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Components of Attentional Bias for Food Cues among Restrained Eaters

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Running head: Attentional bias and dietary restraint

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Abstract

The study aimed to investigate attentional bias for food cues among restrained eaters. In particular, the roles of speeded detection (enhanced orientation of attention toward food stimuli) and slowed disengagement (trouble disengaging attention from food stimuli) were examined. Participants were 78 female undergraduate students aged 18-25 years, classified as restrained (*N* = 38) or unrestrained eaters (*N* = 40). Attentional bias was assessed by a visual search task which required participants to locate the position of an odd-one-out target word in a matrix of 19 distractor words. Restrained eaters were disproportionately faster than unrestrained eaters to detect a food word within a neutral matrix compared to a neutral word within a neutral distractor matrix. Restrained eaters were also disproportionately faster, rather than slower, than unrestrained eaters to detect a neutral word within a food matrix compared to a neutral word within a neutral distractor matrix. Thus restrained eaters show a heightened vigilance for food cues, but no slower disengagement from such cues.

Keywords: attentional bias, dietary restraint, food cues, odd-one-out visual search task, speeded detection

Restrained eaters are characterised by chronic weight and shape concerns, which lead them to intentionally restrict their intake of food and calories (Ruderman, 1986). Such dietary restraint can give rise to a number of negative consequences, including low self esteem, and increased levels of anxiety and depression (Appleton & McGowan, 2006). Compared to unrestrained eaters, restrained eaters also show impaired cognitive performance, particularly on tasks involving concentration (Williams et al., 2002) and speeded responding (Green, Rogers & Elliman, 2000).

Another potentially negative consequence of dietary restraint is a preoccupation with food and eating (Cogan & Ernsberger, 1999; Polivy & Herman, 2002). Restrained eaters are more attuned to food cues in the environment, and attempt to avoid these in order to control their body weight (Green, Elliman & Rogers, 1997; Green & Rogers, 1993). This food preoccupation affects the way in which restrained eaters process information about food. In particular, using a modified Stroop task, several studies have shown that restrained eaters exhibit delayed colour-naming of food words, indicative of an attentional bias for food cues (Francis, Stewart & Hounsell, 1997; Green & Rogers, 1993; Overduin, Jansen & Louwerse, 1995; Perpina, Hemsley, Treasure & de Silva, 1993; Stewart & Samoluk, 1997). This attentional favouring is an automatic process that occurs implicitly (i.e., outside of conscious awareness). However, it should be noted that not all studies have found differences between restrained and unrestrained eaters in colour-naming of food words (Lattimore, Thompson & Halford, 2000; Sackville, Schotte, Touyz, Griffiths & Beumont, 1998).

Biased attentional processing of food cues has generally been interpreted as a heightened vigilance for food. However, more recent investigations, based on Posner and Peterson’s (1990) attentional framework, suggest that this bias could reflect either an enhanced orienting of attention toward food, or slowed disengagement (i.e., a difficulty disengaging attention from food), or both. The Stroop task cannot distinguish between these two possible mechanisms. A more recent task that can make this distinction is the odd-one-out visual search task (Rinck, Reinecke, Ellwart, Heuer & Becker, 2005). In this task, participants are presented with a matrix of stimuli and asked to indicate whether one of the stimuli belongs to a different category from the others (i.e., is the odd-one-out). Among anxiety populations this task has shown speeded detection of, as well as slowed disengagement from, threatening stimuli. In particular, Rinck et al. found that spider-fearful individuals were faster to detect a spider picture among non-spider pictures, and slower to detect a non-spider picture among spider pictures, than non-anxious controls. In the context of food, speeded detection of a food stimulus among non-food stimuli would indicate a shift of attention toward food, while slowed detection of a non-food stimulus among food stimuli would indicate difficulty disengaging attention from food.

