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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.

Keywords

Attentional training; hunger; food intake; incentive salience; craving; addiction

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

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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 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 two hours 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 d.p.i.

Attentional Training Task

The task was adapted from that used in the smoking study by (Attwood et al. 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 the neutral images (avoid group), or replaced the cake or neutral images in equal frequency (control group). Prior to starting the task, participants completed 8 practice trials which consisted of stationery items only. The attentional training task was run using E-prime software (Psychology Software Tools Inc., Pittsburgh, PA, USA).

Procedure

Upon arrival at the laboratory, participants provided a baseline hunger rating on a 100-mm visual analogue scale (VAS). Depending on their group allocation, they then completed the appropriate version of the attentional training task (*i.e.*, attend, avoid, or control). This typically took around 45 min and participants were able to take short breaks in between blocks of trials to minimise boredom and fatigue. A second measure of hunger was taken immediately following completion of the task.

Participants were then invited to take part in a "food preferences test" which included four foods; these were high-fat cakes ("Mini Brownies", Thorntons plc, Alfreton, UK; 20.6%

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fat), low-fat cakes (“Weight Watchers Chocolate Chip Slice”, Lightbody Celebration Cakes Ltd., Hamilton, UK; 9.8% fat), high-fat crisps (Walkers Snacks Ltd., Leicester, UK; 34.1% fat), and low-fat crisps (“Walkers Light”; Walkers Snacks Ltd., Leicester, UK; 22.1 % fat). Note that an image of the high-fat cake was used in the attentional training task. The food preferences test thus included high- and low-fat versions of both the target food (*i.e.*, cake) and non-target food (*i.e.*, crisps) in order to test *Hypotheses 3* and *4*. Each food was presented as a standard portion (according to manufacturer’s guidelines); this was important in order to ensure that the presentation of the cakes was well-matched to the images that were presented during the attentional training. Each food was presented on a white plate. A label displaying the name and brand of the food, and whether it was high- or low-fat, was clearly displayed on the plate. In total, 841 kcal of food was presented (high-fat cake, 390 kcal per 88g portion; low-fat cake, 203 kcal per 58g portion; high-fat crisps, 133 kcal per 25g portion; low-fat crisps, 115 kcal per 25g portion). As part of the task, participants were asked to rate their liking for each food (100-mm VAS) and they also indicated how often they usually ate the food (*never*, *rarely*, *occasionally*, *frequently*, or e*very day*). They were given 5 minutes to complete this task and were invited to eat as much of each food as they wished. Following task completion, the researcher covertly weighed all foods to determine consumption. Participants then completed the restraint and disinhibition scales of the Three Factor Eating Questionnaire (TFEQ) (Stunkard & Messick, 1985). The restraint scale consists of 21 items, for example, “I deliberately take small helpings as a means of controlling my weight”. The disinhibition scale consists of 16 items that assess tendency toward overeating, for example, “Sometimes when I start eating, I just can’t seem to stop”. Finally, the participants’ height (cm) and weight (kg) were measured.

Statistical Analyses

Reaction time (RT) data from trials with incorrect responses were discarded (2.4% of data). To eliminate outliers, RTs were excluded if they were more than 2 standard deviations above or below the mean across all trials (4.4% of data). Attentional bias scores were then calculated by subtracting RTs to probes that replaced cake images from RTs to probes that replaced neutral images. A positive score therefore indicated an attentional bias towards the cake images (*i.e.*, faster RTs to cake images relative to neutral images). A negative score indicated an attentional bias towards the neutral images. For each participant, two attentional bias scores were computed, at pre-training and post-training, respectively. A one-sample *t*-test was used to determine whether the pre-training attentional bias score was different from zero.

To examine the effect of the training on attentional bias scores, a mixed analysis of variance (ANOVA) was conducted with group (attend, avoid, control) as the between-subject factor and time (pre-training, post-training) as the within-subjects factor. A the presence of a group by time interaction would indicate differential effects on attentional bias score as a function of training group (*Hypothesis 1*).

Hunger data were analysed using a mixed ANOVA with group (attend, avoid, control) as the between-subjects factor and time (pre-training, post-training) as the within-subjects factor. A

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group by time interaction would indicate differential effects on hunger as a function of training group (*Hypothesis 2*).

