NO EVIDENCE FOR A FOOD-RELATED ATTENTION BIAS AFTER THOUGHT SUPPRESSION

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The aim of this study was to investigate whether food-related thought suppression results in an attention bias for food cues. Fifty-nine female students took part in the experiment. All completed a modified exogenous cueing task containing pictures of foods and toys with a similar valence (presentation duration: 250 ms and 1050 ms). Half of the participants were instructed to suppress thoughts about food and the other half was given control instructions, prior to completing the exogenous cueing task. No evidence was found for an enhanced cue validity effect for food cues after food-related thought suppression. Hence, the preliminary results do not provide support for the hypothesis that thought suppression is sufficient to yield an attention bias. Since the study was the first to employ an exogenous cueing task to study the attentional processing of food cues, replication is warranted.

Introduction

The past two decades, research has increasingly acknowledged the role of cognitive processes in the aetiology and maintenance of eating problems and weight control behaviours (Faunce, 2002; Lee & Shafran, 2004). These studies are embedded within one of the leading theories on eating pathology: Cognitive Theory (CT). According to CT, the structure of thinking is organised by so-called schemata. A schema is a knowledge structure, involved in directing attention, perception, and deciding how information is processed (Neisser, 1976; Williamson, Muller, Reas, & Thaw, 1999). Schemata can be adaptive, organising information amongst a multitude of stimuli, but they can also disturb information processing. In eating pathology, schemata are believed to involve an overconcern with weight, shape, and eating (Cooper &

Fairburn, 1992; Vitousek & Hollon, 1990). Activation of these schemata can result in memory and judgement biases as well as in an attention processing bias for weight- and food-related environmental cues (Lee & Shafran, 2004; Williamson, White, York-Crowe, & Stewart, 2004). These biases in turn have been found to influence eating behaviour and sustain eating pathology (Overduin, Jansen, & Louwerse, 1995; Williamson et al., 1999). However, it remains unclear which cognitive processes are specifically involved in attention bias and how attention focussing relates to cognitive avoidance. Hence, the scope of this study is to experimentally examine the relationship between food-related thought suppression – as a means of cognitive avoidance – and attention processing bias for food cues.

A bulk of the literature supports a bias in attentional processing of food cues (Cooper & Todd, 1997; Jones-Chesters, Monsell, & Cooper, 1998) and weight- and shape-related stimuli (Dobson & Dozois, 2004; Sackville, Schotte, Touyz, Griffiths, & Beumont, 1998) in both anorexia nervosa and bulimia nervosa (for reviews see Faunce, 2002; Lee & Shafran, 2004). In restrained eaters results are less straightforward, with some studies finding evidence for a hyperaccessibility for food- and weight-related information (Francis, Stewart, & Hounsell, 1997; Green & Rogers, 1998; Perpina, Hemsley, Treasure, & De Silva, 1993), whereas other studies do not find support (Jansen, Huygens, & Tenney, 1998). Restraint herein denotes the cognitively mediated effort to restrict food intake in order to control ones body weight and/or shape (Herman & Mack, 1975). Although providing a clearcut explanation for these contradicting findings is difficult, several hypotheses may be raised.

First, research findings indicate that dietary restraint is not the only crucial factor when studying eating-related concerns. Since the seventies, the Dietary Restraint Theory (DRT, Herman & Mack, 1975; Herman & Polivy, 1980) has been the leading theoretical framework to study the effects of dieting, originally within the context of bulimia nervosa. In essence, the theory states that dieting attempts may backfire under certain circumstances (e.g., stress, negative emotions, eating a small quantity of 'forbidden' foods) and result in more instead of less eating (Herman & Polivy, 1980). This phenomenon is known as the 'counterregulation effect'. Recent studies however, using the Dutch Eating Behaviour Questionnaire (DEBQ, Van Strien, Frijters, Bergers, & Defares, 1986a) or the Three Factor Eating Questionnaire (TFEQ, Stunkard & Messick, 1985) revealed that individuals scoring simultaneously high on dietary restraint measurements *and* disinhibition measurements appear to be particularly at risk for counterregulation effects. Other studies have echoed the vulnerability of high restraint/high disinhibition participants (Haynes, Lee, & Yeomans, 2003; Mitchell & Brunstrom, 2005; Ouwens, Van Strien, & Van der Staak, 2003; Van Strien,

Cleven, & Schippers, 2000). Hence, in future designs, research on attentional processing of food cues has to acknowledge the impact of participants' restraint attitudes as well as their disinhibition tendencies.

Secondly, studies assessing attentional processing of food cues most commonly used an emotional Stroop-task (Stroop, 1935). Yet, the Stroop-task has been subjected to criticism (Faunce, 2002; Faunce & Job, 2000). Results appear highly dependent on the nature and presentation format of stimuli, with more consistent findings for blocked presentations. Because food and shape concerns represent different aspects of eating pathology, their simultaneous administration also makes it hard to draw firm conclusions about specific biases. Even more importantly, the appropriateness of the emotional Stroop-task in measuring attention bias in general has been questioned and it appears that the task is not capable of isolating specific attention processes. Hence, it remains unclear how the Stroop effects should be interpreted and an increasing number of researchers are now calling on Stroop results not to be classified as attentional biases but instead to speak of a more vague 'interference effect' or 'Stroop effect' (for review see Lee & Shafran, 2004).