Smeets, Roefs, van Furth and Jansen (2008) used the odd-one-out search task to examine these attentional mechanisms in the processing of food and body-related stimuli in a sample of patients with eating disorders. In each of two tasks, participants were presented with matrices of 20 words. In the food task, participants searched for a food word among non-food words, or for a non-food word among food words. In the body task, participants searched for a body-related word among non-body words, or for a non-body word among body-related words. Smeets et al. found that in the food task, the patients were slower to detect a non-food word among high-caloric food words than healthy controls, indicative of slowed disengagement; however, they showed no evidence of speeded detection of either high or low-caloric food words. In contrast, in the body task, the patients did show facilitated detection of body-related words. However, contrary to the notion of slowed disengagement, they were also faster, rather than slower, to detect a non-body word among body-related words.

The present study aimed to use the odd-one-out visual search task to disentangle the mechanisms of speeded detection and slowed disengagement in the attentional processing of food cues in restrained eaters. Specifically, we compared restrained and unrestrained eaters on this task to examine whether food stimuli capture the attention of restrained eaters, and whether once captured, restrained eaters have difficulty shifting their attention from food stimuli.

Method

Participants

Participants were 78 women aged 18 to 25 years (*M* = 19.47, *SD* = 1.56) recruited from the Flinders University undergraduate student population. Participants were requested to eat something 2 hours prior to their testing session to ensure that they were not hungry, as individuals who are hungry have been reported to show a general attentional bias for food stimuli (Mogg, Bradley, Hyare, & Lee, 1998). Compliance with this request was assessed by asking participants to indicate how long since they had last eaten. Additionally, participants were asked to rate their level of hunger on a 100-mm visual analogue scale ranging from ‘not at all hungry’ to ‘extremely hungry’. No participant had last eaten more than 3 hours prior to the testing session or reported a hunger score of more than 70.

Materials

Odd-one-out visual search task

The odd-one-out visual search task was adapted from Rinck et al. (2005) and Smeets et al. (2008). In these studies, participants were simply asked to determine ('yes' or 'no') without any verification whether there was an odd-one-out stimulus that belonged to a different category within the matrix. The present study improved on this methodology by requiring participants to specifically indicate the location of the odd-one-out stimulus in the matrix to ensure that participants had actually correctly detected it.

Participants were seated approximately 60 cm in front of a 17-inch computer touch screen. On each trial, a fixation cross was presented in the centre of the screen for 500 ms, followed by a 5 × 4 matrix of 20 words. The matrix contained 19 words that belonged to the same category and one word that belonged to a different category (i.e., the odd-one-out). Participants were asked to locate the odd-one-out word by touching it on the computer screen. They were instructed to respond as quickly and as accurately as possible. The matrix remained on screen until a response was made or for a maximum of 30 s. The inter-trial interval was 1000 ms. To ensure that participants' hands were the same distance from the screen at the beginning of each trial, they were instructed to place their hands face down on a computer mat after each response.

The experiment was performed using Presentation® software (Version 12.10, www.neurobs.com), as it provides sub-millisecond temporal precision and complete timing information for all stimulus and response events. Words were presented in 20-point black font and displayed on a light-grey background with a monitor resolution of 1280 × 1024 pixels. Within the frame of the matrix, the words were horizontally separated from their mid-point by 6.75 cm and vertically separated by 6.5 cm.

Stimuli

There were three basic forms of matrix: (1) one food target word among 19 neutral distractor words, (2) one neutral target word among 19 food distractor words, and (3) one neutral target word among 19 neutral distractor words from a different category. The food words were chosen to be high-caloric (e.g., chocolate, chips) because these are considered to be the most "dietary forbidden" and salient to restrained eaters (Knight & Boland, 1989). The two neutral categories consisted of vehicles (e.g., motorbike, truck) and musical instruments (e.g., saxophone, drum). Each set of neutral stimuli was taken from a single semantic category to ensure that there was no mistaking to which category a word belonged (Green, Elliman, & Rogers, 1996). The vehicle words were a subset from Mogg et al.'s (1998) study using the dot probe task, whereas the musical instruments were translated from Smeets et al. (2008). The list of food words was constructed from both studies in order to be matched on word length: *M* (food) = 5.79, *M* (vehicle) = 5.63, *M* (musical instrument) = 5.79, *t*s < 1, *p*s > .05.

