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Attention bias for food is independent of restraint in healthy weight individuals—An eye tracking study

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ABSTRACT

Objective: Restrained eating style and weight status are highly correlated. Though both have been associated with an attentional bias for food cues, in prior research restraint and BMI were often confounded. The aim of the present study was to determine the existence and nature of an attention bias for food cues in healthy-weight female restrained and unrestrained eaters, when matching the two groups on BMI.
Method: Attention biases for food cues were measured by recordings of eye movements during a visual probe task with pictorial food versus non-food stimuli. Healthy weight high restrained ($n = 24$) and low restrained eaters ($n = 21$) were matched on BMI in an attempt to unconfound the effects of restraint and weight on attention allocation patterns.
Results: All participants showed elevated attention biases for food stimuli in comparison to neutral stimuli, independent of restraint status.
Discussion: These findings suggest that attention biases for food-related cues are common for healthy weight women and show that restrained eating (per se) is not related to biased processing of food stimuli, at least not in healthy weight participants.

1. Introduction

Attention biases for food have been associated not only with craving, (over)consumption and overweight or obesity (e.g., Nijs, Muris, Euser, & Franken, 2010; Smeets, Roefs, & Jansen, 2009; Werthmann et al., 2011) but also with restrained eating (e.g., Hollitt, Kemps, Tiggemann, Smeets, & Mills, 2010; Veenstra, de Jong, Koster, & Roefs, 2010). Overweight and obese people typically report higher levels of restraint than healthy-weight people (Johnson, Pratt, & Wardle, 2011). Therefore, the aim of this study was to test whether restrained eating style, independently of body weight, is associated with an attentional bias for food cues.

Evidence of an attention bias for food in restrained eaters is mixed. For example, minor effects for biased attention for food words in restrained eaters, as assessed by the modified Stroop-paradigm, were reported in meta-analyses (e.g., Brooks, Prince, Stahl, Campbell, & Treasure, 2011). Yet, the interference effect does not inform about the underlying visual attention processes (Mogg, Bradley, Field, & De Houwer, 2003). Other studies have used paradigms that can distinguish specific attention processes (i.e., visual search, visual probe and flanker paradigm). Some found that restrained eaters have an attention bias towards high-calorie food cues (Hollitt et al., 2010; Meule, Vögele, & Kübler, 2012), or avoided attending high-calorie food pictures in an exogenous cueing task (Veenstra et al., 2010), or showed no conclusive evidence of an attention bias for food (Ahern, Field, Yokum, Bohon, & Stice, 2010; Boon, Vogelzang, & Jansen, 2000; Forestell, Lau, Gyurovski, Dickter, & Haque, 2012; study 1).

Apart from the large variety of paradigms that have been used to assess attentional bias for high-calorie foods in restrained eaters, an important problem is that typically body weight (as indicated by the body mass index; BMI) and restraint status have been confounded in prior research. Attention biases for food might be primarily associated with weight problems, and might therefore be more related to weight than restraint per se. Thus, there are two competing explanations for the existing evidence of an attentional bias for food in restrained eaters: Restrained eating itself causes the attentional bias, or, alternatively, heightened BMI, typically associated with restraint, is the cause of the attentional bias.

Our first aim was to test whether restrained eating is related to increased attention bias for food, independent of weight status. We isolated the influence of restraint methodologically by keeping BMI constant (within a healthy BMI range) and varying the distribution of restrained eating behaviour. Thus, our study contributes to unconfounding the effects of BMI and restraint on attentional bias for food.

Apart from the question of whether restrained eating style, independently of BMI, affects attentional processing of food cues, a second aim of this study was to explore the direction and duration of the potential attentional bias. Research on attention biases in eating disorders and

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addictions shows that these attention components are differently related to motivational processing of food (or drug) cues (Bradley, Mogg, Wright, & Field, 2003; Field, Mogg, Zetteler, & Bradley, 2004; Smeets, Roefs, van Furth, & Jansen, 2008). It is possible that restrained eaters display attention avoidance of food cues, in an attempt to follow their dieting rules, or that restrained eaters show attentional approach, reflecting high preoccupation with food (Higgs, Rutters, Thomas, Naish, & Humphreys, 2012; Lowe & Levine, 2005). Another possibility is that restrained eaters show an approach-avoidance conflict (Papies, Stroebe, & Aarts, 2008), for example, an initial orientation towards food (automatic approach), followed by diverting attention away from food in later stages of processing (strategic avoidance).