The shortcomings have stimulated the need for new, subtle experimental paradigms that are better capable of disentangling attention processes and provide a better measure of facilitated attention capture by emotionally relevant stimuli (Cook & Turpin, 1997). One of these tasks is the exogenous cueing paradigm (Posner, 1980), which allows differentiation between two components of visual attention: (1) attentional disengagement from a previously attended stimulus and (2) attentional engagement with a new stimulus (Posner, 1980; Posner, Inhoff, Friedich, & Cohen, 1987). The paradigm consists of a computerized trial-by-trial cueing procedure. First, participants are instructed to look at a central fixation point. When focusing on this fixation point, a cue (word or picture) shortly appears in one of the two peripheral locations (to the left or to the right). Then, the cue disappears and a visual target (e.g., a small square) is presented at one of either peripheral locations. The participants' task is to respond as quickly and as accurately as possible to the target, usually by pressing a button. In some trials, the cue and the target are presented in the same spatial location (valid trials). On the remaining trials, the target is presented at the opposite side of the screen (invalid trials). For cues presented for a short duration (< 300 ms), participants are typically faster at responding to targets on valid trials (benefit), whereas on invalid trials a reaction time cost is observed (Posner, 1980; Posner, Walker, Friedrich, & Rafal, 1984). This is known as the 'cue validity effect'. In the emotional modification of the Posner-task (e.g., see Stormark, Hugdahl, & Posner, 1999), attentional engagement by an emotionally relevant cue can be studied through the examination of reaction time *benefits* on valid trials cued by emotional (e.g., food) information versus non-emotional (e.g., non-food)

information. A faster response to valid trials containing emotional cues reflects enhanced attentional engagement or attentional capture by the emotional information. Difficulties in disengaging attention from the emotionally relevant stimuli reflect attentional holding by the emotional information and can be detected by a slower response on invalid trials containing emotionally relevant cues compared to invalid trials containing neutral cues (Fox, Russo, Bowles, & Dutton, 2001). Finally, Posner and Cohen (1984) discovered that when the interval between cue onset and target (Stimulus Onset Asynchrony; SOA) is 300 ms or greater, the pattern of results described by the cue validity effect reversed, in such a way that reaction time was longer on valid than on invalid trials. This pattern is known as 'inhibition of return' (IOR; Posner & Cohen, 1984; Posner, Rafal, Choate, & Vaughan, 1985). In other words, IOR reflects inhibited attention to the location of a previously attended stimulus in favour of new locations. For emotionally relevant stimuli, it is expected that the IOR effect will not emerge as easily as with nonemotional stimuli (Fox, Russo, & Dutton, 2002).

Recently, a number of clinical studies within the field of anxiety (Broomfield & Turpin, 2005; Koster, Crombez, Verschuere, Van Damme, & Wiersema, 2006; Poy, Eixarch, & Avila, 2004), obsessive-compulsive disorder (OCD, Nelson, Early, & Haller, 1993), schizophrenia (Nestor, Faux, McCarley, Penhune, Shenton, Pollak, & Sands, 1992; Posner, Early, Reiman, Pardo, & Dhawan, 1988) and depression (Smith, Brebion, Banquet, & Cohen, 1995) have used the Posner-task to examine the cognitive processing of emotionally relevant material. As far as we are aware, the Posner-task has never been used before to study information processing within the field of eating pathology. Given the advantages of the paradigm, the present study will include a pictorial variant of the Posner-task in order to examine attentional processing of food cues in depth.

Recent insights claim that hypervigilance or an orientation towards personally relevant information (see Faunce, 2002) and cognitive avoidance or aborting further processing of schema-relevant threatening information are not necessarily opposite processes and may even intertwine (Waller & Meyer, 1997). Wenzlaff, Rude, Taylor, Stultz, and Sweatt (2001) found an association between an attention shift towards negative words, as measured with an Imbedded Word Task (IWT, Wenzlaff & Stultz, 1998), and cognitive avoidance as measured with the White Bear Suppression Inventory (WBSI, Wegner & Zanakos, 1994). Dawkins and Furnham (1989) examined participants with avoidant coping styles and results indicated that the participants showed an attention bias towards emotional words. Lavy and van den Hout (1994) even postulate that cognitive avoidance may be *causally* involved in the appearance of an attention bias. In other words, according to them, a strong motivation for cognitive avoidance may be sufficient for an attention

bias to occur. Lavy and van den Hout (1994) examined their assumption by experimentally combining two paradigms: a Stroop-task and the thought suppression paradigm (Wegner, Schneider, Carter, & White, 1987) as a measure of cognitive avoidance. The authors established that suppressing thoughts about numbers resulted in an attentional interference effect for number words in a subsequent Stroop-task. Dejonckheere, Braet, and Soetens (2003) in turn found evidence for a relationship between food-related thought suppression and an attentional interference effect for food cues (Stroop-task). Because of the shortcomings of the Stroop-task, the findings need to be replicated with other paradigms.

Thought suppression denotes the conscious attempt *not* to think about a specific object, experience, or event (Wegner, 1994), and hence reflects cognitive avoidance. Research on the effects of thought suppression revealed that these attempts may lead to a paradoxical increase in the frequency of those thoughts (for review, see Abramowitz, Tolin, & Street, 2001). The ironic increase in unwanted thoughts after suppression or the recurrence of formerly successfully suppressed thoughts after suppression has ceased, is known as the 'post-suppression rebound effect' (Wegner, 1994, 1997). In order to explain the paradoxical effects associated with thought suppression, Wegner (1989, 1994, 1997) states that the intention to suppress a thought initiates two complementary cognitive processes. The first process, the 'intentional operating process' initiates a conscious search for distracters, that is, for unrelated mental material, anything other than the unwanted thought. It is an effortful, controlled process that requires a great deal of mental capacity. Simultaneously, a second process called the 'ironic monitoring process' is set in motion. This unconscious process is constantly on the lookout for the unwanted thought. Its task is to signal the individual if the unwanted thought should appear. It is a less effortful, automatic mechanism demanding less mental capacity. When mental capacity is inadequate (e.g., due to cognitive loads) or when suppression attempts are voluntarily terminated, the intentional operating process is limited or halted and no longer provides distracting thoughts. Yet, the less effortful ironic monitoring process keeps on scanning for the unwanted thoughts, brings them to mind and leaves the individual with a failed suppression attempt. When these effects occur over and over again, participants may become preoccupied (Wegner, 1989, 1994, 1997; Wegner, et al., 1987). It now remains to be seen whether these rebound effects can present themselves as an attention bias in a methodologically more valid task than the Stroop-task. Before exploring this hypothesis in less accessible groups of clinically weight-concerned participants, normal-weight participants varying in their restraint attitudes may serve here as a reference group.

