term goal requires self-control (e.g., Baumeister & Heatherton, 1996; Metcalfe & Mischel, 1999). This is often difficult as the long-term goal must be sufficiently attractive and accessible to win the competition with the short-term temptation (Logan, 1988). An area in which temptations seem particularly likely to interfere with people's self-control is the domain of eating and dieting behavior.

Although many people try to control their body weight by restricting food intake, most fail in the long term (Mann et al., 2007). One group, which seems especially unsuccessful in controlling their food intake are chronic dieters (i.e., restrained eaters; Herman & Polivy, 1980). Chronic dieters are people who continuously monitor their food intake, but are highly responsive to external food cues which easily disrupt their eating regulation (Herman & Polivy, 1980). For instance, they are more likely to overeat after exposure to tempting food cues such as the sight, smell, or taste of palatable food (e.g., Fedoroff, Polivy, & Herman, 1997; Jansen & Van den Hout, 1991). However, not all dieters fail in their attempts to resist temptations (Fishbach, Friedman, & Kruglanski, 2003; Papiés, Stroebe, & Aarts, 2008b).

At this point, little is known about why some dieters are more successful than others. Therefore, the aim of this paper is to advance our knowledge about the self-control of successful and unsuccessful dieters by focusing on a process that has so far not been investigated, namely size perception of food objects. As will become clear later, size perception reflects the perceived instrumentality of goal-relevant objects, and thereby offers insight on how basic perceptual processes may moderate the success of dieters in regulating food intake in the context of a self-control dilemma. Objects that are perceived to be larger are more easily detected in the environment, and as such facilitate goal attainment. Therefore, goals and size perception of instrumental objects are supposed to be associated. Before elaborating on this issue, we first address how food temptations influence dieters' self-control.

## Food temptations and dieters' goal pursuit

Recent explanations of self-regulatory failures of dieters increasingly acknowledge that eating in food-rich environments is predominantly driven by anticipated pleasure rather than people's need for calories (e.g., Lowe & Butryn, 2007). According to the goal conflict model of eating (Stroebe, 2008; Stroebe, Mensink, Aarts, Schut, & Kruglanski, 2008), dieters' difficulty in resisting food temptations results from a conflict between two incompatible goals, namely the goal of eating enjoyment and the goal of dieting. The dieting goal normally helps them to restrain their eating behavior. However, environmental cues signaling palatable food have a strong positive

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incentive value for dieters and prime the eating enjoyment goal. As a result of continued priming, the eating enjoyment goal becomes the focal goal and the mental representation of the (conflicting) dieting goal is inhibited (Shah, Friedman, & Kruglanski, 2002), making dieters vulnerable to self-regulatory failure. Research confirms that for dieters exposure to tempting food cues triggers hedonic thoughts and affective responses to palatable food rendering the eating enjoyment goal highly accessible (Hofmann, Van Koningsbruggen, Stroebe, Ramanathan, & Aarts, 2010; Papies, Stroebe, & Aarts, 2007), inhibits the mental representation of the dieting goal (Stroebe et al., 2008), and elicits an attentional bias for palatable food (Papies, Stroebe, & Aarts, 2008a).

However, a subgroup of dieters appears successful in regulating their food intake. Current research on temptations and goal pursuit suggests that for some people temptations increase the cognitive accessibility of long-term goals typically undermined by these temptations (Fishbach et al., 2003). According to this theory of temptation-elicited goal activation, such a facilitative link between temptation and goal develops when people repeatedly and successfully exert self-control in tempting situations (e.g., saying no when offered a piece of cake at a birthday party). Indeed, research has shown that whereas tempting food cues inhibit the dieting goal in unsuccessful dieters, they activate this long-term goal in successful dieters (Papies et al., 2008b).

It would have been plausible to assume that successful dieters also suppress the eating enjoyment goal triggered by tempting food cues. However, successful and unsuccessful dieters do not differ in the extent to which exposure to tempting food cues triggers hedonic thoughts (Van Koningsbruggen, Stroebe, & Aarts, 2009). Paradoxically, successful dieters are not successful because they suppress eating enjoyment, but because the activation of eating enjoyment also activates their dieting goal (Papies et al., 2008b). Thus, successful dieters are no less tempted by palatable food than are unsuccessful dieters. But in contrast to unsuccessful dieters, they resist the temptation by keeping their super-ordinate goal of dieting in mind.

