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Attentional Bias Modification Encourages Healthy Eating

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Abstract

The continual exposure to unhealthy food cues in the environment encourages poor dietary habits, in particular consuming too much fat and sugar, and not enough fruit and vegetables. According to Berridge's (1996) model of food reward, unhealthy eating is a behavioural response to biased attentional processing. The present study used an established attentional bias modification paradigm to discourage the consumption of unhealthy food and instead promote healthy eating. Participants were 146 undergraduate women who were randomly assigned to two groups: one was trained to direct their attention toward pictures of healthy food ('attend healthy' group) and the other toward unhealthy food ('attend unhealthy' group). It was found that participants trained to attend to healthy food cues demonstrated an increased attentional bias for such cues and ate relatively more of the healthy than unhealthy snacks compared to the 'attend unhealthy' group. Theoretically, the results support the postulated link between biased attentional processing and consumption (Berridge, 2009). At a practical level, they offer potential scope for interventions that focus on eating well.

Keywords: food cues, attentional bias modification, modified visual probe task, consumption

Attentional Bias Modification Encourages Healthy Eating

1. Introduction

The contemporary Western diet is characterised by consuming too much fat and sugar, and not enough fruit and vegetables. These unhealthy eating behaviours increase the risk of chronic health problems such as obesity (NHMRC, 2003). The global prevalence of obesity has doubled over the last few decades, with 35% of adults classified as overweight and 11% as obese (WHO, 2013). This increasing rate of overweight and obesity has been linked to many factors, including attitudes, beliefs, information, habits, cultural bias, as well as the environment (Polivy, Herman & Coelho, 2008). One aspect of the environment that likely contributes to unhealthy eating is the ready availability of high-caloric foods, in particular the continual exposure to visual food cues through advertising in magazines and on billboards (Havermans, 2013). The present study focused on one potential link between food cue exposure and unhealthy eating, namely biased attentional processing (Polivy et al., 2008). An attentional bias is a 'form of cognitive bias involving preferential attention to one particular type of information' (MacLeod & Matthews, 2012, p.191). Unhealthy food cues are more likely to automatically capture attention as they are seen as attractive, rewarding and palatable (Polivy et al., 2008).

Recent studies have demonstrated attentional biases for unhealthy food cues in a range of eating-related populations. These have shown that restrained eaters (individuals who restrict their food intake) (Hollitt, Kemps, Tiggemann, Smeets, & Mills, 2010) and external eaters (individuals who eat in response to external food cues e.g., the sight of food) (Brignell, Griffiths, Bradley, & Mogg, 2009; Nijs, Franken, & Muris, 2009; Hou et al., 2011), as well as overweight and obese individuals (Castellanos et al., 2009; Njis, Muris, Euser, & Franken, 2010), are faster to respond to a range of high-caloric food cues relative to neutral (non-food) cues. A few studies have further examined the relationship between such biased attentional processing of food cues and unhealthy eating. In particular, Nijs et al. (2010) and Werthmann et al. (2011) reported a positive correlation between attentional bias for high-caloric snack foods and the subsequent consumption of these foods. In addition, Calitri, Pothos, Tapper, Brunstrom and Rogers (2010) found that attentional bias for unhealthy food words predicted an increase in weight (BMI) over a 12 month period.

One theory that explains the relationship between biased attentional processing of food cues and consumption is Berridge's (2009) model of food reward. According to this model, motivational value is attributed to food cues through classical conditioning. Food cues (e.g., the sight or smell of food) in the environment become salient through continual association with a rewarding experience (i.e., eating). As a result, they capture attention, which then drives the consumption of that food. These processes can occur implicitly, without necessary conscious awareness.