In summary, the present study holds the following research questions. In

line with Lavy and van den Hout (1994) and Dejonckheere and colleagues (2003), attentional processing of food cues and its assumed relationship with thought suppression will be experimentally examined. A pictorial emotional cueing paradigm (Posner, 1980), containing food cues and toy cues, will be used to measure the different components of attentional processing. In line with previous research within the field of anxiety (Koster, Crombez, Verschuere, & De Houwer, 2008), two different presentation durations (250 ms and 1050 ms) will be included to examine the time-course of attention to food cues. At 250 ms picture presentation, it is hypothesised that food-related thought suppression will elicit an enhanced cue validity effect for food cues, compared to the non-suppression condition; related to enhanced attentional engagement with and problems in disengaging attention from food cues relative to toy cues. For the 1050 ms condition, we expect that after food-related thought suppression, the usually observed IOR effect will not emerge as easily with food cues as with toy cues (Koster et al., 2006). The role of dietary restraint and disinhibition will be examined by including them as covariates throughout the analyses.

Method

Participants

Seventy-one female first-year university students participated in the study (61.4% psychology students, 28.6% movement and sports students, 10.0% pedagogy and pharmacology students). Impaired vision was an exclusion criterion. Six participants were excluded from the study because of unreliable data (see results section). To ensure homogeneity of the research sample, an additional six participants were excluded because their Body Mass Indices (BMIs) were situated either in the anorectic range (BMI < 17) or in the obese range (BMI > 30). The mean BMI of the remaining 59 participants amounted to 20.67 (*SD* = 1.70) and the mean age was 18.51 (*SD* = 1.01). All participants either received course credit (psychology students) or were given a cinema ticket as a token of appreciation for participation.

Measures

Dutch eating behaviour questionnaire (DEBQ)
The DEBQ (Van Strien, Frijters, Bergers, & Defares, 1986b; originally published in Dutch by Van Strien, et al., 1986a) was administered to assess three characteristics of eating behaviour: restrained eating (10 items), emotional eating (13 items) and external eating (10 items). The latter two sub-

scales are accepted components of disinhibition (Van Strien, 1997a, 1997b, 1999). A composite DEBQ-measure for disinhibition was obtained by calculating the mean of the scores on the latter two subscales (Van Strien, 1997b). The questionnaire consists of 5-point Likert scales with categories ranging from 'never' to 'very often'. In previous research both reliability and validity were proven to be adequate (Banasiak, Wertheim, Koerner, & Voudouris, 2001; Hill, Weaver, & Blundell, 1991; Van Strien et al., 1986a). Cronbach's alpha in the present study amounted to 0.95 for restrained eating, 0.90 for emotional eating and 0.63 for external eating.

Food- and eating-related thought recording

In line with Oliver and Huon (2001), the number of food- and eating-related thoughts reported during the suppression/control phase of the study was registered by asking participants to press a clicking device with their dominant hand, each time a thought about food or eating occurred. The number of clicks throughout the experiment, as well as the expressed food thoughts, were registered by the experimenter. This way, potential accidental clicks could be omitted from the analyses based on a pre-existing codebook (Abramowitz et al., 2001). Based on the codebook, all thoughts referring to particular foods, specific brands of food, desire and willingness to eat, and all actions associated with the process of eating, were included.

Posner-task

As a measurement of attentional processing, a pictorial exogenous cueing task (Posner, 1980) was used. The task was programmed using INQUISIT Millisecond software, and was run on a Windows XP Professional portable computer (Toshiba, Tecra S1-series) with a 15-inch colour monitor. Stimuli were projected onto the computer screen placed in front of the participant (viewing distance approximately 60 cm). The baseline display was composed of a small white central cross (0.5 cm x 0.5 cm) and two identical white peripheral rectangles (6.8 cm wide by 8.3 cm high), presented against a black coloured background (full screen). The middle of both rectangles was 7.5 cm removed from the central fixation cross. Cues and targets were presented in the middle of the rectangles. The cues consisted of 20 pictures (all edited to 4.5 cm wide by 6 cm high), divided in two categories: 10 pictures of high-caloric foods (potato crisps, chocolate sweets, fried snacks, French fried potatoes, ice-cream, pancakes, pastry, croquettes, hamburger, pasta bolognaise) and 10 pictures of toys (ball, doll, football table, puzzle, two kinds of cuddly toys, fun reading books, paint box, party game, box with beads). We wanted to include cue types with comparable valence in this study, to ensure that potential effects would be more likely to be content specific and not merely valence dependent. The decision to include toy cues was