In terms of action control theories (e.g., Logan, 1988, 1989; Norman & Shallice, 1986), the goal conflict model of eating can be conceptualized as a “battle” between the eating enjoyment goal and dieting goal in determining action in dieters. The goal representation which receives the highest level of mental accessibility guides subsequent perception and behavior. Whereas for unsuccessful dieters the representation of eating enjoyment is most accessible and guides behavior, the dieting goal is most accessible for successful dieters. In this article, we examine the implications of this battle on dieters' size perception of food.

### Goal pursuit and functional size perception

Research on functional perception (Bruner, 1957) suggests that tempting food cues that trigger the eating enjoyment goal in dieters may not only result in biased allocation of attention to palatable food (Papies et al., 2008a), but may also affect dieters' size perception of food. Although size perception of objects is determined by objective factors, such as retinal image size, distance, angle, and contextual cues (Kaufman & Rock, 2001; Rookes & Willson, 2000), people also perceive objects that are functional in attaining their goals (i.e., means) as bigger when motivated to attain these goals (Bruner, 1957). To perceive objects that are means for reaching important goals as larger in size is highly functional, because it facilitates the ease with which such objects can be identified in the environment thereby increasing the likelihood of using the object for attaining one's goals.

Consistent with the functional size perception hypothesis, several studies established the basic link between people's motivation to attain desired goals and increased size perception of goal-relevant objects (Aarts, Custers, & Veltkamp, 2008; Brendl, Markman, & Messner, 2003; Bruner & Goodman, 1947; Bruner & Postman, 1948;

Veling & Aarts, 2009; Veltkamp, Aarts, & Custers, 2008). It has been shown that increased size perception of goal-relevant objects is the result of a top-down process that requires a goal to be accessible. For instance, Veltkamp et al. (2008, Study 1) asked participants to estimate the size of an object as displayed on a picture: Participants were then shown the picture of a glass of water. Results indicated that participants, who were motivated to drink, perceived the glass of water as bigger in size, but only when primed with the goal of drinking. For most people, a glass of water is not a very valued commodity. However, as Lewin (1935) emphasized, objects are perceived as positive or negative to the extent that they support or hinder active goals. Thus, by making the goal of drinking highly accessible to thirsty people, the glass of water became a valued means towards the goal of reducing thirst.

Although perceived instrumentality and perceived value are typically correlated, we would argue that size perception is influenced by the perceived instrumentality of an object for reaching an accessible goal rather than its perceived value. We propose that when a goal becomes highly accessible, people will automatically attend to objects instrumental in attaining their goal and scan their environment for potential means to reach that goal. Their attention will become attached to objects that on the basis of past experience can be considered as potential means and these objects will loom larger. As long as there are suitable objects in memory and/or their proximal environment, this whole sequence is likely to unfold automatically (Aarts, Custers, & Marien, 2008). Although objects which serve as means for reaching an important goal are likely to be valued, it is important to note that it is their value as *instruments* of goal achievement rather than value per se which is responsible for size accentuation. Thus, Veltkamp et al. (2008, Study 2) manipulated the value of *goals* by classically conditioning previously neutral goals either positively or negatively, while keeping goal accessibility constant. They then tested effects on size perception of objects that were instrumental for reaching a specific goal. They showed that, whereas the size of objects that were instrumental for reaching goals associated with positive affect (i.e., positive value) was increased, the size perception of objects instrumental for reaching goals associated with negative affect (i.e., negative value) remained unaffected (compared to a neutral control condition). It was not the perceived value of goal-instrumental objects but their *perceived instrumentality* for reaching *valued* goals that affected size perception.

Because for dieters, tempting food cues activate the eating enjoyment goal (Hofmann et al., 2010; Papies et al., 2007), palatable food should be highly functional in the service of their goal pursuit (cf. Bruner, 1957). Accordingly, in Study 1 we tested the idea that dieters may differently perceive the size of palatable food depending on whether the eating enjoyment goal has been activated by pre-exposure to tempting food cues. Participants estimated the size of a muffin because a pilot study confirmed that a muffin was perceived as food functional in attaining the eating enjoyment goal.

