Make up your mind about food: A healthy mindset attenuates attention for high-calorie food in restrained eaters

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ABSTRACT

Attention bias for food could be a cognitive pathway to overeating in obesity and restrained eating. Yet, empirical evidence for individual differences (e.g., in restrained eating and body mass index) in attention bias for food is mixed. We tested experimentally if temporarily induced health versus palatability mindsets influenced attention bias for food, and whether restrained eating moderated this relation. After manipulating mindset (health vs. palatability) experimentally, food-related attention bias was measured by eye-movements (EM) and response latencies (RL) during a visual probe task depicting high-calorie food and non-food. Restrained eating was assessed afterwards. A significant interaction of mindset and restrained eating on RL bias emerged, $\beta = 0.36$, $t(58) = 2.05$, $p = 0.045$: A health mindset − as compared to a palatability mindset − attenuated attention bias for high-caloric food only in participants with higher eating restraint. No effects were observed on EM biases. The current results demonstrate that state differences in health versus palatability mindsets can cause attenuated attention bias for high-calorie food cues in participants with higher eating restraint. Our findings add to emerging evidence that state differences in mindsets can bias attention for food, above the influence of trait differences.

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Living in an "obesogenic" environment where we are constantly surrounded by palatable food poses a serious challenge for weight control (Hill & Peters, 1998). Paying (too much) attention to high-calorie palatable food may contribute to craving and overeating. Researchers have argued that food cues can become potent to "grab" attention, thereby triggering craving which in turn increases the chance of (over)eating (Nijs & Franken, 2012). Accordingly, it has been suggested that individuals prone to overeating and/or with difficulties to control their weight, such as overweight individuals and restrained eaters, have stronger attention biases for high-calorie food than healthy-weight individuals who do not restrain their food intake (Castellanos et al., 2009; Dobson & Dozois, 2004).

Recently, a surge of empirical studies has been published testing this claim, with contradictory results (see for reviews, e.g., Brooks, Prince, Stahl, Campbell, & Treasure, 2011; Doolan, Breslin, Hanna, & Gallagher, 2015; Roefs, Werthmann, & Houben, 2015; Werthmann, Jansen, & Roefs, 2015). The take home message of these reviews is

that it is unclear whether obese participants, when compared to healthy weight participants, have increased attention bias towards (Castellanos et al., 2009), or away from food (Nummenmaa, Hietanen, Calvo, & Hyona, 2011), or express an approach-avoidance pattern of attention bias for food cues (Werthmann et al., 2011). Moreover, some studies also suggested that obese participants might not differ at all in their attention bias for food compared to healthy-weight participants (e.g., Loeber et al., 2012). Similarly, studies on attentional bias in restrained eaters are equally conflicting, with some evidence pointing towards stronger attention bias for food in high restrained eaters (Brooks et al., 2011; Dobson & Dozois, 2004; Francis, Stewart, & Hounsell, 1997; Meule, Vögele, & Kübler, 2012; Neimeijer, de Jong, & Roefs, 2013), whereas others did not find any difference in food-related attention between high versus low restrained eaters (Ahern, Field, Yokum, Bohon, & Stice, 2010; Boon, Vogelzang, & Jansen, 2000; Werthmann, Roefs, Nederkoorn, Mogg, et al., 2013).

An obvious explanation for the divergent results is the inconsistency and wide range of research methods to assess attentional bias for food and comparison groups that have been used (Roefs et al., 2015; Werthmann et al., 2015). Accordingly, one conclusion from the diversity of results could be that the effect of relatively

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stable individual differences (as body mass index or restraint) on food-related attention bias is not very robust. However, the picture might be more complex. Methodological differences between studies not withstanding, a more important factor contributing to the inconsistency of previous results could be that *state* fluctuations in food motivation within individuals have not been taken into account. It may be too simplistic to only consider the influence of relatively *stable* individual differences in variables such as body mass index and restraint status, which has been the case in most studies addressing group differences. Instead, we argue that an alternative explanation for the diverse results could be that momentary state fluctuations, such as different mindsets, influence attention processing of food cues, possibly in interaction with individual difference factors. The role of these state influences may have been underappreciated in previous work (Roefs et al., 2015).

