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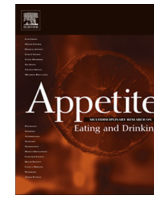

Research report

The effects of food-related attentional bias training on appetite and food intake ☆

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ABSTRACT

Obese and overweight individuals show a marked attentional bias to food cues. Food-related attentional bias may therefore play a causal role in over-eating. To test this possibility, the current study experimentally manipulated attentional bias towards food using a modified version of the visual probe task in which cake-stationery item image pairs were presented for 500 ms each. Participants ($N = 60$) were either trained to attend to images of cake, trained to avoid images of cake, or assigned to a no-training control group. Hunger was measured before and after the training. Post-training, participants were given the opportunity to consume cake as well as a non-target food (crisps) that was not included in the training. There was weak evidence of an increase in attentional bias towards cake in the attend group only. We found no selective effects of the training on hunger or food intake, and little evidence for any gender differences. Our study suggests that attentional bias for food is particularly ingrained and difficult to modify. It also represents a first step towards elucidating the potential functional significance of food-related attentional biases and the lack of behavioural effects is broadly consistent with single-session attentional training studies from the addiction literature. An alternative hypothesis, that attentional bias represents a noncausal proxy for the motivational impact of appetitive stimuli, is considered.

Introduction

Cues that are associated with the receipt of food are ubiquitous in Westernised environments. Food deprivation has been shown to increase selective attention to food-relevant stimuli (Mogg, Bradley, Hyare, & Lee, 1998; Placanica, Faunce, & Soames Job, 2002). An attentional bias to food cues might also be associated with over-consumption. Indeed, several studies, using different methodologies, have shown a marked attentional bias to food in overweight and obese individuals, (Castellanos et al., 2009; Nijs, Muris, Euser, & Franken, 2010; Nummenmaa, Hietanen, Calvo, & Hyönä, 2011; Werthmann et al., 2011; Yokum, Ng, & Stice, 2011). Evidence for a direct relationship between attentional bias and food intake in experimental studies is mixed (Nijs et al., 2010; Werthmann et al., 2011). Furthermore, cross-sectional studies do not provide insight into the direction of causality between attentional bias and over-eating or weight status. However, a higher food-related attentional bias, as measured by the emotional Stroop task, was found to predict greater weight gain over time in university students (Calitri, Pothos, Tapper, Brunstrom, & Rogers, 2010). Interestingly, this relationship was not found using a dot probe measure of attentional bias. Different measures of food-related attentional bias are only weakly correlated with each another and this suggests that they are tapping into different underlying processes (Pothos, Calitri, Tapper, Brunstrom, & Rogers, 2009).

The prospect that food-related attentional bias plays a causal role in overeating is consistent with more general models of addictive behaviour. The incentive sensitization theory (Robinson & Berridge, 1993, 2008) holds that, through repeated administration of substances of abuse, a sensitized dopaminergic response develops which causes such substances to become highly desired and 'wanted'. Through classical conditioning, a cue that is related to the substance also becomes highly salient, so that it grabs attention (i.e., attentional bias) and guides behaviour towards obtaining the incentive goal. Moreover, the relationship between attentional bias and substance craving is believed to be "mutually excitatory" whereby an increase in one produces a corresponding increase in the other (Field & Cox, 2008). Consistent with this idea, the experimental induction of craving for chocolate has been found to

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increase attentional bias to chocolate cues (Smeets, Roefs, & Jansen, 2009).

The converse relationship, that attentional bias increases craving and consummatory behaviours, can be tested by experimentally manipulating attentional bias ("attentional training") using a modified version of the visual probe task. In this task, a substance-related stimulus (e.g., drug- or food-related) and a neutral control stimulus are concurrently presented on a computer screen. When the stimuli disappear, the visual probe appears in the location that one of the stimuli occupied. During attentional training, the probe replaces either the substance-related or neutral stimulus on a greater number of trials, thereby "training" participants' attention towards a particular stimulus type. Using this procedure, Field and Eastwood (2005) trained heavy drinkers to attend towards alcohol images ('attend-alcohol' group) or neutral images ('avoid-alcohol' group). The attend-alcohol group showed an increase in subsequent alcohol attentional bias while the avoid-alcohol group showed a decrease, thus confirming the effectiveness of the training. Importantly, craving and alcohol consumption were higher in the attend-alcohol group relative to the avoid group, which is suggestive of a causal role for attentional bias. Other single-session attentional training studies to alcohol- and smoking-related stimuli using the modified probe task have shown effects on post-training attentional bias; however, the effects on subsequent craving and consummatory behaviours have been inconsistent (Attwood, O'Sullivan, Leonards, Mackintosh, & Munafò, 2008; Field et al., 2007; Field, Duka, Tyler, & Schoenmakers, 2009; McHugh, Murray, Hearon, Calkins, & Otto, 2010; Schoenmakers, Wiers, Jones, Bruce, & Jansen, 2007). The aforementioned studies used a stimulus presentation duration (the stimulus onset asynchrony, or SOA) of 500 ms. A bias that is observed with this SOA is likely to reflect maintained attention (i.e., delayed disengagement), while a shorter SOA (50–200 ms) most plausibly reflects the initial orientation of attention (Field & Cox, 2008). Field, Duka, et al. (2009) found that attentional training successfully modified attentional bias for smoking stimuli regardless of the SOA that was employed (50 vs. 500 ms). It has also been found that effects on subsequent attentional bias are limited to the trained stimuli; that is, they do not often generalize to non-target alcohol- or smoking-related stimuli that were not explicitly used in the training (Field, Duka, et al., 2009; McHugh et al., 2010; Schoenmakers et al., 2007).