based on the valence ratings (7-point Likert scale) of a small sample of female young adults ($N = 7$, mean age = 25 y). The sample granted similar (neutral to positive) valence ratings to the food pictures and the toy pictures. The pictures were taken by the experimenter using a digital photo camera (Canon powershot A80) and care was taken in matching the pictures for brightness, colour scheme, and camera angle as good as possible. Specifically, we tried to take the pictures in comparable environments (in terms of darkness and lightness) and made sure that the focal distance was comparable and that there was an equal amount of bright colours in both categories. The target stimulus was a black square (1.0 cm x 1.0 cm). The test phase consisted of 320 trials. An equal amount (160 trials) of valid (left cue/left target and right cue/right target) and invalid trials (left cue/right target and right cue/left target), was projected. Cues appeared for 200 or 1000 ms and were presented in two blocks to minimise temporal uncertainty and hence the variance on responding (Koster et al., 2008). The order sequence of the blocks was counterbalanced to exclude order effects. There was a short break after the first sequence of 160 trials. Targets were programmed to appear 50 ms after the cue had disappeared and remained on screen until a response was made. In total, 8 categories were created, each containing 40 trials (valid food cues at SOA = 250 ms, invalid food cues at SOA = 250 ms, valid toy cues at SOA = 250 ms, invalid toy cues at SOA = 250 ms, valid food cues at SOA = 1050 ms, invalid food cues at SOA = 1050 ms, valid toy cues at SOA = 1050 ms and invalid toy cues at SOA = 1050 ms). The projection of right and left targets was randomized to prevent that stimulus-response compatibility would affect the measures of alerting, orienting, or reorienting.

Participants were instructed to maintain fixation on the central cross throughout the experiment and to detect the peripheral targets as fast as possible, without loss of accuracy. They were informed that on some trials the cue and the target would appear at the same location (cue predicts location of target correctly), but not on all trials. In order to make sure that the participants stayed focused on the fixation cross throughout the experiment, a number (between '1' and '4') appeared at the centre of the screen, replacing the fixation cross, in an additional 32 random trials (hereafter referred to as 'fixation check trials'). For these trials, participants were instructed to press the key corresponding with the number on an AZERTY keyboard, as fast and as accurate as possible. An error index was calculated. For all other trials, participants were instructed to respond to each target by pressing either the 'q' or the 'm' key on the keyboard, depending on whether the target appeared in the left or right peripheral box, with either their left or right index finger respectively.

All relevant instructions were projected on the computer screen prior to

testing and participants were given the opportunity to ask questions for clarification when needed. Also, a 2-minute training-session (32 trials with neutral pictures; 16 in each block) was included to familiarise participants with the procedure.

Control measures

   In order to get an overall indication of mood at baseline, affect prior to manipulation was measured with nine 7-point bipolar rating scales: happy-sad, aroused-peaceful, confident-unconfident, content-discontent, relaxed-tense, pleasant-unpleasant, pleased-angry, proud-ashamed, anxious-calm (Oliver & Huon, 2001). Participants marked each line connecting the two poles according to their present state. The distance (measurements between 0 for marks closest to the negatively charged feeling and 7 for the positively charged feeling) on each line was measured and these scores were summed to obtain a measure of affect (scores between 0 and 63). The higher the score, the less negative the current mood. In addition, the list included one bipolar rating scale assessing the current feelings of hunger (hungry-satisfied). The participants' response to this question was rated separately from the other scales in the list (scores between 0 and 7).

   In order to check for the participants' evaluation of the valence of the stimuli, they were asked to rate the projected pictures on a valence rating scale. Participants were presented with a list containing each picture used throughout the experiment and they were asked to rate them on a 7-point Likert scale, ranging from 'very negative' to 'very positive'.

Procedure

   The following procedure was approved by the University's Ethical Committee. Participants were tested individually in a stimulus-poor environment and gave informed consent prior to participation. They were told that they would participate in a study about cognition and information processing. They were kept naïve for the further intentions of the research to avoid tailoring of responses to the presumed objectives of the study (Lavy & van den Hout, 1994). Prior to the actual experiments, all participants completed the mood measure, the DEBQ, and reported their age and educational status.

   The first part of the experimental phase consisted of the suppression experiment, which comprised two subsequent thought recording phases (for procedure, also see Abramowitz et al., 2001; Wegner et al., 1987). Participants were randomly allocated to one of two conditions: a suppression condition ($n = 30$) or a non-suppression condition ($n = 29$). During the first phase, all participants were told to think about anything they liked, to report these thoughts out loud and to press a button each time a thought about eat-

ing or food came to mind. This way, participants monitored their thoughts about food and eating, while expressing every thought they experienced. Their food thoughts were registered over a 5-minute time span (trial period 1). During the second phase, the manipulation was carried through. Participants in the suppression condition were given the specific instruction not to think about food and eating, while participants in the non-suppression condition were given the instruction to think about anything they wanted, as was the case during trial period 1. At the same time, both groups were again instructed to monitor their food- and eating-related thoughts over a 5-minute time span (trial period 2). The frequency of references to the target thought (food and eating) in the instructions was held constant across the two phases and across conditions in order to control for priming effects (Salkovskis & Campbell, 1994).

Immediately after the suppression/control instructions, all participants completed the Posner-task. Participants took place in front of the computer screen and were asked to read the instructions displayed on the screen. After they indicated that they had understood the instructions, participants completed the 2-minutes training session. The experimenter monitored the participants' actions in order to be able to give further instructions when needed, although this never appeared to be the case. Subsequently, the experimental phase started. Half of the participants started with block 1 (SOA = 250 ms) and the other half started with block 2 (SOA = 1050 ms). The participants' reaction times (RTs) per trial were recorded.

Afterwards, the participants were handed the manipulation check questionnaire. Information about length, weight, and time since last food intake was also obtained. The valence questionnaire was completed through e-mail. The total experiment took about 45 minutes of the participants' time. After the experiment, full debriefing was provided in group.