However, even though such pre-exposure elicits the eating enjoyment goal in *all* dieters, it has a differential impact on the accessibility of the dieting goal (e.g., Fishbach et al., 2003): Pre-exposure *decreases* the accessibility of dieting thoughts in unsuccessful dieters but *increases* their accessibility in successful dieters. Thus, for successful dieters, diet-food should be highly functional in the service of their goal pursuit. Accordingly, tempting food cues may perceptually accentuate food objects that are functional in attaining the goal of dieting—leading to increased size perception of diet-food—depending on self-regulatory success. In Study 2, we put this idea to the test by letting participants estimate the size of an apple—food perceived as functional in attaining the dieting goal according to our pilot study.

According to the goal conflict model of eating (e.g., Stroebe, 2008), eating enjoyment is not an important goal for normal eaters. Consistent with this assumption, there is empirical evidence that pre-

exposure to tempting food cues does not influence normal eaters' hedonic thoughts (Papies et al., 2007), accessibility of their dieting goal (e.g., Stroebe et al., 2008) or consumption of palatable food (e.g., Fedoroff et al., 1997). We therefore expect that pre-exposure to tempting food cues would not affect normal eaters' size perception of food.

## Study 1

Study 1 was designed to provide an initial test of our hypothesis that pre-exposure to tempting food cues would affect basic perceptual processes in dieters. We hypothesized that dieters—both successful and unsuccessful—would perceive palatable food as bigger, but only if the eating enjoyment goal had been activated through exposure to tempting food cues.

Participants were exposed to a tempting food or control prime prior to estimating the size of a food object functional in attaining the goal of eating enjoyment (chocolate muffin). The tempting food prime was expected to activate the eating enjoyment goal in (successful and unsuccessful) dieters, but not in normal eaters. According to the functional size perception hypothesis (Bruner, 1957), we predicted that primed dieters should then perceive the muffin as bigger since a muffin is highly functional in attaining dieters' goal of eating enjoyment. Without activation of the goal of eating enjoyment, the muffin would not be goal-relevant even to dieters. There should therefore be no size accentuation without priming. Because pre-exposure to tempting food cues does not influence normal eaters (e.g., Fedoroff et al., 1997), enhanced size perception of the muffin should not occur among normal eaters. Finally, we assessed perceived value of the muffin to rule out changes in mere value as an explanation for differences in size perception.

## Methods

### Design and participants

This study used a prime condition (food vs. control) between-subjects design, with dietary restraint and perceived self-regulatory success in dieting as continuous variables. In return for lottery tickets, 113 participants—24 males, 89 females ( $M_{\text{age}} = 28.72$  years,  $SD_{\text{age}} = 8.79$  years)—were randomly assigned to the food or control prime condition. Gender did not affect the results reported below.

### Independent variables

#### Prime condition

To activate the eating enjoyment goal, participants in the food prime condition were shown a cover of a culinary magazine depicting a tasty dessert. In the control prime condition, participants were shown a cover of a gardening magazine not containing any food cues. These stimuli were adopted from previous research in which it was shown that this type of food (vs. control) prime increases the accessibility of hedonic thoughts (i.e., eating enjoyment goal) for dieters (Van Koningsbruggen et al., 2009).

#### Restraint scale

Dietary restraint was assessed with the Concern for Dieting subscale of the Revised Restraint Scale (Herman & Polivy, 1980). Participants also reported their body weight and height.

#### Perceived self-regulatory success

We assessed perceived self-regulatory success in dieting by asking participants to indicate on a 7-point scale how successful they were in losing weight, watching their weight, and how difficult they found it to stay in shape ( $\alpha = .65$ ; Fishbach et al., 2003).

### Size perception measure

Participants were informed that they would see a picture on the screen and that their task was to estimate the size of the object as it was presented on the screen (i.e., its height). The object was not specified beforehand, the picture of the chocolate muffin just appeared on the next screen, and participants could type their size estimation in centimeters with two decimals. The procedure was similar to previous research on goals and size perception (e.g., Veltkamp et al., 2008).