To date, the application of attentional training in the food literature has been limited. Smith and Rieger (2009) trained female participants to attend to either high-calorie food words, low-calorie food words, or neutral words using the modified visual probe task where the SOA was 500 ms. The training induced the desired attentional biases. However, participants trained to the high-calorie food words were more likely to choose a low-fat biscuit over a full-fat biscuit relative to the control group. A possible explanation is that the repeated exposure to high-calorie food words during the attentional training acted as a diet reminder, and dieters have been shown to make more healthy choices when they are reminded of dieting goals (Papies & Veling, 2013). In this way (and contrary to the findings from the addiction literature), training attention towards high-calorie food stimuli could actually reduce caloric intake. However, Smith and Reiger did not measure actual food intake and included only female participants who might be particularly susceptible to this sort of effect due to high levels of dietary restraint. One may therefore expect to see gender differences in the effects of attentional training on food intake.

The aim of the current study was to examine the effect of experimentally-manipulated food-related attentional bias on hunger and food intake in male and female participants. Using a modified visual probe task with an SOA of 500 ms, participants were either trained to attend to images of cake (attend group), trained to avoid images of cake (avoid group), or assigned to a no-training control group (control group). Firstly, attentional bias to cake was predicted to increase in the attend group and decrease in the avoid group (*Hypothesis 1*). Secondly, subjective hunger was predicted to be higher in the attend group relative to the avoid or control groups (*Hypothesis 2*). Thirdly, the attend group was predicted to show greater consumption of cake relative to a non-target food (crisps) that was not included in the training and in comparison to the other groups (*Hypothesis 3*). Fourthly, female participants in the attend group were predicted to show greater consumption of a low-fat "healthier" version of the cake, relative to male participants (*Hypothesis 4*). To test these latter two hypotheses, the food intake measure included high- and low-fat versions of both the cake and the crisps.

Method

Participants

Sixty undergraduate students (35 female, 25 male) participated in the study. They all had normal-to-corrected vision and gave written informed consent to participate. Participants were told that the study was about reaction times and food preferences. Ethics approval was granted by the Faculty of Science Human Research Ethics Committee, University of Bristol. Participants were alternately allocated to one of three attentional training conditions: trained towards cake (attend group); trained away from cake (avoid group); and no training (control group). All participants were instructed to refrain from eating for at least 2 h prior to the study.

Stimuli

Stimuli consisted of 16 images each showing a different type of cake, presented as a standard portion (according to the manufacturer's guidelines). Each cake image was paired with an image of a neutral stationery item (e.g., a roll of tape, a stapler) and the images were matched on visual characteristics such as shape and colour. Cake and stationery items were photographed individually, positioned in the centre of a plain white background, with a high-resolution digital camera. An additional four image pairs, showing stationery items only, were used in practice trials. Each image was 84 mm wide by 59 mm high (actual displayed size) at a resolution of 300 dpi.

Attentional training task

The task was adapted from that used in the smoking study by Attwood, O'Sullivan, Leonards, Mackintosh, and Munafò (2008) and consisted of 768 trials. Each trial began with the presentation of a fixation cross centrally on a computer screen for 500 ms. This was followed by presentation of a cake–stationery image pair for a further 500 ms. After the disappearance of the image pair, a probe (either a circle or a square) appeared for up to 2000 ms in one of the two screen locations previously occupied by an image. Participants were required to identify each probe by pressing pre-defined keys on the keyboard as quickly as possible. The probe disappeared once the participant had made a response. The response latency was recorded for each trial. The task consisted of 512 training trials (presented in four blocks) and 256 test trials. Half of the test trials (128) were presented prior to the training trials and half (128) after the training trials, in order to assess the effects of the training trials on attentional bias. In all test trials, the probe replaced the cake or neutral images in equal frequency. In the training trials, the probe always replaced the cake images (attend group), always replaced