Therefore paradigms that can distinguish between these attentional components are more informative for the question of whether restrained eating is associated with attention avoidance of food cues (e.g. reflecting dieting motivation) or attentional approach towards food cues (e.g. reflecting food pre-occupation or eating enjoyment). In this respect, a meta-analysis recently concluded that eye movement recording is the most sensitive measure for attention biases in the context of addiction because it allows for an unambiguous distinction of specific components of attention allocation processes, and, due to the dynamic character, provides an assessment of change in attention biases over time following stimulus onset (Field, Munafó, & Franken, 2009).

2. Method

2.1. Participants

Potential participants were screened on restraint and self-reported BMI (kg/m^2) and matched as closely as possible on their self-reported BMI. Female healthy-weight unrestrained ($n = 21$) and restrained eaters ($n = 24$), based on a median-split on their Restraint Scale scores (Herman & Polivy, 1980) (*Mdn* = 11; *Range* = 4–27), were included. Four additional participants were tested but excluded because their actual BMI did not meet the inclusion criterion of healthy weight (See Table 1).

Table 1
Characteristics and attention bias scores of restrained and unrestrained eaters.

	Restrained eaters (n = 24)		Unrestrained eaters (n = 21)			
	M	*SD*	*M*	*SD*	t(43)	*p*
RS score	15.75	4.34	7.19	1.97	8.70[1]	<0.001
Age	21.50	1.34	21.87	2.66	0.84	0.40
BMI	21.77	1.59	21.11	1.60	1.38	0.17
Hunger	47.95	20.49	47.36	28.10	0.08	0.94
Time since last meal (in min)	107.67	63.80	139.29	88.15	1.39	0.17
Gaze direction bias[a]	51.97	6.56	52.63	7.26	0.37	0.75
Initial gaze duration bias[b]	66.81	123.59	93.28	120.94	0.72	0.47
Dwell time bias[b]	32.71	128.03	51.68	129.10	0.49	0.62
Response latency bias[b]	5.99	18.87	5.57	17.48	0.08	0.94

Note. RS = Restraint Scale (Herman & Polivy, 1980), BMI = Body Mass Index. Gaze direction Bias = N of first fixations on high-calorie food stimuli/(N of first fixations on high-calorie food stimuli + N of first fixations on non-food stimuli) * 100. Initial gaze duration bias = mean duration of the sum of initial fixations occurring within region of high-calorie food stimuli when initially fixated on – mean duration of the sum of initial fixations occurring within region of non-food stimuli when initially fixated on. Dwell time bias = mean total dwell time on high-calorie food stimuli – mean total dwell time on non-food stimuli. Response latency bias = Mean response latency in congruent trials – mean response latency in incongruent trials.

[a] In %.

[b] In ms.

[1] Unequal variances: df were corrected to 32,975, and *t* and *p* were reported accordingly.

2.2. Pictorial visual probe paradigm

2.2.1. Overview

Attention biases for high-calorie food were assessed from concurrent eye movements recording and manual response latencies during a visual probe paradigm with pictures of high-caloric food and non-food stimuli (for a complete description of this task, see Werthmann et al. (2011). The visual probe paradigm comprised 120 trials (80 critical and 40 filler trials) which were divided into two blocks of 60 trials. For critical trials, 20 picture pairs, with high caloric food paired with non-food pictures (musical instruments), were presented four times. Picture pairs on filler trials showed neutral non-food objects, each presented four times. Practice trials also used pictures of common non-food items. Pictures used on filler and practice trials were different from those used for critical trials. Image pairs were the same as those used in Werthmann et al. (2011) and were presented for 2000 ms. Each stimulus was presented equally often on the left and right side of the screen. The position of the probe was equally distributed per stimulus type and appeared equally often on the left and right side of the screen. The order of trials was randomized individually for each participant.

2.3. Eye movement measurements

Eye movements were recorded by a desktop mounted Eyelink 1000 system (SR Research, Mississauga, Ontario, Canada) and extracted using Data Viewer (SR Research, Mississauga, Ontario, Canada) exlcuding anticipatory eye movements, gaze fixations in the mid area and filler trials (see Werthmann et al., 2011). Three attention bias scores were calculated: (i) gaze direction bias: the proportion of trials on which the first fixation was directed to a food stimulus versus a non-food stimulus (a score above 50% indicates a higher proportion of first fixations on food stimuli); (ii) initial gaze duration bias: a measure for early attention maintenance, defined as the difference between the sum of fixations between food and non-food stimuli, before gaze was shifted away from the initially fixated picture (a positive score indicates longer initial gaze on food, than non-food, stimuli), and (iii) gaze dwell time bias: the average total dwell time on food versus non-food stimuli (a positive score indicates a bias towards food stimuli), (e.g., Castellanos et al., 2009; Werthmann et al., 2011).