Momentary state fluctuations in mindset might be triggered by subtle context cues that frame how high-calorie food is perceived. We suggested earlier that the choice of contrast stimuli paired with high-calorie food cues used in attention paradigms may have contributed to the diversity of findings by highlighting either palatability or health aspects of high-calorie food (e.g., Houben, Roefs, & Jansen, 2010; Roefs et al., 2015; Werthmann et al., 2015). For example, depicting high-calorie food next to low-calorie food might stress the adverse health consequences of eating high-calorie food, which in turn could trigger a "health" mindset. Depicting high-calorie food pictures next to neutral, non-food items might emphasize their palatability, thereby contributing to a "palatability" mindset.

Thus, our idea is that next to stable individual differences, momentary variations in mindsets might contribute to attention bias for food and that variations in mindset could be influenced by subtle design differences (e.g. choice of stimuli pairs) across previous studies, which may have obscured previous results based on stable individual group differences.

Preliminary evidence that momentary states such as mindset can influence cognitive processing of food cues is provided by two earlier studies from our laboratory. In a study assessing attention bias for chocolate and non-chocolate cues, attention maintenance on chocolate cues was increased in participants who disclosed at the end of the experiment that they had allowed themselves to eat chocolate in comparison to participants who indicated that they did not allow themselves to eat chocolate (Werthmann, Roefs, Nederkoorn, & Jansen, 2013). Thus, participants' momentary decisions about eating influenced their attention bias for food.

Earlier (Roefs et al., 2006) we also showed that implicit measures of association with high caloric foods were affected by mindset. In this study, overweight and healthy-weight participants were either primed with a health mindset or with a palatability mindset and their positive versus negative associations with high-calorie (palatable and unpalatable) versus low caloric (palatable and unpalatable) food were measured in the affective priming paradigm (Fazio, Sanbonmatsu, Powell, & Kardes, 1986). Associations with food were not affected by weight status, but only by induced mindset, with a palatability mindset leading to relatively

more positive associations with high-calorie and palatable foods (Roefs et al., 2006).

In a similar line, recent research demonstrated that thoughts about food (versus neutral objects), held in the working memory, influenced and steered subsequent attention (Higgs, Robinson, & Lee, 2012; Higgs, Rutters, Thomas, Naish, & Humphreys, 2012; Rutters, Kumar, Higgs, & Humphreys, 2015). Thus, emerging evidence seems to suggest that variations in thoughts or mindsets about food (as state variable) influence perception and attention for food.

In the current study, we tested experimentally if a health versus palatability mindset manipulation affects attention bias for food. We hypothesized that a health mindset would result in decreased attention bias for high-calorie food cues in comparison to a palatability mindset. It is further possible that the impact of mindset on attention might be moderated by trait-like differences in restrained eating. Individuals with higher restrained scores find high-calorie food very attractive but perceive it also as "forbidden" (Houben et al., 2010), and might therefore be more readily susceptible to subtle cues leading to rapid changes in mindsets, which in turn is reflected in their attention allocation for high-calorie food cues. Thus, we hypothesized that attention bias for food would be most affected by our mindset manipulation in participants with higher restrained eating scores.

1. Materials and methods

1.1. Participants

Female students were recruited via advertisements. Only female participants were recruited to sample a relatively homogeneous group and eliminate potential gender effects on attention bias for food. We were unable to calculate the exact sample size because the influence of a mindset manipulation on food-related attentional bias has not been tested previously. We therefore based our sample size on similar sample sizes in previous studies testing attention bias or mindset ranging between 20 and 30 participants per cell. We anticipated that several participants would be excluded due to insufficient number of eye-movements for valid attention bias calculations: When eye-movements are made in less than 50% of critical trials during the visual probe task, participants are identified as "starer" and excluded from analyses (Bradley, Mogg, Wright, & Field, 2003). We therefore decided to extend our recruitment to 64 participants. Four participants were excluded from further analyses because they were identified as "starer" (Bradley et al., 2003), resulting in a final sample of 60 participants. Participants in the "health mindset" condition did not differ from participants in the "palatability mindset" condition on age, body mass index (BMI), and restrained eating, see Table 1 for all participant characteristics.

1.2. Materials

1.2.1. Mindset manipulation

The experimental mindset manipulation was a variation of the

Table 1
Participants characteristics per experimental mindset condition (health mindset vs. palatability mindset).