Given the potential negative health consequences of unhealthy eating, it is important to modify such behaviour. According to Berridge's (1996) model of food reward, one way to counter unhealthy eating may be to focus on changing the underlying cognitive process, in particular, the attentional bias. Thus, it is proposed that decreases in the attentional bias for unhealthy food will lead to decreases in the consumption of unhealthy food. Supporting evidence comes from alcohol research (e.g., Field and Eastwood, 2005; Field et al., 2007) which has used a visual dot probe task, originally developed to modify attentional biases in the anxiety literature (MacLeod, Rutherford, Campbell, Ebsworthy, & Holker, 2002). For example, Field and Eastwood (2005) trained heavy social drinkers to direct their attention towards, or away from, alcohol-related cues. Specifically, a dot probe consistently replaced alcohol-related pictures (‘attend alcohol’ group) or neutral pictures (‘avoid alcohol’ group). As predicted, participants in the ‘attend alcohol’ group showed an increased attentional bias for alcohol cues, whereas those in the ‘avoid alcohol’ group showed a decreased bias for such cues. Importantly, participants in the ‘avoid alcohol’ group drank less beer in a subsequent taste test than those in the ‘attend alcohol’ group. Therefore, Field and Eastwood were able to show that an experimental manipulation of attentional bias for alcohol reduced beer consumption.

One study has extended this finding into the food domain. Kemps, Tiggemann, Orr, and Grear (in press) showed that attentional bias modification for chocolate cues affected chocolate consumption in young women. Specifically, participants in the ‘attend chocolate’ group showed an increased attentional bias for chocolate cues, whereas those in the ‘avoid chocolate’ group showed a reduced bias for such cues. In addition, participants in the ‘avoid chocolate’ group subsequently ate less of a chocolate product (muffin) than those in the ‘attend chocolate’ group. Therefore, Kemps et al. were able to show that a similar experimental manipulation of attentional bias reduced chocolate consumption.

The present study aimed to determine whether attentional bias modification can discourage the consumption of unhealthy food in general (defined as food containing a high amount of sugar or fat, e.g., cake, chips), beyond the specific food of chocolate. In addition, the study sought to use the established attentional re-training paradigm in a novel way, namely to induce an attentional bias for healthy food cues and thereby, increase the consumption of healthy food (e.g., fruit, vegetables, fish). Thus, in contrast to previous attentional re-training protocols for alcohol (Field & Eastwood, 2005) and chocolate (Kemps et al., in press), people were trained towards a desirable outcome (healthy food), as well as being trained to avoid an undesirable one (unhealthy food).

A number of hypotheses were derived from these aims. Specifically, it was predicted that training would produce changes in attentional bias between groups, such that participants trained to attend to healthy food cues would show an increase in attentional bias to healthy foods (and a reduced attentional bias to unhealthy foods), whereas participants trained to attend to unhealthy food cues would show an increase in attentional bias to unhealthy foods (and a reduced attentional bias to healthy foods). It was also predicted that changes in attentional bias would be related to subsequent consumption, such that participants trained to attend to healthy food cues would eat more healthy snacks (relative to unhealthy snacks) than those trained to attend to unhealthy food cues.

2. Method

2.1. Participants

Participants were 146 women from the Flinders University undergraduate student population. They were aged 18-25 years (*M* = 20.16, *SD* = 2.19). Most participants were within the healthy weight range (i.e. 18.5-24.9 kg/m^2) with a mean BMI of 22.2 kg/m^2 (*SD* = 4.16). Only women were recruited as they have shown a greater tendency to overeat (Burton, Smit, & Lightowler, 2007). Participants were included if they spoke English as their first language, liked most foods, and did not have any food allergies or dietary requirements. As hunger has been shown to increase attentional biases for food cues (Mogg, Bradley, Hyare, & Lee, 1998), participants were instructed to eat something two hours before the session to avoid being hungry. All participants reported having complied with this instruction.

2.2. Design

The study used a 2 (training condition: attend healthy food, attend unhealthy food) x 2 (time: pre-training assessment, post-training assessment) mixed factorial design. It should be noted that in the ‘attend’ healthy food condition participants also ‘avoided’ unhealthy food, and conversely, in the ‘attend’ unhealthy food condition participants also ‘avoided’ healthy food. Participants were randomly assigned to one of the two training conditions, with equal numbers in each condition.