The food intake data were analysed using a mixed ANOVA with group (attend, avoid, control) and gender as between-subjects factors and food category (target cake, non-target crisps) and food label (high-fat, low-fat) as within-subject factors. In order to adjust for differences in calorie content across the four foods (see Procedure), the percentage consumed of each food was computed for each participant (*i.e.*, by dividing the amount consumed of each food by the total kcal of that food *e.g.*, 195 kcal consumed of the total 390 kcal of high-fat cake would be expressed as 50% consumption). The dependent variable for food intake was percentage kcal consumed. *Hypothesis 3* predicted greater consumption of the target food (cake) in the attend group relative to the non-target food (crisps) and relative to the other groups; this effect would be indicated by a group by food category interaction. *Hypothesis 4* predicted that female participants in the attend group would consume more of the low-fat version of the target food, relative to male participants and to the other groups; this effect would be indicated by a group by gender by food category by food label interaction.

Results

Participant Characteristics

Participants had a mean age of 23.2 (*SD* = 8.8) years and a mean BMI of 22.4 (*SD* = 2.7) kg/m^2. As would be expected, females had higher scores than males on TFEQ-restraint (means ± *SD*s; 9.4 ± 5.7 and 4.4 ± 3.0, respectively) and disinhibition (8.1 ± 3.3 and 6.2 ± 2.1, respectively) (both $p < 0.01$). Training groups did not differ on age, BMI, restraint, disinhibition or pre-training ratings of hunger (Table 1).

Attentional Training

Across all participants, the mean bias score for the first block of test trials (*i.e.*, pre-training) was 15.6 ms. This was greater than zero, $t(59) = 3.9$, $p < 0.001$, indicating an initial, pre-training attentional bias towards the cake images in all participants. Pre-training attentional bias was positively correlated with disinhibition ($r = .29$, $p = 0.03$) but not with restraint ($r = .22$, $p = 0.09$) or BMI ($r = -.19$, $p = 0.16$).

Pre-training and post-training attentional bias scores in the three groups are shown in Figure 1. Post-training bias scores were higher in the attend group relative to the avoid and control groups. There was weak evidence for the hypothesized group by time interaction, $F(1, 57) = 3.0$, $p = .056$ (*Hypothesis 1*).

Post hoc, we tested whether the effects of the attentional training trials might have been extinguished over the course of the 128 post-training test trials (*i.e.*, these were 50/50 trials where the probe replaced the cake and neutral images in equal frequency). The post-training test trials were split into two halves and the mean attentional bias scores within each half were computed. Mean attentional bias scores did not differ in the first half of these test trials [*i.e.*, trials 1-64, mean (*SD*) = 15.1 (40.6) ms] compared to the second half of the trials [trials

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65-128, mean (*SD*) = 14.9 (42.7) ms], $F(1, 57) = 0.001$, $p = .98$. Crucially, there was little evidence of an interaction between trial half and group, $F(1, 57) = 0.07$, $p = .93$.

Appetite and Food Intake

For hunger, there was a main effect of time, $F(1, 57) = 36.4$, $p < 0.001$, which reflected increased levels of hunger from baseline to post-training in all groups (Mean ± *SD* = 55.1 ± 24.0 and 66.7 ± 21.7 mm, respectively). There was little evidence of an interaction between time and group, $F(1, 57) = 0.85$, $p = 0.43$ (*Hypothesis 2*).

For food intake (percentage kcal consumed), there was little evidence for the hypothesized group by food category interaction, $F(2, 54) = 0.88$, $p = .42$ (*Hypothesis 3*). Similarly, the group by gender by food category by food label interaction was not evident, $F(2, 54) = 0.64$, $p = .53$ (*Hypothesis 4*). There was little evidence for a main effect of group [$F(2, 54) = 0.89$, $p = .42$] indicating no overall effect of training group on food intake (Figure 2). There was a main effect of gender [$F(1, 54) = 7.0$, $p =.01$] indicating greater percentage consumption in men compared to women [Means (*SE*) = 41.1% (3.8) and 28.2% (3.2), respectively]. There was also a main effect of food label [$F(1, 54) = 28.8$, $p < .001$] indicating greater percentage consumption of the high-fat foods relative to the low-fat foods [Means (*SE*) = 42.5% (3.0) and 26.8% (2.7), respectively].