Characteristics	Health mindset condition (n = 28)		Palatability mindset condition (n = 32)		t(58)	p
	M	SD	M	SD		
Age (in years)	19.33	1.57	19.94	2.19	1.19[a]	0.24
BMI	22.29	2.93	21.72	2.30	0.84	0.40
RS	12.36	5.21	10.91	4.77	1.12	0.27

Note. [a] df = 56, because two participants did not indicate their age at testing BMI = body mass index; RS = Restraint Scale (Herman & Polivy, 1980) scores.

manipulation by Roefs et al. (2006). In both conditions participants received menu-cards and were asked to choose their personal favorite menu options. During the break of the visual probe task the experimental manipulation was boosted by asking participants to look again at the menu and at their favorite food choices.

1.2.1.1. Palatability mindset. To induce a palatability mindset, participants were asked to imagine that their best friend is getting married and asked for their advice for a delicious wedding menu. Participants received a menu consisting of four high-calorie food options per course (starter, intermediate course, main course, dessert). Participants had to choose one meal per course based on their personal preference for the most palatable option. The menu card depicted pictures of gourmet meals (e.g., a festive decorated table, nicely presented high-calorie food) to further prime participants with the concept of palatability.

1.2.1.2. Health mindset. To induce a health mindset, participants were asked to imagine that their best friend wants to lose weight (3–4 kg) and asked for their advice on a healthy menu that will aid achieving this goal. Participants received a menu including four healthy, low-calorie food options per meal (breakfast, lunch, dinner, snack). Participants should choose their favorite meal per mealtime based on their personal preference for the most healthy option. The menu card depicted health-related (food) pictures (e.g. a healthy juice) to further prime participants with the concept of dieting.

1.2.2. Visual probe task

1.2.2.1. Overview. Attention biases towards high-calorie food were assessed by concurrent eye movements recordings and by manual response latencies during a visual probe paradigm, which measures spatial attention (for a complete description of this task, see Werthmann et al. 2011). Participants initially fixated on a fixation cross in the middle of screen. Then two pictorial stimuli were presented side by side for 2000 ms, and then a probe appeared in the position of one of the two stimuli (Werthmann et al. 2011, 2013). Participants had to indicate the location of the probe by pressing a corresponding key on a button box. Attention bias for food stimuli was assessed in critical trials when stimuli consisted of a high-calorie food image paired with a visually matched non-food image. In filler trials, two neutral non-food images were paired based on visual features. Stimuli were the same as in Werthmann et al. (2011). Each stimulus was counterbalanced for the side of the screen (left, right). The position of the probe was counterbalanced per stimulus type and side of the screen (left, right). Overall, 80 critical trials and 40 filler trials were presented, resulting in a total of 120 trials. After 60 trials, a brief break was inserted. The order of trials was randomized individually for each participant.

1.2.2.2. Eye movement measurements. Eye movements were recorded by a desktop mounted EyeLink 1000 system (SR research Ltd., Mississauga, Ontario, Canada) after a 9-point calibration and validation procedure. Attention bias calculations were based on participant's gaze fixations, which were defined as any period that was not a blink or saccade and lasted at least 100 ms (Eyelink Dataviewer User's Manual, 2002–2008, SR Research Ltd.). Eye movements in filler trials, gaze fixations in the mid area of the screen (where no stimuli were depicted) and anticipatory eye movements were excluded from further analyses (Castellanos et al., 2009; Werthmann et al., 2011).

Three attention bias scores were calculated based on eye-movements recordings (Werthmann, Roefs, Nederkoorn, & Jansen, 2013; Werthmann et al., 2011): (i) Direction bias, a measure of early attention allocation, which is calculated as the proportion of trials on which the first fixation was directed to a food stimulus versus a non-food stimulus (N of trial of first fixation on food/N of trials of first fixation on food + N of trials of first fixation on non-food). A score above 50% suggests a direction bias towards food. (ii) Initial gaze duration bias: a measure for early attention maintenance, which is calculated as the duration of all initial fixations on a food stimulus before gaze is shifted away (averaged over the number of trials when food was fixated first) minus the duration of all initial fixations on a non-food stimulus before gaze is shifted away (averaged over the number of trials when non-food was fixated first) (M duration of initial fixations on food − M duration of initial fixations on non-food). A positive score suggests an initial gaze duration bias for food. (iii) Gaze dwell time bias, which reflects maintained attention, is calculated as the total dwell time on food stimuli (averaged over the number of critical trials) minus the total dwell time on non-food stimuli (averaged over the number of critical trials) (M duration on food − M duration on non-food). A positive score suggests a bias in maintained attention for food.