The three stimulus categories gave rise to 6 combinations: (1) one food word among 19 vehicles, (2) one food word among 19 musical instruments, (3) one vehicle word among 19 food words, (4) one musical instrument among 19 food words, (5) one vehicle word among 19 musical instruments, and (6) one musical instrument among 19 vehicles. There were 19 trials per combination, giving a total of 114 trials per participant. The location of each word in each matrix was random for each trial and each participant, with the constraint that the odd-one-out word did not appear directly above or below the fixation cross to avoid facilitated detection (Smeets et al., 2008). There were 12 practice trials with stimulus words from the categories of animals and office supplies.

Response times were collated for the three basic matrix types: food in neutral (combinations 1 and 2); neutral in food (combinations 3 and 4); and neutral in neutral (combinations 5 and 6).

Dietary restraint

Participants were divided into restrained and unrestrained eaters on the basis of the mid-point (3) of the Restraint Scale of the Dutch Eating Behavior Questionnaire (DEBQ) (van Strien, Frijters, Bergers, & Defares, 1986). This scale consists of 10 questions that ask participants how often they engage in certain eating behaviours (e.g., “Do you watch exactly what you eat?”). Responses are recorded on a 5-point Likert scale, ranging from 1 (never) to 5 (very often). Averaged scores range from 1 to 5, with a higher score indicating a higher level of dietary restraint. The restraint scale has high test-retest reliability (r = .92) (Allison, Kalinsky, & Gorman, 1992), and high internal consistency (α = 95) (van Strien et al., 1986). Internal consistency was also high in the present sample (α = .94). Fortuitously, the median fell at the mid-point of the scale, resulting in 38 restrained eaters (score above 3) and 40 unrestrained eaters (score of 3 or below).

Height and weight

Participants recorded their height and weight, from which body mass index (BMI) was calculated as the ratio of weight (in kg) to height (in m^2).

Procedure

Participants were tested individually in the Applied Cognitive Psychology Laboratory in a single session of 30 min. duration. Participants first completed a brief background questionnaire, followed by the odd-one-out visual search task, the self-report measures of height and weight, and finally the Restraint Scale.

Results

Sample characteristics

Mean restraint scores were 3.79 (*SD* = .53) for restrained eaters and 2.21 (*SD* = .60) for unrestrained eaters, $t(76) = 12.39$, $p < .001$. Importantly, the low and high restraint groups did not differ significantly on a number of important variables which could potentially explain any observed differences found in attentional bias. In particular, as indicated in Table 1, restrained and unrestrained eaters did not significantly differ on age, hunger or BMI (all *t*s < 1, *p*s > .05).

Odd-one-out visual search performance

As is common practice, data from trials with errors were discarded. To eliminate outliers, response times more than 3 *SD*s above or below the mean were also excluded (Smeets et al., 2008). Errors and outliers accounted for 5.7% of the data (cf. 8.6-8.9% in Smeets et al., 2008). Partial eta squared (η^2) was used as the effect size measure, with cut-off values of .01, .06, and .14 for small, medium and large effects, respectively (Kittler, Menard, & Phillips, 2007).

In the visual search task, speeded detection is determined by comparing response times for the food in neutral with the neutral in neutral matrix types. Slowed disengagement is determined by comparing response times for the neutral in food with the neutral in neutral matrix types.

Speeded detection of restrained and unrestrained eaters

To investigate speeded detection in restrained and unrestrained eaters, reaction times were analysed by a 2 (group: restrained eaters, unrestrained eaters) × 2 (matrix type: food in neutral, neutral in neutral) repeated measures ANOVA. The main effect of matrix type was significant, $F(1, 76) = 330.14$, $p < .001$, $\eta^2 = .81$. On average, participants were significantly faster to locate a food target in a neutral matrix (M = 5515 ms, SD = 1050 ms) compared to locating a neutral target in a neutral matrix (M = 7371 ms, SD = 1258 ms), indicating overall speeded detection of food stimuli. The main effect of group approached significance, $F(1, 76) = 2.93$, $p = .09$. Most importantly, there was a significant, moderate sized group × matrix type interaction, $F(1, 76) = 7.91$, $p < .05$, $\eta^2 = .09$, as illustrated in Figure 1. Post-hoc comparisons showed that the difference in reaction times for the two matrix types (food in neutral vs. neutral in neutral) was significantly greater for restrained eaters (M = 2144 ms, SD = 1041 ms) than for unrestrained eaters (M = 1570 ms, SD = 747 ms), $t(76) = 2.81$, $p < .05$. These results provide evidence for relatively greater speeded detection of food stimuli in restrained eaters.