A series of one-way ANOVAs, conducted for each food separately, found no group differences for the ratings of food liking or food familiarity (all *p*s > 0.19).

Discussion

Cross-sectional and prospective studies suggest that food-related attentional bias might play a causal role in over-eating. To test this possibility, the current study experimentally manipulated attentional bias towards cake using an attentional training procedure. The resultant effects on hunger and food intake were examined.

Our first hypothesis predicted that attentional bias to cake would increase in the attend group and decrease in the avoid group. Attentional bias did increase in the attend group following training, however, the magnitude of this increment (12 ms, see Figure 1) was modest. In addition, the avoid group showed a post-training attentional bias to cake that was indistinguishable from the no-training control group. Other studies, in contrast, have reported much larger increases in attentional bias when participants are trained towards alcohol- or smoking-stimuli (≥ 30 ms), as well as meaningful reductions in the respective avoid-training groups (Attwood, et al., 2008; Field & Eastwood, 2005). Our attentional training task was adapted from that used by Attwood et al. and, importantly, the number of training trials (512) was consistent. Therefore the divergent results in our study do not appear attributable to differences in the duration of attentional training. Post hoc, we tested the idea that the trained attentional bias might have been “extinguished” during the post-training test trials (*i.e.*, where the probe replaced the cake and neutral images in equal frequency); however we found little evidence for this to be the case. To our knowledge, only one other study has examined the effects of food-related attentional training on dietary behaviour (Smith & Rieger, 2009). While this training appeared to successfully modify attentional bias (interestingly, using fewer training trials than in our study), these authors did not report the initial pre-training bias scores in the different training groups. It is possible, therefore, that group differences in attentional bias were present prior to the training.

Our data did show an existing attentional bias to food images prior to attentional training. Together with the modest effects of our training, this suggests that food-related attentional bias might be particularly ingrained and difficult to modify. A single-session of attentional training may not be sufficient to induce changes. It will be important for future studies to investigate the behavioural effects of several sessions of attentional training. Interestingly, more stable and generalizable effects on alcohol consumption have been reported in clinical settings using multiple sessions of attentional training over time (Fadardi & Cox, 2009; Schoenmakers et al., 2010).

Contrary to our second hypothesis, there was a lack of evidence for effects of attentional training on subjective hunger levels. We also predicted that the effects of the training on food intake would be strongest for the target food (cake) that was used in the training, relative to a non-target food (crisps) (*Hypothesis 3*). Importantly, we ensured that the cake presented in the food intake test was well-matched to the images that were used in the training task, in terms of type of cake and portion size. Despite this, we found little evidence that the training selectively increased consumption of cake, and neither was there evidence for effects on food intake overall. Finally, and in contrast to (Smith and Rieger 2009), we did not find that female participants in the attend group consumed more of the low-fat cake, relative to male participants and to the other groups (*Hypothesis 4*). This could be due to methodological differences as Smith and Rieger (2009) simply measured choice whereas we measured the amount of food that was consumed.

The lack of behavioural effects of attentional training that we report is broadly consistent with single-session attentional training studies from the addiction literature and a recent meta-analysis (Attwood, et al., 2008; Field, et al., 2007; Field, Duka, et al., 2009; Field & Eastwood, 2005; Field, Munafò, & Franken, 2009; McHugh, et al., 2010; Schoenmakers, et al., 2007). On this basis, it seems reasonable to suggest that attentional bias has, if anything, a weak causal role in the maintenance of subjective craving and substance-seeking behaviours. Consistent with above studies, we employed a SOA of 500 ms, which likely reflects maintained attention (Field & Cox, 2008). It is possible that behavioural effects may have been detected if we had instead manipulated the initial orientation of attention by using a shorter SOA. However, this would seem unlikely given the study by Field, Duka, et al. (2009) where different SOAs (50 vs. 500 ms) were used to modify attentional bias but there was little evidence for effects on behavioural measures.