1.2.2.3. Manual response latencies to probes. Response latency bias scores were based on manual response latencies recordings. Response latencies were excluded from analyses if they were errors (0.76% of all trials), if they were faster than 200 ms, slower than 2000 ms, and then if they deviated more than 3 SDs from each participant's mean (1.36% of all trials) (Bradley et al., 2003). Response latency bias scores were computed by subtracting the mean response latency on congruent trials (i.e., when the probe replaced a food image) from the mean response latency on incongruent trials (i.e., when the probe replaced the non-food image). As our stimulus duration time was 2000 ms, positive bias scores suggest maintained attention bias towards food (Bradley et al., 2003).

1.2.3. Manipulation check (visual analogue scales; VAS)

To test if the mindset manipulation affected the importance of palatability and healthiness of food for participants and to evaluate the stability of this effect throughout the assessment of attention bias, a brief self-report manipulation check was conducted at two timepoints: directly after the manipulation (t1) and again after the visual probe task (t2). For this aim, participants were asked to indicate, hidden among other questions, how important they find "healthiness" and "palatability" of food right now on a 100 mm visual analogue scale (VAS) ranging from 0 (not at all important) to 100 (very much important). Due to the experimental design with randomisation of participants to their respective conditions, a baseline measure of momentary importance of palatability and healthiness of food was not necessary. Accordingly, baseline measure of momentary importance of palatability or healthiness was omitted to minimise the chance of initial priming, which could have been induced by thinking about the healthiness of food, prior to the mindset manipulation.

1.2.4. Restrained eating

The Restraint Scale (RS, Herman & Polivy, 1980) was used to measures restrained eating. The RS is a validated self-report scale with 11 items assessing weight concerns, weight fluctuations and self-reported attempts to diet, for example by asking "Do you give too much time and thought to food?". Answers can be scored on a scale from 0 to max. 4 with higher scores indicating stronger intentions to restrict food intake and increased weight concerns.

Internal consistency in the current study was $\alpha = 0.79$.[1]

1.3. Procedure

The institutional Ethic Review Board of the Faculty of Psychology and Neuroscience, Maastricht University, approved this study and all participants signed informed consent. Participants were randomly allocated to either the health mindset or the palatability mindset condition, received their respective experimental instructions and indicated their preferred menu options. Participants then answered the first set of manipulation check questions (t1) on the importance of palatability and healthiness of food. Subsequently, participants completed the first part of the visual probe task. During the break after 60 trials, participants received the manipulation booster in which they were asked to re-read their the experimental instructions and their menu preferences. After completing the remaining 60 trials of the visual probe task, participants filled in the second set of manipulation check questions (t2). Afterwards, a brief awareness check was conducted in which participants were asked to write down what they thought the purpose of the study was. Participants then completed the restraint scale. Height and weight were measured, and participants were thanked for their participation and received a compensation of either a study credit or 7.50€ gift voucher.

2. Results

2.1. Manipulation check

To test if participants in the health mindset condition differed from participants in the palatability mindset condition on their ratings for the importance of healthiness and palatability of food and to evaluate the stability of this effect throughout the visual probe task, a 2 (ratings after the manipulation (t1) vs. ratings after the visual probe task (t2)) × 2 (condition: health vs. palatability mindset) repeated measures ANOVA was conducted separately for both VAS items (palatability and health).

2.1.1. Palatability ratings

Participants in the palatability mindset condition scored the importance of palatability of food on average similarly high, $M = 87.34$, $SD = 10.08$, directly after the manipulation and $M = 83.66$, $SD = 16.10$, after the visual probe task, respectively, as participants in the health mindset condition, $M = 84.71$; $SD = 15.71$, after the manipulation and $M = 83.64$, $SD = 14.47$, after the visual probe task, respectively, $F(1,58) = 0.16$, $p = 0.70$. No main-effects or interaction effects were observed, all Fs (1, 58) < 2.2, all ps > 0.14.

2.1.2. Health ratings

Participants in the health mindset condition rated the importance of health on average higher at both timepoints after the manipulation, $M = 75.54$, $SD = 16.36$, directly after the manipulation and $M = 73.29$, $SD = 17.78$, after the visual probe task, respectively, than participants in the palatability mindset condition, $M = 65.97$, $SD = 21.05$, directly after the manipulation and $M = 62.53$, $SD = 22.40$, after the visual probe task, respectively,

$F(1,58) = 4.59$; $p = 0.036$. This main effect was not qualified by an interaction with time, $F(1, 58) = 0.10$, $p = 0.75$, nor was the main effect of time significant, $F(1,58) = 2.30$, $p = 0.14$, meaning that the effect of our mindset manipulation on health ratings in the health mindset condition remained present during the assessment of attention bias for food.