Design and analytic plan

After data preparation, reaction times were first subjected to a 2 (Cue type: food/toys; within-subjects) x 2 (Presentation duration: 250 ms/1050 ms; within-subjects) x 2 (Cue validity: valid/invalid; within-subjects) x 2 (Suppression condition: suppression/non-suppression; between-subjects) mixed Analysis of Variance (ANOVA). Dietary restraint, disinhibition, as well as the interaction between these two variables were entered as covariates in a second round of the same analyses.

To test our *a priori* hypotheses, two ANOVA's with repeated measures design were conducted for the 250 ms and 1050 ms condition separately. Again, Cue type and Cue validity were entered as within-subjects factors and Suppression condition was entered as a between-subjects factor. If the high-

er-order effects including Cue type, Suppression condition, and cue validity reached significance, two methods were employed to further examine the effects. First, cue validity indices were calculated as measures of overall attention (Koster et al., 2008; MacLeod & Mathews, 1988). This was done for the different cue types separately in each suppression condition, using the following formula: Cue Validity Index (CVI) = RT invalid cue - RT valid cue. Positive scores indicate attention towards the cue (cue validity effect), whereas negative scores indicate attention away from the cue (Koster et al., 2006). The CVIs will also be compared to zero (a score of zero indicates no faster responding on valid trials than on invalid trials). Second, in order to examine the specific components of attention, attentional engagement and disengagement scores were calculated for each suppression condition. The following formulas are used: (1) engagement score = RT valid/toy cue - RT valid/food cue; (2) (difficulties in) disengagement score = RT invalid/food cue - RT invalid/toy cue. A positive engagement score indicates facilitated attentional engagement to food cues. A positive score for disengagement indicates difficulties in shifting attention away from food cues compared with toy cues (denoting attentional holding). Negative scores imply the opposite attentional processes. Both scores will also be compared to zero (a score of zero indicates no difference in attentional engagement/disengagement for food cues *versus* toy cues).

Results

Descriptive statistics

Independent sample t-tests revealed no differences between the suppression condition and the non-suppression condition in age, BMI, baseline feelings of hunger, elapsed time since the last meal, global affect, emotional eating, external eating, and restrained eating (see Table 1).

In addition, one-sample t-tests were executed in order to compare the observed mean scores for restrained eating, emotional eating, and external eating to norm means for the DEBQ-subscales in question. The reference sample consisted of 405 female students (Van Strien, 2005). Results revealed no significant differences (all $t < 1.50$, all $p > .10$) between our sample and the norm group.

Table 1
Descriptive characteristics for the suppression and non-suppression condition

	Suppression ($n = 30$)		Non-suppression ($n = 29$)		
	M	*(SD)*	*M*	*(SD)*	*t*(63)
Age	18.47	(1.14)	18.55	(0.87)	-0.32
BMI	20.44	(1.43)	20.91	(1.95)	-1.06
Hunger	4.19	(2.05)	4.87	(1.65)	-1.40
Time last meal	282.67	(306.86)	178.10	(206.23)	1.54[a]
Affect	42.29	(9.55)	43.83	(8.60)	-0.65
Emot eating (DEBQ)	2.59	(0.66)	2.56	(0.56)	0.19
Ext eating (DEBQ)	3.27	(0.39)	3.12	(0.40)	1.45
Restr eating (DEBQ)	2.59	(0.94)	2.45	(0.81)	0.59

Note. BMI = Body Mass Index (weight/height^2); Emot eating = Emotional eating scale; Ext eating = External eating scale; Restr eating = Restrained eating scale; DEBQ = Dutch Eating Behaviour Questionnaire.
* $p < .05$; ** $p < .01$
[a] Levene's Test for Equality of Variances was significant so results were based on 'equal variances not assumed' with df (50.92)

Valence check

A mixed ANOVA was executed to examine the participants' overall valence ratings of the presented cues. Cue type was included as a 2-levelled within-subjects factor and Suppression condition as a 2-levelled between-subjects factor. As expected, participants overall did not rate the valence of the food cues ($M = 4.60$) any different from the valence of the toy cues ($M = 4.34$): $F(1, 45) = 1.31$, $p = .26$. The main effect of Suppression condition, as well as the interaction-effect between Suppression condition x Cue type, was also non-significant (all $F < 1.35$). When dietary restraint, disinhibition, and the interaction between these variables were included as covariates, conclusions remained the same.

Manipulation check

None of the participants saw through the main intention of the study, namely to examine whether food-related thought suppression elicits an atten-

tion bias for food cues. The categories listed by the participants were the following (some participants listed more than one category): thoughts/thinking (in general, about food, frequency, operating processes, provoking factors, controlling thoughts) (33.8%); attention/concentration/response readiness (20.4%); eating habits/eating behaviour (17.6%), emotions (in general or linked to eating behaviour) (17.6%); eating disorders (4.9%); no idea (3.5%), (inducing feelings of) hunger (2.1%).

Suppression instructions

An ANOVA with repeated measures design was executed with Trial period (trial period 1/trial period 2) as within-subjects factor and Suppression condition (suppression/non-suppression) as between-subjects factor on the number of reported food words. Results revealed no significant Suppression condition x Trial period interaction effect ($F < 1.0$). In the suppression condition, the number of reported food words during the second trial period ($M = 3.20$) was lower than the number of reported food words at baseline ($M = 3.93$), but the same pattern was found in the non-suppression condition ($M1 = 3.14$, $M2 = 2.28$). This indicates that participants found it hard to suppress their thoughts and, despite their attempts, could not suppress all food thoughts.