In our study, the standard portions of high- and low-fat foods may have acted as diet reminders (Papies & Veling, 2013), which could have produced a general attenuation in intake or shifted choice towards the low-calorie foods. This potential concern is countered by the finding that, overall, participants showed greater percentage consumption of the high-fat foods relative to the low-fat foods. Nonetheless, in future studies, it will be informative to examine the effects of attentional training on food intake in a typical “taste-test” paradigm where large bowls of high-calorie foods are presented. Participants in the attend group may also have habituated to images of cake during the attentional training which, in turn, might have reduced subsequent consumption of cake. This is consistent with previous research which found that repeatedly imagining the consumption of a food led to lower actual intake of the same food (Morewedge, Huh, & Vosgerau, 2010). This an intriguing possibility for future research, which also emphasises the importance of including other non-target foods in the intake measure, as in our study. Studies might also consider the potential moderating effects of motivational state on appetitive responses to attentional training. Participants in our study had abstained from eating for 2 hours, but it is possible that attentional training influences food intake only in satiated individuals. Relatedly, it may be easier to train an attentional avoidance response in participants who are satiated.

An alternative idea is that attentional bias is an epiphenomenon of drug seeking. In a study with smokers, a stimulus (the S+) acquired parallel control over an attentional bias and a tobacco-seeking response during a series of training trials (Hogarth, Dickinson, Janowski, Nikitina, & Duka, 2008). In a subsequent phase of the experiment, exposure to a concurrent visual task abolished the attentional bias for the S+. The S+, however, maintained strong control of the tobacco-seeking response. Such findings suggest that attentional bias is not necessary for the initiation of drug-related behaviours and may more plausibly represent a noncausal proxy for the motivational impact of drug stimuli (Hogarth, et al., 2008). The veracity of this hypothesis in the food literature merits further scrutiny. Interestingly, in our study we found a positive association between trait disinhibition and initial (*i.e.*, pre-training) attentional bias. Disinhibition may reflect individual differences in the motivational salience of food-related stimuli (Tapper, Pothos, Fadardi, & Ziori, 2008). Our finding therefore provides support for the idea that attentional bias is an index of food motivation but, as yet, there is little evidence in the literature for a causal role in food intake.

Both food and drug stimuli are associated with attentional biases, which are likely to develop as a result of classical conditioning (Field & Cox, 2008), and might reflect common underlying neurobiological mechanisms. To our knowledge, no studies have directly compared the magnitude of attentional biases for drugs with those that are elicited by natural reinforcers such as food. However, evidence from the animal literature indicates that sweet beverages can have greater motivational value than cocaine (Lenoir, Serre, Cantin, & Ahmed, 2007). Incentive sensitization theory proposes that an attentional bias is one of the by-products of the sensitized dopaminergic release that develops in response to motivationally-relevant cues. To date, there is little evidence that dopaminergic sensitization occurs in response to food in humans (Havermans, 2011). This possibility could be further investigated using acute tyrosine/phenylalanine depletion to acutely reduce global levels of brain dopamine. Interestingly, existing studies using this technique have found a reduced attentional bias to smoking cues (Hitsman et al., 2008; Munafò, Mannie, Cowen, Harmer, & McTavish, 2007) and a reduction in subjective appetite for food (Hardman, Herbert, Brunstrom, Munafò, & Rogers, 2012), which provides initial support for the idea that dopamine sensitization is involved in both drug and food motivation.

To conclude, our study represents a first step towards elucidating the potential functional significance of food-related attentional biases. We found weak effects of attentional training on food-related attentional bias only in the group who were trained to attend to food images.

There was little evidence of training effects on subjective hunger or food intake. This study highlights numerous avenues for future research, including investigating the potential moderating effects of motivational state on attentional training. The prospect that attentional bias represents a noncausal index of food motivation is particularly worthy of further scrutiny.