Thus, our manipulation of mindset was successful in inducing a healthy mindset because results show that participants in the health condition found healthiness significantly more important than participants in the palatability condition during the assessment of attention bias. Based on this result we conclude that we induced a health mindset in the health condition. It seems that our manipulation of palatability was not successful in inducing significant differences in the importance of palatability of food between conditions. Palatability of food seems to be a highly important aspect of food, irrespective of whether health is also considered as important aspect of food.

2.2. Effects of mindset and restrained eating on attentional bias for food

To test if attention bias for food was influenced by mindset condition and individual differences in restraint, four step-wise hierarchical regression analyses were conducted, each with one of the bias measures as dependent variable (direction bias, initial fixation duration bias, dwell time bias and response latency bias). In the first step, restrained eating score (centred) was entered as continuous variable and mindset condition was entered as dummy variable (coded 0 and 1). In the second step, the interaction term of restrained eating × mindset was entered.

Results showed no significant effects of restrained eating, mindset or the interaction of restrained eating × mindset on direction bias, initial fixation duration bias or dwell time bias, with all overall model fits of the complete models including the interaction term $R^2 < 0.04$, Fs (3, 56) < 0.83, all ps > 0.48, no β value was significant in these models either, all ps > 0.16, see Table 2 for predicted mean values of all bias measures per condition, for higher (+1SD) and lower restrained (- 1SD) eaters, respectively.

The regression analysis with response latency bias as dependent variable showed a significant main effect of mindset condition in the first step, $\beta = 0.27$, $t(58) = 2.08$, $p = 0.042$, which was further qualified by a significant restrained eating × mindset interaction, in the second step, $\beta = 0.36$, $t(58) = 2.05$, $p = .045$[2]. Adding the interaction term in step 2 led to a significant change in the explanatory power of the model, $R^2_{Change} = 0.07$, F_{Change} (1, 56) = 4.18, $p = 0.045$, resulting in a significant overall model, $R^2 = 0.14$, $F(3, 56) = 2.93$, $p = 0.042$.[3]

We then proceeded to test the effect of mindset condition on attention bias for participants with higher restrained eating scores (+1 SD) and for participants with lower restrained eating scores (- 1SD) separately. Mindset affected attention bias for food only for participants with higher restrained eating scores, $\beta = 0.52$, $p = 0.005$, whereas attention for food was not influenced significantly by mindset condition for participants with lower restrained

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[1] Note that we also assessed the body image concern inventory (BICI, Wilson & Wallis, 2013), a 19-item self-report questionnaire to measure concerns about appearance and preoccupation with appearance, for a student project, but this questionnaire was not relevant for our target research question. The BICI was administered together with the RS. Internal consistency of the BICI in the current study was $\alpha = 0.82$ and correlation with the restraint scale was strong ($r(60) = 0.43$, $p < 0.01$). Participants in both conditions did not differ in their BICI scores and results obtained for BICI scores were similar to results obtained with RS scores.

[2] The same results were obtained when using BICI scores, instead of restrained eating scores: a significant interaction of BICI scores and condition were observed on the response latency based attention bias measure, but not on other attention bias scores.

[3] Data of our awareness check indicated that one participant might have been potentially aware of the mindset manipulation. Excluding this participants did not, however, affect the main effect of mindset on attention bias, which remained significant, it did however, affect the interaction of mindset condition and restrained eating, resulting in a reduced significance of $p = 0.071$, rendering an overall trend-significant model ($F(3,57) = 2.69$, $p = 0.055$).

Table 2
Predicted mean values of attention bias measures per experimental mindset condition, for high (+1SD) and low-restrained (- 1SD) eaters, respectively.