Reaction time data

Data preparation
Trials with errors (incorrect responding to targets) were removed from the data set ($M = 2.45$). In line with Koster, De Raedt, Goeleven, Franck, and Crombez (2005), RTs smaller than 150 ms and RTs higher than 750 ms were also removed from the dataset due to anticipatory responding and delayed responding, respectively. Participants responding incorrectly or out of the 150 ms-750 ms range on > 20% of the administered trials were considered unreliable and were discarded from the analyses. RTs deviating more than three standard deviations from the mean RT were also discarded (outliers). These procedures resulted in the exclusion of 4 participants. Finally, the error rate for the fixation check trials was calculated ($M = 2.25\%$, range 0-10). Two participants made errors on more than 1/5 of the fixation check trials and were therefore also excluded from the analyses.

Overall effects
The mixed ANOVA including Cue type, Cue validity, Presentation duration, and Suppression condition (see Design and analytic plan) revealed two main effects and two interaction effects. Table 2 gives an overview of the

mean RTs as a function of Cue type, Cue validity and Suppression condition at 250 and 1050 ms picture presentation (in ms). First, an expected significant main effect for Cue validity was found ($F(1, 57) = 4.82$, $p = .03$), due to faster responding on valid ($M = 395$ ms) compared with invalid trials ($M = 400$ ms) (= overall cue validity effect). Also, an expected significant main effect for Presentation duration was found ($F(1, 57) = 8.28$, $p < .01$), as responding was faster in the 1050ms condition ($M = 390$ ms) compared with the 250ms condition ($M = 405$ ms).

A significant two-way interaction effect was found for Cue type x Cue validity ($F(1, 57) = 4.02$, $p = .05$) and for Cue validity x Suppression condition ($F(1, 57) = 4.82$, $p = .03$). The inclusion of dietary restraint, disinhibition, and the interaction between these variables did not sort any additional effects. Participants in the suppression condition responded faster on valid trials ($M = 385$ ms) than on invalid trials ($M = 395$ ms) ($t(29) = -2.83$, $p < .01$), whereas participants in the non-suppression condition responded equally fast on both kinds of trials ($M = 404$ ms) ($t(28) = .08$, $p = .94$). In other words, no cue validity effect emerged in the non-suppression condition.

The latter finding was unexpected since simple cue validity effects are generally robust in exogenous cueing tasks. However, this could be due to the fact that the analyses were run on the 250 ms and the 1050 ms condition together. Theoretically, in the 250 ms condition a cue validity effects is expected, while in the 1050 ms condition, an inhibition of return effect is expected. To test our *a priori* hypotheses, planned analyses will be performed in the 250ms and the 1050ms condition separately (Jaccard & Guilamo-Ramos, 2002). This way, we will be able to check whether the unexpected findings in the non-suppression condition hold for both presentation conditions.

We further explored the data by conducting two additional repeated measure ANOVAs testing (1) the hypothesis that the duration of the suppression effect might be limited; therefore an analysis was performed on the presentation condition that was first administered, and (2) whether differences due to differences in successful suppression affected the findings. For the first analysis, only the reaction time data of the first block were used. A mixed three-way ANOVA including Cue type, Cue validity as within participants variables and Presentation duration as a between participants variable revealed a significant main effect of Cue type ($F(1, 57) = 7.60$, $p < .01$) and Cue Validity ($F(1, 57) = 6.54$, $p < .05$) but no significant three-way interaction effect ($F(1, 57) = .46$, $p = .50$). Including Suppression condition did not sort a significant four-way interaction ($F(1, 55) = .15$, $p = .70$). For the second additional analysis, participants in the suppression condition were divided in three groups: participants who successfully suppressed food-related thoughts ($n = 17$), participants who reported an increase in food-related

thoughts after suppression (n = 9), and participants who reported an equal amount of food-related thoughts before and after suppression (n = 4). A mixed ANOVA including Cue type, Cue Validity, Presentation duration, and Suppression success as factors revealed no significant four-way interaction effect ($F(2, 27)$ = .42, p = .66). As no different results were found with these analyses, we opted to report the analysis for the entire data set in order not to lose too much power.

250 ms condition

A mixed ANOVA including Cue type, Cue validity, and Suppression condition as factors (see Design and analytic plan) was executed at 250 ms picture presentation. Results revealed a significant main effect for Cue type ($F(1, 57)$ = 4.05, p = .05), as responding was faster on trials with food cues (M = 403 ms) than on trials with toy cues (M = 406 ms). Also, a significant main effect for Cue validity was found ($F(1, 57)$ = 4.25, p = .04). As expected, participants responded faster on validly cued trials (M = 402 ms) than on invalidly cued trials (M = 408 ms), reflecting the overall cue validity effect. The two-way interaction effect between Cue validity x Suppression condition was not significant ($F(1, 57)$ = 0.98, p = .33). No other significant effects were revealed (all F < 1.00). The inclusion of dietary restraint, disinhibition, and the interaction between these two variables did not sort any additional significant effects.

Cue validity indices (CVIs) were calculated for each cue type separately in the suppression and the non-suppression condition (see Table 2).

Results showed that participants in the suppression condition attended to the food cues (CVI = 10). A one-sample t-test revealed that this CVI significantly differed from zero ($t(29)$ = 2.02, p = .05). The CVI for food cues for participants in the non-suppression condition (CVI = -1) did not significantly differ from zero ($t(29)$ = -0.16, p = .88). Contrary to expectations, independent sample t-test further revealed that the difference in CVIs for food cues between the two suppression conditions was not significant: $t(57)$ = 1.59, p = .11. For the toy cues, participants in the suppression condition (CVI = 8) and the non-suppression condition (CVI = 7) both responded faster on valid trials than on invalid trials, which was expected. For the toy cues, no significant differences in CVIs were found between the suppression and the non-suppression condition: $t(57)$ = 0.14, p = .89. This was expected since the suppression instructions only involved food-related thoughts. Finally, paired sample t-tests were executed in order to compare the CVIs for the two cue types in each suppression condition separately. There was no significant difference between the CVI for food cues and the CVI for toy cues in the suppression condition: $t(29)$ = 0.54, p = .60.