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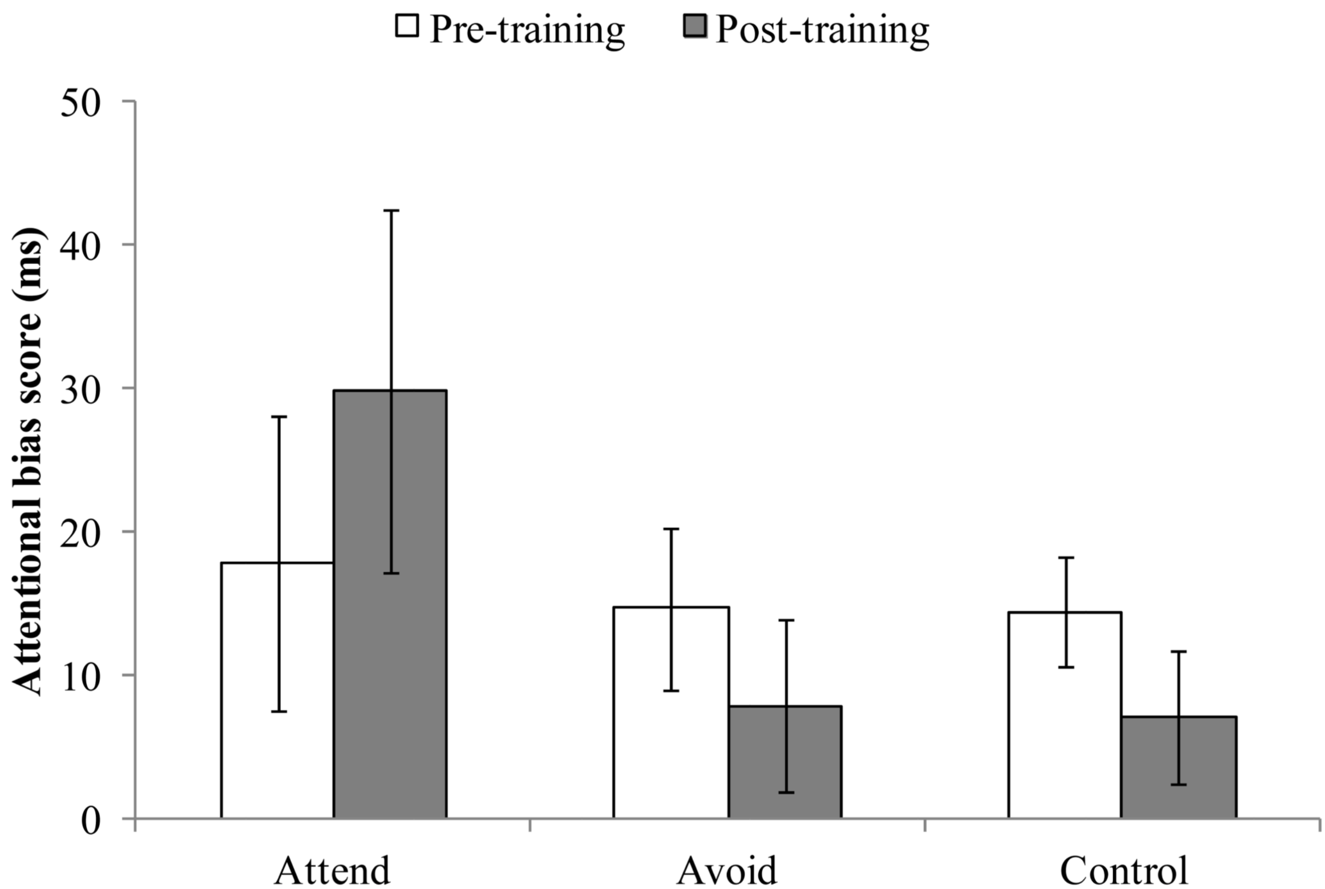

Figure 1.
Attentional bias scores (ms) for images of cakes at pre-attentional training and post-attentional training time points. Values are mean ± SEM.