2.4. Manual response latencies to probes

Response times (RTs) were excluded from analyses if they were faster than 200 ms, slower than 2000 ms, and then if they deviated more than 3 *SD*s from each participant's mean (Mogg, Bradley, Hyare, & Lee, 1998). RT bias scores were computed by subtracting the mean RT on congruent trials (i.e., when the probe replaced a food image) from the mean RT on incongruent trials (i.e., when the probe replaced the neutral image). A positive bias score indicates an attention bias towards food.

2.5. Questionnaires

2.5.1. Restrained eating

The Restraint Scale (RS; Herman & Polivy, 1980) assesses weight concerns, weight fluctuations and self-reported attempts to diet, and was used to identify unrestrained and restrained eaters in this study.

2.5.2. Hunger

Subjective hunger was assessed by three 100 mm visual analogue scales (rating how hungry, how much craving, and how much she thought she could eat) and a compound measure was computed for data analyses. Additionally, the participant indicated the time passed since her last meal and time that would elapse until her next meal.

2.6. Procedure

After informed consent and practice trials, the visual probe task was performed. Afterwards, the participant filled in the RS and hunger scales. Height (m) and weight (kg) were measured. Finally, the participant was debriefed and compensated. The local ethical committee approved the study.

3. Results

3.1. Descriptive statistics

Restrained and unrestrained eaters did not differ on hunger measures or BMI when they entered the lab (see Table 1), confirming that average BMI was matched between the groups.

3.2. Attention bias scores

3.2.1. Analyses group as a whole

One sample *t*-tests, comparing gaze direction bias scores against a score of 50% (which indicates no attention bias), revealed a significant gaze direction bias for food cues in the whole sample ($M = 52.28$, $SD = 6.83$, $t(44) = 2.24$, $p = .030$). Overall, participants also showed a bias for food stimuli in later visual attention processes, as revealed by one-sample *t*-tests against 0 (indicating no bias), for initial gaze duration bias ($M = 79.16$, $SD = 121.71$, $t(44) = 4.36$, $p < .0001$); dwell time bias ($M = 41.57$, $SD = 127.42$, $t(44) = 2.19$, $p = .034$); and RT bias ($M = 5.80$, $SD = 18.03$, $t(44) = 2.16$, $p = .037$) scores.

3.2.2. Comparing restrained and unrestrained eaters

Restrained eaters did not differ from unrestrained eaters on any of the bias scores, as shown by independent *t*-tests (all t's < 0.72; all p's > .47), see Table 1.

4. Discussion

The current study was conducted in an effort to unconfound the effects of restraint and weight-status on attentional bias for food and to examine the exact nature of the hypothesized attentional bias for food. Results indicated that, overall, participants showed increased attention to food stimuli relative to non-food stimuli on all attention bias scores. Moreover, these bias scores were not larger for restrained than unrestrained eaters.

These results suggest that attention biases for food cues are "normal" and apparent in healthy weight women, irrespective of restraint level. The lack of an effect of restraint on attention bias could not be explained by other confounding factors, such as hunger or BMI, as these did not differ between the groups. These results are in line with previous studies that also reported no differences in attention biases for food between restrained and unrestrained eaters (Ahern et al., 2010; Boon et al., 2000; Forestell et al., 2012: study 1). Former null results have often been the basis for speculations on whether null findings reflected a lack of attention bias or a zero net effect resulting from the co-occurrence of approach and avoidance processes. The present study did not support these latter speculations, while using an online assessment of eye movements, the most sensitive measure of visual attention currently available (Field et al., 2009).

The present results, however, contrast with findings of previous studies that did report a significant difference in attention bias between restrained and unrestrained eaters (Hollitt et al., 2010; Meule et al., 2012; Overduin, Jansen, & Louwerse, 1995; Veenstra et al., 2010). The present results suggest a possible reason for the divergence of previous results, namely that unconfounding of weight and restraint (as attempted in the current study) eliminates the formerly observed bias effect. Typically, restrained eating and BMI are highly correlated. Indeed, studies that reported an attention bias observed this bias in restrained eaters who were significantly heavier than unrestrained eaters (e.g. Meule et al., 2012; Veenstra et al., 2010). In combination with the present results, these findings suggest that not restraint per se, but weight problems (i.e., overweight and obesity) could have contributed to previously observed differences between restrained and unrestrained eaters. In line with this, several studies have reported differences in attention biases between healthy weight and overweight or obese participants (Castellanos et al., 2009; Nijs et al., 2010; Werthmann et al., 2011).

In conclusion, restrained eating per se does not contribute to biased attentional processing of food stimuli, at least not within healthy weight females. Given that attention biases for food could be universally present, the relationship between attention biases and actual food intake should be further investigated.

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Contributions

All authors contributed to the design of the study and writing the manuscript. JW collected data and conducted the data analysis.

Conflict of interest

None.

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