2.3. Materials

2.3.1. Visual dot probe task

A modified version of the visual dot probe task was used to train participants to attend to pictures of healthy or unhealthy food. The pictures were divided into 16 critical pairs (healthy-unhealthy food) and 16 control non-food pairs (animal-animal). This differs from previous attentional bias studies because the negative stimulus (unhealthy food) was paired with a positive stimulus (healthy food) rather than a neutral one (e.g., office supplies, modes of transport). The pictorial stimuli comprised coloured photographs of healthy foods (e.g., fruit, sushi), unhealthy foods (e.g., chocolate, chips), and animals (e.g., giraffe, koala). The healthy food pictures were obtained from a pilot study conducted with 20 women aged 18-25 years (M = 21.60, SD = 1.50). Participants were asked to rate 36 pictures of healthy food items on 9-point pleasure and arousal scales. The ratings for the unhealthy food pictures were obtained from a previous pilot study (Kemps et al., in press). Based on these ratings, pairs of healthy and unhealthy food pictures were created so that the pictures in each pair were individually matched on pleasure and arousal. The animal pictures were obtained from a study by Kemps, Tiggemann and Hollitt (under revision) and depicted species not commonly eaten in Western society.

Each trial of the dot probe task began with the display of a fixation cross in the centre of the computer screen for 500 ms. This was followed by the presentation of the picture pair for 500 ms. The pictures were displayed on the left and right hand side of the screen and were an equal distance (40 mm) from the centre. Immediately after the pictures disappeared, a probe stimulus (small dot) appeared in the location of one of the pictures and remained there until the participant responded. Participants were asked to indicate, as quickly and accurately as possible, whether the probe replaced the picture on the left or the right side of the screen by pressing the corresponding key labelled as ‘L’ (z) or ‘R’ (/) on the computer keyboard.

Based on standard attentional bias modification procedures (MacLeod et al., 2002), the re-training task involved three phases: (1) pre-training assessment, (2) training, and (3) post-training assessment. Phases 1 and 3 were essentially the same and consisted of 128 trials. The 16 critical pairs (healthy-unhealthy food) and the 16 control pairs (animal-animal) were presented in a different random order for each participant. Each picture pair was presented four times, once for each of the picture (left, right) and probe location (left, right) replacement variations. The dot probes replaced the pictures in each pair with equal frequency (50/50).

Phase 2, the training phase, consisted of 256 trials. Each of the 16 critical picture pairs were presented 16 times (eight times on each side of the screen). Following previous research (Schoenmakers et al., 2007), a 90/10 contingency was used to manipulate attentional bias. Specifically, in the ‘attend healthy’ condition, the dot probes replaced healthy food pictures in 90% of trials and unhealthy food pictures in 10% of trials. In the ‘attend unhealthy’ condition, the dot probes replaced unhealthy food pictures in 90% of trials and healthy food pictures in 10% of trials.

2.3.2. Taste test task

Consumption was measured using a so-called taste test. Participants were presented with a platter of four individual bowls equally filled; there were two healthy snacks, strawberries and mixed unsalted nuts, and two unhealthy snacks, chocolate M&Ms and potato crisps. These snack foods were chosen as they are commonly eaten and are bite-sized to facilitate eating. The presentation order of the bowls was counterbalanced across participants using a 4x4 Latin square. Participants were instructed to taste and rate each snack on several dimensions (e.g., sweetness, saltiness). They were given 10 minutes to complete their ratings and told that they could try as much of the food as they liked. Each bowl was weighed (in grams) before and after the taste test.

2.3.3. Contingency awareness

Following Field and Duka (2002), participants' awareness of the contingency (i.e., the relationship between picture type and dot probe location) during the training phase was assessed with a brief questionnaire. Participants were first given an open-ended question asking them to describe the relationship between picture type and dot probe location. They were then given a multiple-choice question asking them to select the correct option from five statements describing possible relationships (e.g., 'dots mainly appeared on the same side of the screen as healthy food pictures'). Some studies have shown that training only affects those who are aware of the contingencies (Field & Duka, 2002). Others suggest that awareness does not impact training effects (Field & Eastwood, 2005; Field et al., 2007).

2.4. Procedure

The experiment took place in the Food Laboratory in the School of Psychology at Flinders University, South Australia. The testing session took approximately 45 minutes.