Slowed disengagement of restrained and unrestrained eaters

To investigate slowed disengagement in restrained and unrestrained eaters, reaction times were analysed by a 2 (group: restrained eaters, unrestrained eaters) × 2 (matrix type: neutral in food, neutral in neutral) repeated measures ANOVA. The main effect of matrix type was significant, $F(1, 76) = 368.12$, $p < .001$, $\eta^2 = .83$. On average, participants were significantly faster to locate a neutral target in a food matrix (*M* = 5340 ms, *SD* = 908 ms) compared to locating a neutral target in a neutral matrix (*M* = 7371 ms, *SD* = 1258 ms). The main effect of group approached significance, $F(1, 76) = 3.13$, $p = .08$. Importantly, there was a significant group × matrix type interaction of moderate to large effect size, $F(1, 76) = 8.11$, $p < .05$, $\eta^2 = .10$. However, as illustrated in Figure 1, the interaction was in the opposite direction to that predicted. Post-hoc comparisons revealed that the difference in reaction times for the two matrix types (neutral in food vs. neutral in neutral) was again significantly greater, rather than smaller, for restrained eaters (*M* = 2333 ms, *SD* = 1019 ms) than for unrestrained eaters (*M* = 1730 ms, *SD* = 847 ms), $t(76) = 2.85$, $p < .05$. Thus, restrained eaters do not have greater difficulty disengaging attention from food cues.

Discussion

Previous research using the modified Stroop task has found that restrained eaters display a general attentional bias for food cues (Francis et al., 1997; Green & Rogers, 1993; Overduin et al., 1995; Perpina et al., 1993; Stewart & Samoluk, 1997). The present study attempted to disentangle this attentional bias by examining whether speeded detection, slowed disengagement, or both of these attentional processes play a role. To achieve this aim, restrained and unrestrained eaters were compared on the odd-one-out visual search task.

We found support for greater speeded detection of food cues among restrained eaters. The difference in reaction times for the food in neutral and the neutral in neutral matrix types was greater for restrained than for unrestrained eaters. This result shows that restrained eaters display an enhanced orientation of attention toward food cues, supporting interpretations of a heightened vigilance for food cues found in previous studies using other methodologies such as the Stroop task (Francis et al., 1997; Green & Rogers, 1993; Overduin et al., 1995; Perpina et al., 1993; Stewart & Samoluk, 1997). Most likely because of their preoccupation with food (Cogan & Ernsberger, 1999; Polivy & Herman, 2002), restrained eaters' attention is more readily captured by environmental food cues.

It needs to be noted, however, that unrestrained eaters also showed speeded detection for food cues, although to a lesser extent. This is not particularly surprising, as food is personally relevant to all human beings because of its survival function. Other studies using other tasks have similarly shown a less pronounced general attentional bias for food cues in unrestrained eaters (Green & Rogers, 1993; Perpina et al., 1993; Stewart & Samoluk, 1997).

In contrast, we found no support for slower disengagement from food cues among restrained eaters. The difference in reaction times for the neutral in food and the neutral in neutral matrix types was again greater, rather than smaller, for restrained than for unrestrained eaters. This finding shows that restrained eaters do not experience more difficulty shifting attention away from food cues. One possibility is that the food words were more salient to restrained eaters, making them relatively more distinctive and therefore more easily distinguishable from the neutral words. Consequently, restrained eaters could not only detect a food word among neutral words more easily, but could also detect a neutral word among food words more easily. Thus, restrained eaters found it easier to differentiate the food and neutral categories than to distinguish between the two neutral categories.