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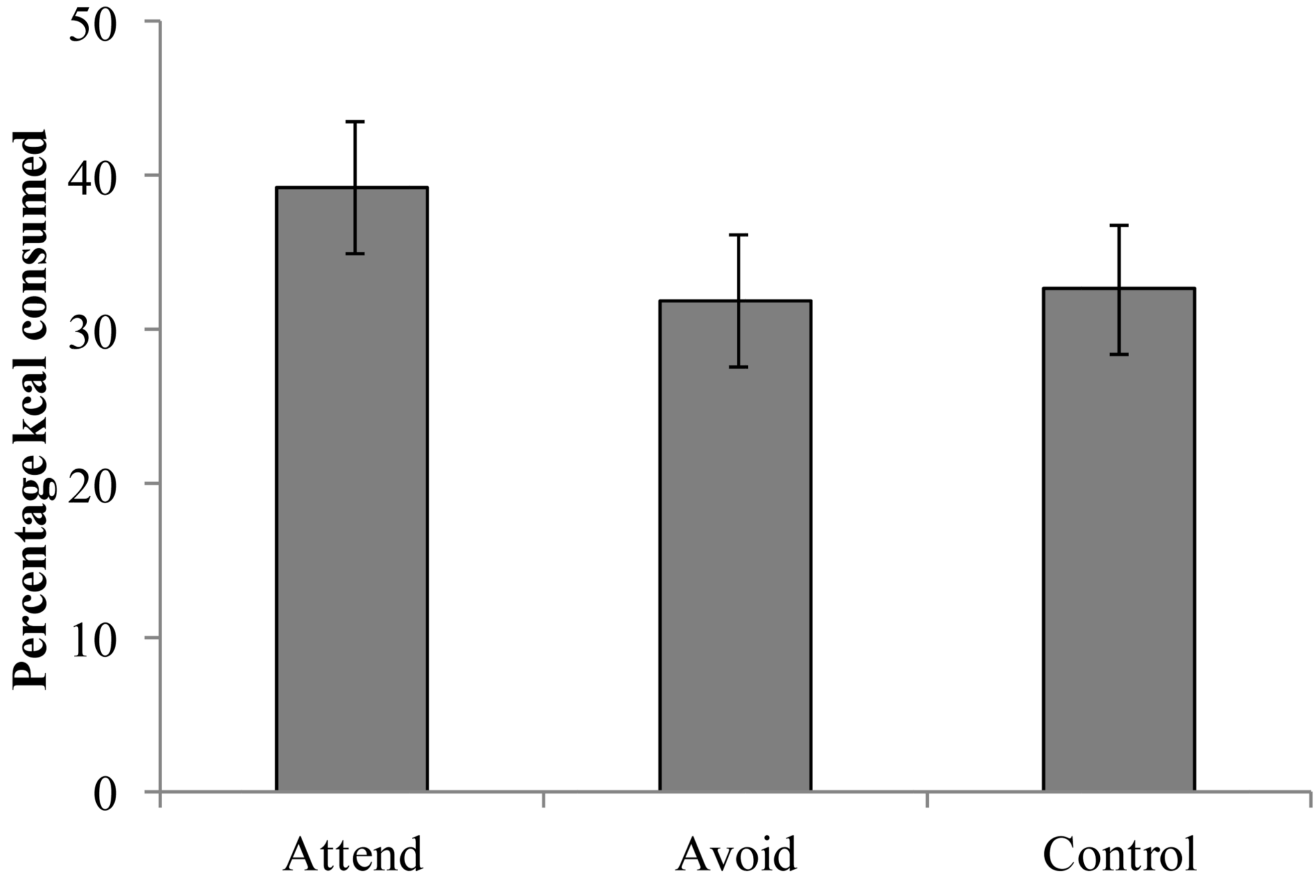

Figure 2.
Food intake (percentage consumed of the total 841 kcal that was presented) in the attend, avoid and control groups. Values are mean ± SEM.

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Table 1

Descriptive characteristics of the sample by training group. Values are means with *SDs* in parentheses, unless otherwise specified.

	Attend	Avoid	Control	Between-group *F* and *p*-value
N	20 (12 F, 8 M)	20 (12 F, 8 M)	20 (11 F, 9 M)	-
Age (y)	22. 1 (6.7)	23.9 (10.1)	23.7 (9.5)	$F(2, 59) = .25$, $p = .78$
BMI (kg/m^2)	21. 6 (3.1)	23.1 (2.0)	22.5 (2.8)	$F(2, 59) = 1.54$, $p = .22$
Restraint	6.0 (4.5)	7.4 (4.9)	8.5 (6.4)	$F(2, 59) = 1.1$, $p = .34$
Disinhibition	6.3 (2.7)	8.2 (2.8)	7.5 (3.4)	$F(2, 59) = 2.0$, $p = .15$
Pre-training hunger (mm)	51.7 (24.0)	56.0 (26.3)	57.7 (22.3)	$F(2, 59) = 0.32$, $p = .73$

F = female, M = male