After providing informed consent, participants completed a brief demographics questionnaire, followed by the dot probe task, the taste test, and finally the self-report measures of contingency awareness. The study was approved by the University's Social and Behavioural Research Ethics Committee.

3. Results

3.1. Statistical considerations

An alpha value of .05 was used to determine significant *p* values. Effect size measures used were partial eta^2 for ANOVA and Cohen's *d* for *t*-tests. For partial eta^2, .01, represented a small effect, .06, a medium effect, and .14, a large effect and for Cohen's *d*, .20 represented a small effect, .50 a medium effect, and .80 a large effect (Cohen, 1992).

3.2. Attentional bias

The reaction time data used were from the critical trials of the pre-training and the post-training phases of the modified version of the dot probe task. Following previous studies (e.g., Nijs et al., 2010), the small number of incorrect responses (2.41%) were removed. Reaction times that were less than 150 milliseconds and greater than 1500 milliseconds (0.12%) were also excluded, as indicative of responses that were due to anticipation or a lapse in concentration (e.g., Kemps & Tiggemann, 2009).

An attentional bias score was calculated for each of the pre-training and post-training assessment phases by subtracting the mean reaction time to the dot probes replacing healthy food pictures from the mean reaction time to the dot probes replacing unhealthy food pictures. Therefore, positive scores indicated an attentional bias towards healthy food pictures, while negative scores indicated an attentional bias towards unhealthy food pictures.

Participants showed an initial tendency for an attentional bias toward unhealthy food cues that fell just short of significance (M = -2.92, SD = 20.04), t(145) = 1.76, p = .08. Importantly, there was no pre-existing difference in attentional bias between the two experimental groups, t(144), = .19, p = .85.

To assess the effect of training on attentional bias, a 2 (training condition: attend healthy, attend unhealthy) x 2 (time: pre-training, post training) mixed model ANOVA was conducted. As predicted, there was a significant interaction between training condition and time, F(1,144) = 6.12, p = .02, p^2 = .04. As can be seen in Figure 1, paired samples t-tests revealed that participants trained to attend to healthy food showed a significant increase in attentional bias toward healthy food from pre-training to post-training, t(72) = 2.17, p = .03, d = .34. Although participants trained to attend to unhealthy food similarly showed an increase in attentional bias toward unhealthy food cues, this change was not statistically significant, t(72) = 1.31, p = .19.

3.3. Consumption

To measure consumption, the total amount of each food consumed was calculated by subtracting the weight (in grams) of the snacks after the taste test from the weight of the snacks before the taste test. The weight in grams was then converted into the number of kilojoules consumed for each food. The two healthy snack foods were summed, as were the two unhealthy snack foods. Following Field and Eastwood (2005), the amount of healthy snack food consumed as a proportion of total snack food consumption was then compared between the two training conditions. An independent samples t-test revealed that participants in the attend healthy group (*M* = .49, *SD* = .20) consumed significantly more healthy snack food relative to unhealthy snack food than participants in the attend unhealthy group (*M* = .42, *SD* = .19), $t(144) = 2.23$, $p = .03$, $d = .36$.

3.4. Contingency awareness

A little over half (*n* = 84; 57.5%) of the participants correctly recalled or recognised the relationship between the type of picture and the location of the probes during the training phase. The other 62 participants (42.5%) were not aware of (or at least did not report) the contingency. To examine the effect of contingency awareness on attentional bias scores and consumption, the previous ANOVAs were repeated with awareness (aware, unaware) as an additional between-subjects factor. Across analyses, there was no main effect of awareness or, most importantly, any interactions involving awareness (all *F*s <1, *p*s > .05).

4. Discussion

The present study investigated whether attentional re-training using the visual dot probe task could be used to manipulate attentional processing and the consumption of healthy and unhealthy snack foods. The findings clearly show that the re-training protocol produced the predicted changes in attentional bias. Furthermore, increasing the attentional bias towards healthy food cues resulted in increased relative consumption of healthy snack food.

The finding for attentional bias replicates previous findings for alcohol (Field & Eastwood, 2005) and chocolate cues (Kemps et al., in press). Here, participants in the ‘attend healthy’ (‘avoid unhealthy’) re-training group reported a significantly reduced attentional bias for unhealthy food cues after training. Thus, this finding extends the existing work on attentional re-training from avoidance of one specific food, namely chocolate, to foods high in fat or sugar (unhealthy food) in general.