Bias scores	Health mindset condition		Palatability mindset condition	
	Higher restrained eating (+1 SD)	Lower restrained eating (−1 SD)	Higher restrained eating (+1 SD)	Lower restrained eating (−1 SD)
	Mean	Mean	Mean	Mean
Direction bias	52.77	56.97	53.44	52.81
Initial fixation duration bias	92.89	106.51	22.34	72.26
Dwell time bias	85.79	97.50	42.40	84.04
Response latency bias	−2.36	12.17	30.81	12.62

eating scores, $\beta = 0.007$, $p = 0.97$. As can be seen in Fig. 1, participants with higher restrained eating scores paid less attention to food in the health mindset condition than in the palatability mindset condition. Note that within each condition, participants with higher restrained eating scores did not differ in their attention bias for food from participants with lower restrained eating scores, $\beta = 0.29$, $p = 0.12$ for the palatability condition, $\beta = -0.23$, $p = 0.20$ for the health condition, respectively.

3. Discussion

The current study investigated experimentally if mindset, next to stable individual differences in restraint, influences attention bias for food. This question is important, because, until now, research has largely focussed on testing the influence of relatively stable, trait-like individual differences (such as restrained eating or BMI) on food-related attention bias, with very mixed result (Roefs et al., 2015; Werthmann et al., 2015).

We have argued that it is important to consider differences in current state, such as mindset, when measuring attention bias for food, in interaction with relatively stable trait-like differences. Accordingly, we successfully induced a healthy mindset and were able to show that a health mindset caused an attenuated attention bias for high-calorie food cues on a response latency based measure of attention in participants with higher restraint scores. Participants with lower restraint scores were not affected in their attention bias for food cues by our experimental mindset condition.

Our results demonstrate that it is necessary to take state, next to trait-like variables into account when measuring attention bias for food. In this respect, our result suggests that the way restrained eaters look at food depends on their current mindset (e.g., focus on health aspects versus focus on palatability aspects of high-calorie

food), whereas unrestrained eaters seem to be less influenced by their current mindset. This means that individuals who feel conflicted about eating may be more susceptible for mindset fluctuations. Restrained eaters, who are concerned about their weight but do not necessarily restrict their calorie food intake significantly (Markowitz, Butryn, & Lowe, 2008; Stice, Cooper, Schoeller, Tappe, & Lowe, 2007), may often feel very conflicted about eating: on the one hand they would like to indulge in eating high-calorie food, on the other hand they would like to lose weight and control what they eat (Lowe & Levine, 2005). This conflict may be reflected in the processing of tempting, but "forbidden" food cues, with current mindset influencing whether restrained eaters have an attention bias towards food, when focussing on the palatable aspects of high-calorie food, or show attentional avoidance of food cues, when focussing on the "health" aspects of high-calorie food. In this respect our results might shed light on previous mixed findings of attention bias in restrained versus unrestrained eaters (Werthmann et al., 2015). Restrained eaters fluctuate in their dieting versus non-dieting intentions, irrespective of their overall restraint scores (Lowe, 1993), and thus possibly fluctuate in their mindsets (e.g. having a health mindset when dieting intention are high). These mindset fluctuations within the group of restrained eaters, which have not been assessed in previous research, could have contributed to mixed findings when compared to unrestrained eaters.

Though not specific for restrained eaters, these findings are in line with previous results demonstrating that implicit measures of association with high-calorie food were influenced by mindset (Roefs et al., 2006). Our results also fit with another study showing that the induction of chocolate craving through chocolate exposure caused an attention bias for chocolate (Smeets, Roefs, & Jansen, 2009) thereby demonstrating that situational (e.g. exposure) and internal state differences (e.g. craving) can also influence
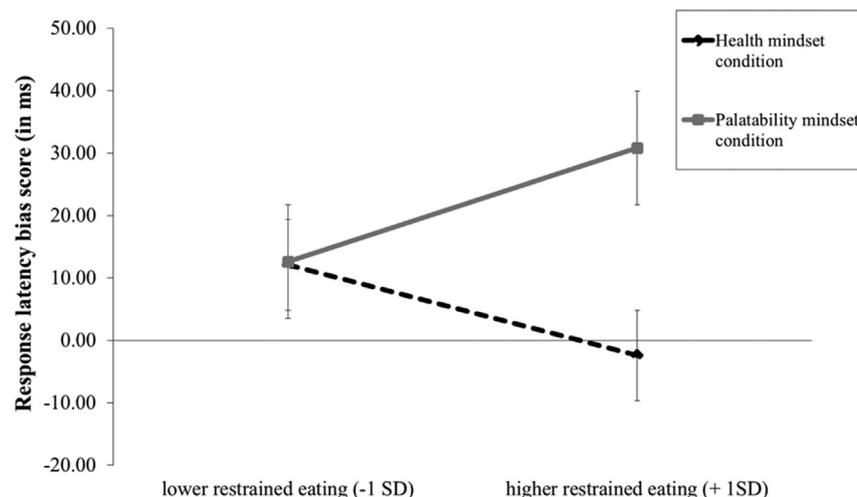

Fig. 1. Response latency (RL) bias (in ms) as a function of restrained eating style (respectively 1 SD below and 1 SD above the mean RS scores) and mindset condition.

attentional bias for food cues.