Another possibility is that of attentional avoidance, whereby restrained eaters, with their greater weight concerns, may seek to avoid food stimuli because of what they represent, viz. potential weight gain. Such an avoidance response, coupled with a heightened vigilance, is consistent with studies of attentional bias in anxiety research. For example, using a modified exogenous cueing task, Koster, Crombez, Verschuere, Van Damme and Wiersema (2006) found that high trait anxious individuals showed an initial enhanced attention to threat, followed by an attentional avoidance. Similarly, in an eye-tracking study, Rinck and Becker (2006) showed that spider-fearful individuals initially fixated on a spider picture presented among pictures of other animals, but then quickly diverted their gaze from the spider. Similar exogenous cueing or eye-tracking paradigms could be used to test the vigilance-avoidance of food stimuli in restrained eaters.

This greater salience and/or attentional avoidance of food words seem likely a function of the use of high-caloric food words in the current odd-one-out visual search task. These were deliberately chosen to be “dietary forbidden” (Knight & Boland, 1989). The use of high-caloric food words could also account for the similar (although less marked) pattern observed in unrestrained eaters. Specifically, various healthy eating campaigns continually remind us all to avoid eating too much unhealthy (high-caloric) foods. Thus high-caloric foods are likely to carry generally greater salience and elicit both conscious and implicit attempts to avoid them among the population at large. Future investigations could usefully incorporate low-caloric foods in the odd-one-out visual search task. Additionally, to improve ecological validity, pictorial food stimuli could be used instead of words.

Taken together, our findings indicate that restrained eaters display a facilitated detection of food cues, but once detected, they have no trouble disengaging attention from these cues. This pattern of results is at odds with the Smeets et al. (2008) findings for eating disordered patients in their odd-one-out food search task. In contrast to our restrained eaters, these patients did not show a rapid shift of attention toward food cues (no speeded detection), but when they were confronted with such cues, they had difficulty disengaging attention from them. Our results do, however, exactly mirror those of Smeets et al. for their body search task, i.e., speeded detection of body-related words, but no slowed disengagement from these words. This suggests that individuals who suffer from eating disorders exhibit a heightened vigilance for body-related cues (but not for food cues), in line with more consistent Stroop and dot probe findings of greater vigilance for body shape stimuli than food stimuli in eating disordered populations (Faunce, 2002; Lee & Shafran, 2004), whereas restrained eaters exhibit a heightened vigilance for food cues. This discrepancy in target of attentional processing may reflect the respective major concerns of eating disorder patients (body) and restrained eaters (food). Thus the implicit processing of food and body-related information might be able to distinguish between individuals who engage in the kind of dietary restriction which characterises the “normal” eating of women in Western societies (Polivy & Herman, 1985) from those who may be at risk of developing an eating disorder. Future research could usefully more systematically investigate this intriguing possibility.

Although restrained eaters were relatively faster to detect both food words within neutral matrices, and neutral words within food matrices (compared to neutral words within neutral matrices), in absolute terms they were in fact slower than unrestrained eaters to detect neutral words within neutral distractor matrices. This slowed responding to neutral matrices could be indicative of a general cognitive slowing. This interpretation fits with previous reports of longer reaction times in restrained eaters (Green et al., 2000) and poorer general cognitive performance among weight-loss dieters (Green et al., 1997, 2003; Green & Rogers, 1998; Kemps & Tiggemann, 2005; Kemps, Tiggemann & Marshall, 2005; Shaw & Tiggemann, 2004;

Vreugdenburg, Bryan & Kemps, 2003). Such performance decrements have generally been attributed to restrained eaters' preoccupation with food-related thoughts which are primarily verbal in nature. As these preoccupying thoughts take up limited verbal processing resources, they leave fewer available for competing verbal demands, such as distinguishing words from different semantic categories as in the present study. In support, several studies have shown that dieters' preoccupation with food contributes to poorer performance on specifically verbal tasks (Green & Rogers, 1998; Shaw & Tiggemann, 2004; Vreugdenburg et al., 2003). Future studies could include a reaction time task to further test the possibility that restrained eaters respond more slowly in general on the food search task.