### Perceived value

We assessed perceived value of the muffin by asking participants to indicate on a 7-point scale how attractive the chocolate muffin was for them at that moment (1 = not at all attractive, 7 = very attractive).

### Procedure

To get a wider range of chronic dieters than typical among university students, we conducted this study via the Internet. Participants were informed that they would participate in several unrelated studies, and were told that the first study was concerned with people's impressions of magazine covers. They were then shown the magazine cover that contained the food or control prime and answered six filler questions to bolster our cover story. They then continued with the next study that was announced as a basic study on size estimation where participants provided their size estimation of the muffin. Finally, participants filled out the question assessing perceived value, followed by the restraint and perceived self-regulatory success in dieting scales.

## Results

Means, standard deviations and correlations for the study variables are presented in Table 1. Restraint correlated negatively with self-regulatory success and positively with Body Mass Index (BMI), suggesting that, on average, chronic dieters are rather unsuccessful. Self-regulatory success, however, correlated negatively with BMI, confirming that dieters can be successful in their dieting attempts. These results are consistent with previous findings (Papies et al., 2008b).

The size estimations were analyzed in the General Linear Model (GLM) as a function of prime condition (food vs. control), restraint and success (both mean centered), and all interactions. The analysis revealed a significant Prime  $\times$  Restraint interaction,  $F(1, 105) = 5.38$ ,  $p < .05$ ,  $\eta_p^2 = .05$ , while none of the main or other interaction effects were significant. To test our hypothesis, we examined the effect of priming for dieters and normal eaters separately (+1 SD vs. -1 SD of the mean of restraint; Aiken & West, 1991). For dieters, the effect of priming was significant,  $B = 3.60$ ,  $t(109) = 2.71$ ,  $p < .01$ ,  $\eta_p^2 = .06$ , indicating that dieters in the food prime condition perceived the muffin as bigger than dieters in the control prime condition. As expected, the effect of priming was not significant for normal eaters,  $B = -1.79$ ,  $t(109) = -1.22$ ,  $p = .23$ ,  $\eta_p^2 = .01$ . Fig. 1 displays the

**Table 1**  
Means, standard deviations, and correlations between Study 1 variables.

	M	SD	1	2	3	4	5
1. Perceived size	10.27	5.03	–				
2. Perceived value	5.31	1.80	.06	–			
3. Restraint (concern for dieting)	6.61	3.57	.12	.01	–		
4. Self-regulatory success	3.94	1.22	–.05	.14	–.33**	–	
5. Body Mass Index	22.84	3.26	.05	–.04	.48**	–.45**	–

\*\*  $p < .001$ .



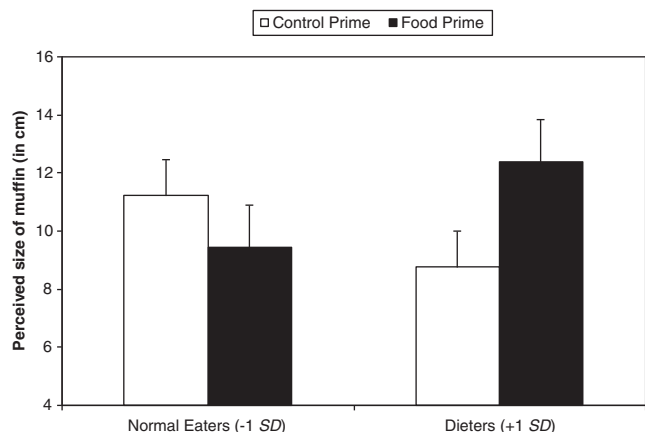


Fig. 1. Perceived size of the muffin as a function of prime condition and dietary restraint. Error bars represent the standard error.

pattern of means for the interaction.<sup>1</sup> Similar analyses on perceived value yielded no significant effects ( $F_s < 1$  to 2.64,  $p_s = .89$  to .11, all  $\eta_p^2 < .03$ ).