Thus, our results contribute to emerging evidence that state variables (such as situation, internal state, decision about eating) influence an attention bias for food, possibly through triggering different mindsets, and moreover suggest that particularly individuals who feel ambivalent about high-calorie food might be more susceptible to the influence of state fluctuations on their attention processing of food cues. In line with this argument, attention researchers from other psychology domains have also stressed the importance of considering state anxiety as well as trait-anxiety, and the stability of attentional bias for threat cues over time (Heeren, Philippot, & Koster, 2014), to take momentary variations in substance-related motivation into account when assessing attentional bias for drug cues (Christiansen, Schoenmakers, & Field, 2015) and demonstrated goal dependence of attention processing (Vogt, Lozo, Koster, & De Houwer, 2011). This highlights that variations in motivational states and goals, and corresponding mindsets, should be considered when assessing attention bias, for example either by experimentally controlling for mindsets or by incorporating the assessment of mindsets or motivational states when measuring attention bias.

Thus, our current results offer an overlooked alternative explanation for the diversity of previous findings of a food-related attentional bias based on relatively stable group-differences in eating behaviour or weight status (Roefs et al., 2015). Obese participants and restrained eaters might have varied considerably in their mindset for food, both within as well as between individuals, during the assessment of food-related attention in previous studies, including our own studies, which may have influenced the direction of attention bias in between-group comparisons. To gain a more accurate understanding of the impact of food-related attention bias on eating behaviour and weight, our results stress the necessity to account for variations in mindsets on attentional processing in future research, at least when testing participants with higher restrained eating behaviour. Our findings may also have clinical implications by suggesting that it could be more helpful to modify mindsets rather than modifying attentional bias when targeting malfunctional food-related cognitions.

Note that our manipulation of mindset was only successful in inducing a health mindset. Our interpretation about the influence of mindset on attention bias in restrained eaters should be viewed under this limitation. It is also to note that we observed significant effects only on the response latency measure of attention bias, but not on attention bias measures based on eye movements. Researchers have argued that response latency might be a less accurate or insightful measure for attention than the more direct assessment provided by eye-tracking (Field & Christiansen, 2012; Field & Cox, 2008; Field, Munafó, & Franken, 2009; Werthmann et al., 2015). Moreover, recent research suggest that the internal reliability of response latency based measures of attention in the alcohol-related visual probe task is low (Christiansen, Mansfield, Duckworth, Field, & Jones, 2015). At this moment, we can only speculate why we found the effect of mindset only for this bias score: It is possible that mindset affects attention processing only at a very late stage of attention allocation, namely just shortly before response selection, which is not captured by the measure of maintained attention based on eye-tracking data (which is averaged over the total trial duration). It is also possible that our experimental manipulation was not strong enough to affect earlier indices of biased attention. It is also possible that clinical groups are needed to fully demonstrate this effect on other attention bias measures. Moreover, a post-hoc power calculation suggested that the sample size of the present study was slightly underpowered. Accordingly, future research directives could be to increase stimulus duration, in order to capture later attention processes, to strengthen the mindset manipulation, or to replicate the study in clinical and larger samples. In this study we focussed on testing the effects of inducing a health versus palatability mindset and effects of these opposing mindsets on attentional processing of unhealthy food, however, it could be interesting for future research to test an additional "neutral mindset" control condition, to disentangle the effects of being primed with health versus palatability versus having a neutral mindset about food on attentional processing.

3.1. Conclusion

Thus, even though our findings warrant replication, overall our results add to emerging evidence from initial studies that current motivational states have been an overlooked psychological factor explaining variance in cognitive domains (e.g., attention bias or implicit measures of associations, see Roefs et al., 2011; Roefs et al., 2015). Here, we provide first experimental evidence that state differences in health versus palatability mindsets can cause attenuated attention bias for high-calorie food cues in participants with higher eating restraint.

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