In addition to clarifying the underlying theoretical mechanisms of biased attentional processing of food cues in restrained eaters, the results have important practical implications. Clearly there is an abundance of food and eating cues (e.g., fast food outlets, bill-boards, television advertisements) in our contemporary "obesogenic" environment (Wadden, Brownell & Foster, 2002). Accordingly, individuals have little choice but to encounter such cues on a daily basis. Our results indicate that restrained eaters in particular will automatically be drawn to these cues, even though reminders of food are the very thing that they are consciously trying to avoid. This facilitated detection of food cues likely makes it very difficult for restrained eaters to maintain their dietary restriction, and potentially contributes to the high rates of relapse and breaking of diets (Polivy, Herman & Coelho, 2008).

In conclusion, the current study represents the first attempt to disentangle the components of attentional bias for food cues in restrained eaters. In so doing, it extends our understanding of the complexity of the cognitive processes that underlie this bias.

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Table 1

Descriptive Statistics for Sample Characteristics

	Restrained eaters		Unrestrained eaters	
	M	*SD*	*M*	*SD*
Restraint	3.79	.53	2.21	.60
Age	19.63	1.70	19.33	1.42
Hunger	35.93	24.84	36.74	21.77
BMI	22.84	3.08	23.11	4.11

Figure captions

1. Mean reaction times (with standard errors) for the three matrix types (food in neutral, neutral in food and neutral in neutral) for restrained and unrestrained eaters. Speeded detection is determined by comparing the food in neutral and the neutral in neutral matrix types. Slowed disengagement is determined by comparing the neutral in food and the neutral in neutral matrix types.

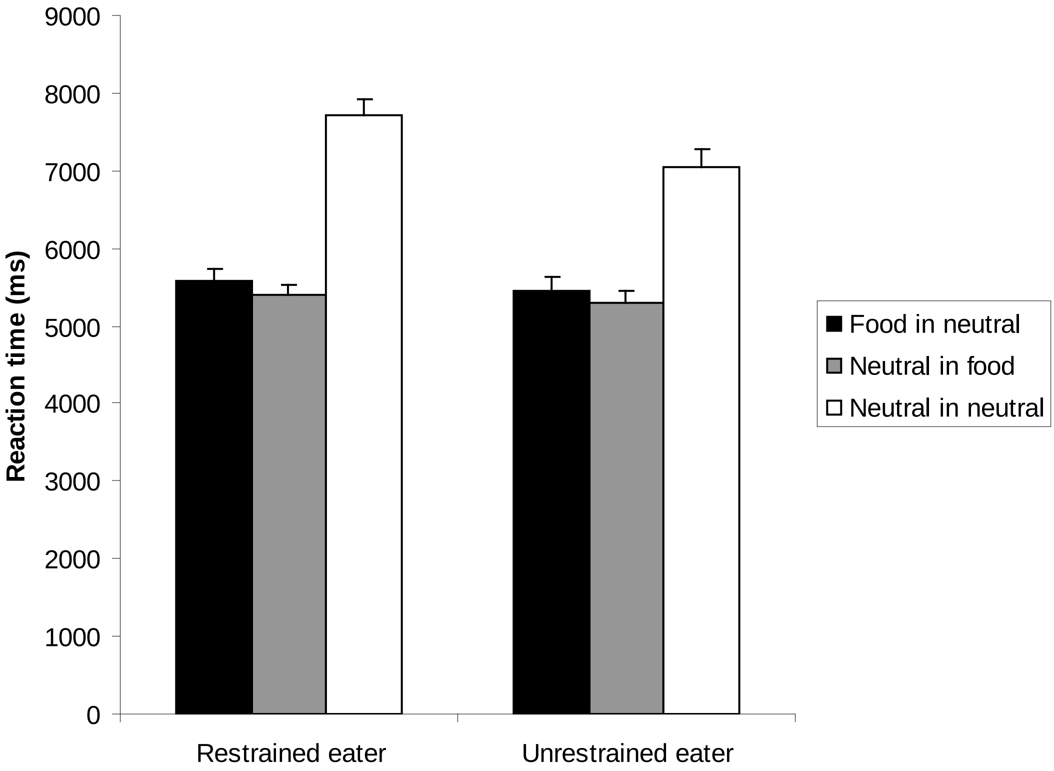
9000
8000
7000
6000
5000
4000
3000
2000
1000
0
Reaction time (ms)
Restrained eater
Unrestrained eater
Food in neutral
Neutral in food
Neutral in neutral

Figure 1.