### Discussion

The findings demonstrate that pre-exposure to tempting food cues perceptually accentuates palatable food for dieters. After pre-exposure, dieters perceived the muffin as bigger. Normal eaters' size perception of the muffin was not influenced by the pre-exposure treatment. In line with earlier findings (Papies et al., 2007; Van Koningsbruggen et al., 2009), we would argue that by triggering hedonic thoughts about the pleasure of eating palatable food, tempting food cues activate the eating enjoyment goal in all dieters. Because a muffin is a means for attaining the goal of eating enjoyment, the size of the muffin becomes accentuated for these dieters. Thus, consistent with the functional perception hypothesis (Bruner, 1957) and extending previous research on goals and size perception (Aarts et al., 2008; Veltkamp et al., 2008), these dieters perceive the muffin as bigger than dieters for whom eating enjoyment had not been primed. Supporting the idea that successful dieters are no less tempted by palatable food than are unsuccessful dieters (Van Koningsbruggen et al., 2009), enhanced size perception was observed regardless of success. Since the independent variables did not influence perceived value, it seems unlikely that perceived value accounts for the present findings.

### Study 2

Study 1 demonstrated that pre-exposure to tempting food cues increases the perceived size of palatable food for all dieters. The aim of Study 2 is to extend these findings by investigating whether self-regulatory success in dieting moderates the effect of food priming on dieters' size perception of diet-food. This hypothesis is based on research suggesting that temptations increase the cognitive accessibility of the dieting goal for a subgroup of dieters, namely those who are successful in their dieting efforts (Fishbach et al., 2003; Papies et al., 2008b). Diet-food (e.g., an apple) would be highly functional for this subgroup of dieters in attaining their focal goal. Based on the functional size perception hypothesis (Bruner, 1957) and the results

<sup>1</sup> We also examined the effect of restraint per condition. In the food prime condition, the analysis showed a significant effect of restraint ( $B = 0.41$ ,  $t(60) = 2.43$ ,  $p < .05$ ,  $\eta_p^2 = .09$ ): Dieters perceived the muffin as bigger than normal eaters. As expected, the effect of restraint was not significant in the control prime condition ( $B = -0.34$ ,  $t(49) = -1.61$ ,  $p = .11$ ,  $\eta_p^2 = .05$ ).

of Study 1, we therefore predicted that tempting food cues would increase the perceived size of diet-food for successful dieters.

For unsuccessful dieters, diet-food mismatches the eating enjoyment goal triggered by the food prime. Since diet-food would not constitute a suitable means for attaining the goal of eating enjoyment (in fact, diet-food is in a sense dysfunctional), we would expect a decrease in the perceived size of such food. Decreased size perception of diet-food could be seen as functional in the sense that it makes goal-dysfunctional objects less likely to detect among other objects in the environment, thereby decreasing the likelihood that these objects interfere with the attainment of the eating enjoyment goal. This finding would not only be consistent with theorizing about the devaluation of objects that do not satisfy an activated need (Brendl et al., 2003), it would also be consistent with neuroscientific research suggesting that goal-relevant objects are allocated more processing resources in the visual cortex, while dysfunctional objects are inhibited (e.g., Bundesen, Habekost, & Kyllingsbæk, 2005; Serences, 2008). This may lead to increased size perception of goal-relevant objects and decreased size perception of goal-dysfunctional objects.

We also included a condition in which we primed participants with the concept of dieting. If the difference in size perception between unsuccessful and successful dieters is due to the fact that exposure to tempting food cues decreased the accessibility of the dieting goal in unsuccessful dieters (while increasing it in successful ones), explicitly priming dieting should eliminate this difference. By making the dieting goal highly accessible even in unsuccessful dieters, priming should increase the size perception of diet-food for all dieters, regardless of self-regulatory success. Similar to Study 1, we predicted that normal eaters' size perception of diet-food would not be influenced by the primes.

### Methods

#### Design and participants

This study used a prime condition (food vs. diet vs. control) between-subjects design, with dietary restraint and perceived self-regulatory success in dieting as continuous variables. In return for lottery tickets, we randomly assigned 140 participants—30 males, 110 females ( $M_{\text{age}} = 32.95$  years,  $SD_{\text{age}} = 14.86$  years)—to one of three priming conditions. Gender did not affect the results reported below.

#### Independent variables

##### Prime condition

Participants in the food and control prime conditions were shown the same materials as in Study 1. In the diet prime condition, participants were shown a cover of a dieting magazine with headlines concerning dieting and being slim to activate the dieting goal.