Table 2

Mean reaction times (RT in ms), standard deviations (SD) and cue validity indices (CVI) as a function of Cue type, Cue validity and Suppression condition at 200 and 1000 ms picture presentation

			Suppression	Non-suppression
			M (SD) CVI	*M (SD) CVI*
Presentation	Cue type	Cue validity		
	Food	Valid	395 (54)	408 (43)
		Invalid	405 (52) 10	407 (45) -1
200 ms				
	Toys	Valid	398 (54)	406 (42)
		Invalid	406 (54) 8	413 (49) 7
	Food	Valid	375 (44)	404 (47)
		Invalid	385 (44) 10	396 (42) -8
1000 ms				
	Toys	Valid	372 (39)	400 (50)
		Invalid	385 (42) 13	401 (49) -1

Note. CVI = RT invalid cue – RT valid cue. Positive scores indicate attention towards the cue (cue validity effect), whereas negative scores indicate attention away from the cue (IOR effect) (Koster et al., 2005b).

Next, attentional engagement and disengagement scores were calculated for each suppression condition (see Table 3).

Comparing the suppression and non-suppression condition on attentional engagement with food cues did not reveal any significant differences: $t(57) = 1.34$, $p = .19$. The same conclusions hold for the disengagement scores: $t(57) = 1.22$, $p = .23$. Comparison of the engagement and disengagement scores to zero in the suppression condition, also failed to reach significance (engagement: $t(29) = 1.59$, $p = .12$; disengagement: $t(29) = -0.56$, $p = .58$), indicating that the scores did not significantly differ from zero (recall that zero = no difference between attending food *versus* toy cues). In the non-suppression condition, it was found that the (negative) disengagement score did differ significantly from zero ($t(28) = -2.06$, $p = .05$). In other words, participants in the non-suppression condition needed less time to shift attention away from food cues than to shift attention away from toy cues.

Table 3

Mean engagement and disengagement scores (in ms) as a function of Suppression condition at 200 ms picture presentation

	Suppression condition		Non-suppression condition	
	M	*(SD)*	*M*	*(SD)*
Engagement	4	(12)	-1	(14)
Disengagement	-1	(16)	-6[a]	(17)

Note. [a] indicates that the engagement/disengagement score differs significantly from zero ($\alpha <$ .05).

1050 ms condition

A mixed ANOVA including Cue type, Cue validity, and Suppression condition was executed at 1050ms picture presentation (see Design and analytic plan). No main effects were found (all $F < 1.5$). One significant interaction effect between Cue validity x Suppression condition was revealed ($F(1, 57) = 5.05$, $p = .03$). In the suppression condition, participants responded significantly faster on valid trials ($M = 374$ ms) than on invalid trials ($M = 385$ ms) ($t(29) = -2.13$, $p = .04$). In the non-suppression condition, RTs on valid trials ($M = 399$ ms) were statistically similar to RTs on invalid trials ($M = 402$ ms) ($t(28) = .92$, $p = .37$). The three-way interaction effect between Cue type x Cue validity x Suppression condition was not significant: $F(1, 57) = 0.92$, $p = .34$. No further analyses were warranted here.

Discussion

In previous studies, hypersensitivity for food cues was demonstrated in various research samples (Lee & Shafran, 2004). Yet, these studies have been criticised on their methodology and more research is needed to investigate the precise cognitive processes involved in attention biases. The present study's overall aim was to explore whether food-related thought suppression could elicit an attention bias for food cues. Unique to this study was the use of a pictorial exogenous cueing task (Posner, 1980) with pictures of foods and toys, which had never been used before to study attentional processing within the field of eating pathology. This task not only allowed us to obtain a general index of attention bias but also made it possible to study the structural components of attentional processing: engagement and disengagement.

Specifically, in the 250 ms picture presentation condition, we expected to find an enhanced cue validity effect for food cues after food-related thought

suppression, compared to a non-suppression control group. This hypothesis could not be confirmed. Participants in the suppression condition did attend to food cues whereas participants in the non-suppression condition did not, but the difference in cue validity indices between the two conditions was not significant. Furthermore, in the suppression condition there was no difference between attending food *versus* toy cues. No enhanced engagement and no problems in disengaging attention from food cues emerged. One explanation here for the unexpected findings is that, given the monitoring process instigated by thought suppression, individuals may simply pay attention to all cues as in 50% of the cases a food-cue is presented on the screen.

At 1050 ms picture presentation, we hypothesised that the usually observed IOR effect would not emerge as easily for food cues after thought suppression. In other words, we expected that the time course of the cue validity effect would be extended for food cues after thought suppression (Koster et al., 2006). Again, no evidence was found to subscribe to this assumption of maintained attention. In the suppression condition, participants generally responded faster on valid trials than on invalid trials, but the three-way interaction between Cue type x Cue validity x Suppression condition did not reach significance and further analyses were not warranted.