To our knowledge, the current study represents the first attempt at using attentional bias modification to train people towards healthy appetitive cues, rather than merely training them to avoid unhealthy ones. Here, training participants to attend to healthy food cues actually induced an attentional bias for these cues. The finding that people's attention can be directed towards positive (healthy food) cues is a novel one. Previous studies have only used neutral cues as a contrast to negative reward-related cues such as alcohol (Field & Eastwood, 2005) and chocolate (Kemps et al., in press).

While training participants to attend to healthy food cues induced an attentional bias to such cues, the same did not apply to unhealthy food. Although participants in the 'attend unhealthy' group showed an increase in attentional bias for unhealthy food after training, this increase was not statistically significant. This is perhaps not surprising as participants already showed an initial tendency to direct their attention towards unhealthy food cues (which fell just short of significance), and hence may have resulted in less scope for any increase in attentional bias.

Importantly, the results confirmed that manipulating attentional biases for healthy and unhealthy food also affected subsequent food intake. In particular, the participants trained to attend to healthy food consumed relatively more of the healthy than unhealthy snack foods compared to those trained to attend to unhealthy food. Thus, the current study extends on previous findings for beer (Field & Eastwood, 2005) and chocolate (Kemps et al., in press) by using attentional bias modification in a novel way, namely, to encourage the consumption of healthy food, as well as to discourage the consumption of unhealthy food. As this training approach primarily focuses on promoting positive behaviour (healthy eating), it may well have greater acceptability than one that focuses on avoiding negative behaviour (not eating certain foods).

The current findings have theoretical implications for the underlying mechanisms proposed in Berridge's (1996) model of food reward. For example, the finding that training participants to attend to healthy food cues induced an attentional bias for such cues is consistent with the predicted link between repeated exposure to food-related cues and biased attentional processing. The results also support the causal link postulated between biased attentional processing and consumption. Specifically, after an attentional bias towards healthy food cues was induced in the 'attend healthy' group, participants consumed relatively more healthy snacks. In addition, the impact of training on attentional bias and consumption was not dependent upon whether or not participants were aware of the experimental contingency. This is consistent with the proposition that biased attentional processing can occur implicitly (i.e., rewarding cues automatically capture attention), and confirms some previous studies which showed no effect of contingency awareness (Field & Eastwood, 2005; Field et al., 2007).

The present study also has some important practical implications. The results show that attentional bias modification can be used to direct attention away from unhealthy food, towards healthy food, as well as to encourage healthy snack food intake. These findings offer potential scope for those individuals most vulnerable to the abundance of unhealthy food cues in the contemporary environment, such as overweight and obese individuals (Castellanos et al., 2009, Nijs et al., 2010) as well as restrained eaters (Hollitt et al., 2010), and external eaters (Brignell, et al., 2009; Nijs, et al., 2009; Hou et al., 2011).

A number of limitations of the present study need to be acknowledged. First, this study focused on modifying an attentional bias for unhealthy food cues. This is only one of many factors that have been linked to unhealthy eating. Future studies will need to also investigate the interaction of other factors (e.g., attitudes, beliefs, information, habits, and cultural bias) that contribute to eating behaviour. Second, this study used a sample of young female undergraduate students who reported no existing weight or eating problems. Future studies should aim to extend these findings to individuals with problem eating behaviours, who likely have a stronger pre-existing attentional bias towards unhealthy food. Third, the current study showed immediate effects of attentional re-training on attentional bias and consumption. Future research should aim to investigate the stability of these effects to determine whether they can be sustained over time.

Despite the above limitations, the present study has demonstrated that it is possible to experimentally induce an attentional bias for healthy food, which translates into relatively greater healthy snack consumption in young women. These findings have theoretical implications for the mechanisms underpinning consumption, as well as practical implications for the use of attentional bias modification as an intervention aimed at discouraging unhealthy eating, and instead promoting healthy eating. This is particularly important in a contemporary Western environment characterised by such an abundance of unhealthy food cues.

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