##### Restraint scale

Participants completed the same scale used in Study 1 to assess dietary restraint, and also reported their body weight and height.

##### Perceived self-regulatory success

The same scale used in Study 1 served as our measure of perceived self-regulatory success in dieting ( $\alpha = .66$ ).

##### Size Perception measure

The size perception measure was similar to the one used in Study 1, with the exception that participants now estimated the size of an apple.

##### Procedure

The procedure was similar to Study 1.

**Table 2**  
Means, standard deviations, and correlations between Study 2 variables.

	M	SD	1	2	3	4
1. Perceived size	12.34	3.80	–			
2. Restraint (concern for dieting)	6.14	2.91	.10	–		
3. Self-regulatory success	4.25	1.23	.04	–.28*	–	
4. Body Mass Index	23.56	3.93	–.11	.23*	–.48**	–

\*  $p < .01$ .  
\*\*  $p < .001$ .

**Results**

Means, standard deviations and correlations for the study variables are presented in Table 2. Similar to Study 1, restraint correlated negatively with self-regulatory success and positively with BMI, whereas self-regulatory success correlated negatively with BMI.

The size estimations were submitted to a GLM analysis with prime condition (food vs. diet vs. control) as between-subjects factor, restraint and success (both mean centered) as continuous variables, and all interactions. This analysis revealed a main effect of restraint,  $F(1, 128) = 5.69, p < .05, \eta_p^2 = .04$ , and a near-significant interaction between prime and restraint,  $F(2, 128) = 2.63, p < .08, \eta_p^2 = .04$ . These effects were qualified by a significant Prime  $\times$  Restraint  $\times$  Success interaction,  $F(2, 128) = 3.37, p < .05, \eta_p^2 = .05$ . To test our hypotheses, we examined the effects of priming and success for dieters (+1 SD) and normal eaters (–1 SD) separately.

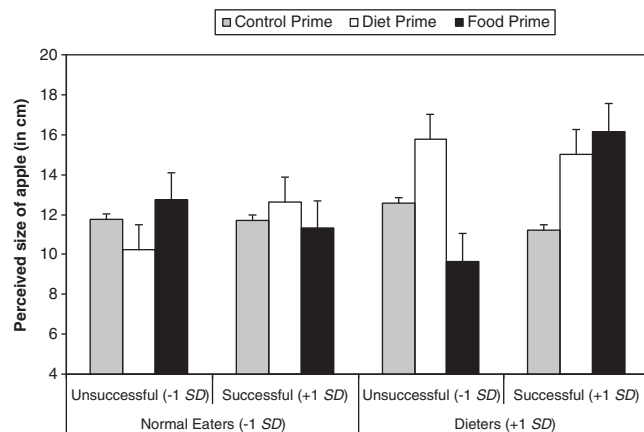
For dieters, the analysis revealed a main effect of priming,  $F(2, 128) = 4.41, p < .05, \eta_p^2 = .06$ . However, this effect was moderated by a significant Prime  $\times$  Success interaction,  $F(2, 128) = 4.22, p < .05, \eta_p^2 = .06$ . For successful dieters (one SD above the mean of success), the effect of priming was significant,  $F(2, 128) = 3.28, p < .05, \eta_p^2 = .05$ . Contrast analyses showed that successful dieters perceived the apple as bigger compared to the control prime condition both when primed with tempting food,  $B = 4.94, t(128) = 2.32, p < .05, \eta_p^2 = .04$ , and with dieting,  $B = 3.81, t(128) = 1.95, p = .05, \eta_p^2 = .03$ . For unsuccessful dieters (one SD below the mean of success), the effect of priming was also significant,  $F(2, 128) = 6.46, p < .01, \eta_p^2 = .09$ . Compared to the control prime condition, unsuccessful dieters perceived the apple as smaller when primed with tempting food,  $B = -2.92, t(128) = -2.08, p < .05, \eta_p^2 = .03$ , but as bigger when primed with dieting,  $B = 3.20, t(128) = 2.01, p < .05, \eta_p^2 = .03$ .