An important observation that demands further explanation is that, during suppression, there was no significant decrease in the number of reported food-thoughts. Although this is inconsistent with some previous research findings (Soetens & Braet, 2007), others reached the same conclusions, which, according to them, indicates that it is hard and stressing for some individuals to suppress thoughts (Oliver & Huon, 2001). Some authors even found evidence for an *increase* in unwanted thoughts during suppression, which is known as the immediate enhancement effect (for review, see Abramowitz et al., 2001). Hence, the fact that no decrease in food-thoughts was found during suppression, relative to the non-suppression condition, does not necessarily imply that the participants did not follow up on the instructions. This was also noticeable during testing, as participants expressed their disappointment when food thoughts did pop up despite their attempts to avoid them, indicating that they did in fact try to follow up on the instructions. However, when taking into account whether or not participants successfully suppressed food-related thoughts, again no effect of suppression was found. As a related remark, we cannot exclude that the suppression instructions were not sensitive enough to sort prolonged effects. Lavy and van den Hout (1994) suggest that standard thought suppression instructions are quite fragile. Since mental capacity per definition is limited, it could well be that thought suppression instructions are overridden when performing an attention task, especially when this attention task is as complex as an exogenous cueing paradigm. Nevertheless, analysing only the data of the first pre-

sentation block, did not reveal an effect of suppression.

In the terminology of the ironic processing theory for thought suppression (Wegner, 1994), the results of the present study indicate that food-related thought suppression did not result in an attention bias for food cues. When the suppression attempts were disrupted by the introduction of the Posner-task, the automatic processes did not seem to exert influence as time moved on, and beyond the participants' personal control. The results are not in line with previous studies on the relationship between thought suppression and attentional interference. When Lavy and van den Hout (1994) asked participants to suppress thoughts about numbers, they established that this resulted in an interference effect for numbers in a subsequent Stroop-task. Dejonckheere and colleagues (2003) reached the same conclusions for sweets words that were presented subliminally, after suppression of thoughts about sweets.

Why was our study not able to replicate the results of these previous studies? Several hypotheses can be raised. First of all, previous studies used an emotional Stroop-task to measure attentional processing. We aimed to further elaborate the findings by using an exogenous cueing task which enables us to specify the attention processes involved. More research is probably necessary to find out whether and how this paradigm offers possibilities to detect differential attentional processes for positive words (like food) on top of general attention effects. Secondly, the study by Dejonckheere and colleagues (2003) only found effects of thought suppression on attention focussing when the sweets words were presented subliminally. When the words were presented supraliminally, their results were similar to our study. Therefore, it is possible that we will be able to find effects of thought suppression on attentional processing as measured with the Posner-task, when subliminal presentation durations are included. The importance of presentation duration has been demonstrated by research within the field of anxiety, where evidence was found for an attention bias for threat at some presentation durations, but not at others (Fox et al., 2002; Koster et al., 2005; Yiend & Mathews, 2001). Hence, future research needs to replicate the findings of the present study, preferably including different picture presentation durations.

In the current study, we also wanted to examine the role of dietary restraint and disinhibition in the attentional processing of food cues. No effects were found. Although some earlier studies did find hypersensitivity for food- and weight-related cues in high restrained eaters and individuals with a high drive for thinness (Green & Rogers, 1998; Perpina et al., 1993), our results are in line with the bulk of the studies that failed to find these effects, using a Stroop-task (Ben-Tovim & Walker, 1991; Jansen et al., 1998; Sackville et al., 1998). Our specific hypothesis that high restraint/high disinhibition participants would be more vulnerable to show an attentional bias for food cues,

due to prioritised processing of food cues (Williamson et al., 1999), could not be confirmed. Because previous research did find higher thought suppression tendencies (Soetens, Braet, Dejonckheere, & Roets, 2006) *and* more dysfunctional eating patterns (Westenhoefer, Broeckmann, Munch, & Pudel, 1994) in this subgroup of restrained eaters, the role of dietary restraint and disinhibition in the cognitive processing of eating-related stimuli demands further investigation, preferably including participants with extreme scores for both characteristics.

This study is limited in several ways and holds some unexpected findings, which require further investigation. First of all, in the overall analysis, no significant four-way interaction effect between Cue type x Cue validity x Suppression condition x Presentation duration was found. This is probably due to a lack of power. Furthermore, because studies predict different response patterns for presentation durations shorter than 300 ms than for presentation durations longer than 300 ms *a priori* analyses were performed at 250 ms presentation duration and 1050 ms presentation duration separately. Because the separate analyses were not protected by a significant four-way interaction effect in the overall analysis, caution is warranted when interpreting the effects.

Secondly, it might be the case that food cues are less 'interesting' for people in the general population than toy cues, because of the everyday contact with foods, during meal times, through advertising, etc. Brownell and Horgen (2004) even speak of a 'toxic environment', referring to the overemphasis on food stimuli in western societies. Another explanation could be that individuals in the general population are ambivalent towards high-caloric foods. On the one hand, fatty foods are palatable, tasty, and liked but on the other hand they pose a caloric threat and they are often unhealthy (Herman & Polivy, 1993). This may well reflect an approach-avoidance conflict (Lang, 1995), which may interfere with the attentional processing of high-caloric food cues. Toy cues on the other hand appear much less ambivalent and do not seem to evoke an approach-avoidance conflict. This 'unique' characteristic of food cues distinguishes these types of stimuli from other stimuli such as anxiety-related cues. It now remains to be seen how attention towards food cues should best be measured. More research is needed to address these issues further.

In conclusion, no evidence was found for an attention bias for food cues after food-related thought suppression. Because the effects of suppression were not measured directly in this study, the results do not exclude more direct effects of food-related thought suppression on the frequency of these thoughts, as was found in earlier studies (Mann & Ward, 2001; Soetens et al., 2006). The impact of dietary restraint tendencies and disinhibition remained unclear in this study and demands further clarification.

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