As expected, for normal eaters, the analyses revealed no significant effects. Fig. 2 displays the pattern of means for the three-way interaction.<sup>2</sup>

**Discussion**

The results of Study 2 support our prediction that perceived self-regulatory success in dieting moderates the effect of food priming on dieters' size perception of diet-food. Based on recent theorizing about the role of processes of self-regulatory success in dieting (Fishbach et al., 2003; Papies et al., 2008b), we predicted that tempting food primes would increase the accessibility of the long-term dieting goal in successful, while decreasing accessibility in unsuccessful dieters. With both eating enjoyment and dieting goals activated, successful dieters should consider an apple as functional for satisfying both

<sup>2</sup> We also examined the effects of restraint and success per condition. In the food prime condition, the analysis showed a significant Restraint  $\times$  Success interaction ( $B = 0.55, t(42) = 2.11, p < .05, \eta_p^2 = .10$ ). For dieters (+1 SD), the effect of success was significant ( $B = 2.65, t(42) = 2.59, p < .05, \eta_p^2 = .14$ ): Successful dieters perceived the apple as bigger than unsuccessful dieters. As expected, for normal eaters (–1 SD), the effect of success was not significant ( $B = -0.58, t(42) < 1, p = .51, \eta_p^2 = .01$ ). In the diet prime condition, the analysis only showed the expected main effect of restraint ( $B = 0.68, t(39) = 3.37, p < .01, \eta_p^2 = .23$ ): Dieters perceived the apple as bigger than normal eaters. As expected, in the control prime condition, the analysis revealed no significant effects (all  $t$ 's < 1).



**Fig. 2.** Perceived size of the apple as a function of prime condition, dietary restraint and success. Error bars represent the standard error.

goals. Consistent with the functional size perception hypothesis (Bruner, 1957), successful dieters perceived the apple as bigger in size after the pre-exposure treatment. In contrast, unsuccessful dieters solely geared for the goal of eating enjoyment, should consider an apple dysfunctional for satisfying their goal. It is therefore consistent with the functional size perception hypothesis that they perceived the apple as smaller after pre-exposure. Additionally, the present findings show that temporarily heightening the accessibility of the dieting goal can increase the perceived size of diet-foods for dieters as a whole. In the diet prime condition, dieters perceived the apple as bigger independent of self-regulatory success in dieting.

**General discussion**

Our research examined successful and unsuccessful dieters' size perception of palatable (Study 1) and diet-related food (Study 2) as a function of pre-exposure to tempting food cues. By focusing on a perceptual process that may moderate the success of dieters in regulating food intake, the results of these studies add to our understanding of the possible processes that differentiate successful from unsuccessful dieters. Currently, not much is known about why some dieters are more successful than others. Demonstrating a link between self-regulatory success in dieting and size perception of food objects when dieters are brought into a "hot" state by pre-exposure to tempting food stimuli sheds further light on the dynamic relationship between dietary restraint and the regulation of food intake.

Study 1 showed that both successful and unsuccessful dieters perceive palatable food as bigger in size when primed with tempting food. These findings are consistent with the goal conflict model of eating and earlier research (e.g., Papies et al., 2007; Stroebe et al., 2008). We would argue that the tempting food stimuli presented in our pre-exposure manipulation triggered hedonic thoughts about palatable food in all dieters and thus increased the accessibility of the eating enjoyment goal (cf. Hofmann et al., 2010; Papies et al., 2007). Because the muffin constituted a means for satisfying their eating enjoyment goal, these dieters perceived it as bigger than did dieters who had not been primed. This finding is in line with the functional size perception hypothesis (Bruner, 1957) that predicts that people perceive objects that are functional in attaining a specific goal as bigger when motivated to attain this particular goal. That activation of the eating enjoyment goal increased the perceived size of the muffin for both successful and unsuccessful dieters confirms earlier findings that tempting food cues trigger the eating enjoyment goal in dieters, regardless of success (e.g., Van Koningsbruggen et al., 2009). The observed size accentuation may be one of the mechanisms by which tempting food cues undermine dieters' self-control (e.g., Fedoroff et al., 1997; Jansen & Van den Hout, 1991). Because this perceptual

accentuation facilitates the detection of palatable food in their environment, it increases the likelihood of consuming this food. The hedonic response to palatable food appears not to be moderated by self-regulatory success.

When participants assess the size of diet-food (i.e., an apple), a different pattern of findings can be expected. Even though priming with tempting food cues elicits the eating enjoyment goal in all dieters, the impact on dieting goal accessibility depends on self-regulatory success in dieting (Fishbach et al., 2003; Papies et al., 2008b): While inhibiting dieting thoughts in unsuccessful dieters, tempting food primes increase the accessibility of dieting thoughts in successful dieters. Thus, with the goals of eating enjoyment and dieting both highly accessible, these successful dieters should perceive the apple as a means of satisfying both goals. In contrast, unsuccessful dieters, who inhibit dieting thoughts in response to exposure to tempting food cues, should experience a mismatch between the apple and the hedonic thoughts triggered by the food prime. A healthy apple cannot be considered an appropriate means for satisfying unsuccessful dieters' desire to eat pleasant food. Study 2 confirmed this prediction by showing that the tempting food prime increased the perceived size of an apple for successful dieters, but decreased it for unsuccessful dieters.

This latter finding extends previous research on goals and size perception (Aarts et al., 2008; Veltkamp et al., 2008) by showing that people decrease the perceived size of objects that are dysfunctional in attaining desired goals. Perceiving dysfunctional objects as smaller preserves processing resources in the visual cortical stream involved in the identification and utilization of goal-relevant objects (e.g., Serences, 2008), thereby reducing the probability that perception of dysfunctional objects interferes with goal attainment. Additionally, when dieting was explicitly primed in Study 2, the previously observed differences between successful and unsuccessful dieters on size perception of diet-food were eliminated and unsuccessful dieters' size perception mirrored that of successful dieters. This finding offers corroborating evidence for the role of dieting goal accessibility in effective self-control among dieters (Shah et al., 2002; Stroebe et al., 2008).

Whereas our research did not directly examine the mechanism underlying these differences in size perception, neuroscientific studies suggest that this may be caused by more allocation of processing resources to goal-relevant objects in the visual cortex, while dysfunctional objects are inhibited (e.g., Bundesen et al., 2005; Serences, 2008). Additionally, the idea that the aspect responsible for the size accentuation effects is not mere value but perceived instrumentality of the object as a means for reaching an activated goal is strengthened since Study 1 ruled perceived value out as an explanation (see also Veltkamp et al., 2008, Study 2). This is further corroborated by a study that demonstrated that successful and unsuccessful dieters do not differ in their implicit evaluation of diet-food after being primed with tempting food cues (Van Koningsbruggen et al., 2010).

Alternatively, one may argue that the results are driven by mere exposure: Did participants in Study 1 perceive the muffin as bigger because they had recently seen a tempting dessert on the magazine cover (food prime) or not (control prime) making the muffin more familiar? On a related note, the culinary magazine cover might have worked as a contextual cue, making the muffin more contextually relevant to what participants had seen earlier. However, these explanations seem unlikely since Study 2 showed size accentuation effects following a diet prime that did not involve pictures of food or other food cues. Nevertheless, more directly disentangling the mechanisms responsible for the differences in size perception constitutes an important agenda for future studies.

So why do some dieters succeed in controlling their diet while others do not? Our findings suggest that successful dieters resist the temptation of eating palatable food by keeping their super-ordinate

goal of dieting in mind, which subsequently influences perceptual processing of food objects that serves this goal. Standing in front of a buffet, both successful and unsuccessful dieters would like to enjoy a chocolate muffin. But whereas activation of the eating enjoyment goal reduces the perceived size of the diet alternatives on offer for unsuccessful dieters, the diet-related alternatives will be perceptually accentuated for successful dieters rendering healthy alternatives more likely to be attended to and easier to find. This way, biased size perception, as part of its functional link with attention and behavior, helps successful dieters to accomplish their dieting goal. Unsuccessful dieters, on the other hand, are less likely to resist the temptation of eating the chocolate muffin, as they are less likely to attend to and find healthy alternatives on the same buffet. These findings shed further light on how perceptual processes can be detrimental or beneficial in resolving self-control conflicts in the domain of eating and dieting behavior—and probably other domains of self-control as well.

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