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### Abstract

This study aimed to investigate the existence of an approach bias for food cues in obese individuals. A community sample of fifty-six obese women and 56 normal weight controls completed an approach-avoidance variant of the implicit association task. The obese participants were faster to respond to trials that paired food words with approach words, and trials that paired non-food words with avoid words, than the converse pairings, thus demonstrating an approach bias for food. This bias was evident for both high caloric and low caloric food words, and was not attributable to a state of deprivation or feelings of hunger. By contrast, the normal weight controls did not show any such bias. The results are consistent with recent neuro-cognitive perspectives of obesity. At a practical level, approach biases for food may present a potential target for modifying (excessive) food intake.

*Keywords:* food cues, obesity, approach bias, implicit association task; hunger

### Approach Bias for Food Cues in Obese Individuals

Obesity is an escalating global health concern, largely driven by an over-consumption of easily accessible, palatable food. However, contrary to popular belief, obesity is not invariably linked to an increased hedonic responsiveness to food (Mela, 2006). Food hedonics refers to the pleasure derived from eating, or “liking” food. While some studies have reported a greater liking for food in obese individuals, particularly food high in fat (Drewnowski, Kurth, Holden-Wiltse & Saari, 1992; Rissanen et al., 2002), others have not (Cox, Perry, Moore, Vallis & Mela, 1999).

One possible explanation for these inconsistent outcomes is the use of self-report measures, which are prone to socially desirable response tendencies. Subsequent studies have therefore attempted to use indirect measures, in particular the implicit association task and the affective priming paradigm, to access food liking in obese individuals. These measures can capture automatic cognitions (e.g., attitudes, preferences) of which the individual may not be aware or may wish to conceal (Roefs et al., 2011). However, outcomes of studies that have used such implicit measures to investigate food liking in obesity have also been mixed. While some studies have observed a greater implicit liking for high-fat food in obese adults and children (Craeynest et al., 2005; Roefs et al., 2006), others have not (Craeynest, Crombez, De Houwer, Deforche & De Bourdeaudhuij, 2006; Craeynest, Crombez, Haerens & De Bourdeaudhuij, 2007). Two studies even found a greater implicit dislike for such food in their obese samples (Roefs & Jansen, 2002; Roefs et al., 2005).

Nevertheless, obese people are clearly drawn to food. According to Mela (2006), this is not so much because they “like” food, but because they “want” food. Wanting food refers to the motivation to engage in eating, and is a related yet separate process from liking food (Robinson & Berridge, 1993). For example, restrained eaters have been shown to want low-fat food even though they do not particularly like it (Veenstra & de Jong, 2010). Similarly,

heavy drinkers have been found to want alcohol but do not necessarily like it (Wiers, van Woerden, Smulders & de Jong, 2002; De Houwer, Crombez, Koster & De Beul, 2004). Accumulating evidence suggests that obese individuals are highly motivated toward food. Compared to people of normal weight, obese people are willing to work harder for food rewards (Giesen et al., 2010; Saelens & Epstein, 1996) and report a stronger motivation to eat when exposed to food cues (Kemps, Tiggemann & Hollitt, 2014).

Recent neuro-cognitive perspectives of obesity attribute this heightened motivation to eat to an increased activation in the brain's reward system (Berridge, Ho, Jocelyn & DiFeliceantonio, 2010; Volkow & Wise, 2005). This serves to increase the reinforcing value of the cues that signal eating in two ways: (1) it makes food cues more "attention grabbing", and (2) it guides people's behaviour to approach such cues. Consequently, obese individuals demonstrate a heightened disposition both to attend to (attentional bias) and approach (approach bias) food cues. Like hedonic biases ("liking"), such motivational biases for food are thought to occur automatically, without necessary conscious awareness, and are thus best captured by implicit measures. In support, a growing number of studies has demonstrated an attentional bias for food stimuli in obese individuals using a range of implicit measures, including the modified Stroop task, the dot probe task, eye movement tracking and event-related potentials (Braet & Crombez, 2003; Castellanos et al., 2009; Graham, Hoover, Ceballos & Komogrotsev, 2011; Nijs, Franken & Muris, 2010a; Nijs, Muris, Euser & Franken, 2010b; Long, Hinton & Gillespie, 1994; Werthmann et al., 2011).

Over recent years, a handful of studies has also demonstrated that food cues elicit an approach bias (using the stimulus response compatibility task or an approach-avoidance variant of the implicit association task) in a variety of samples. Specifically, Veenstra and de Jong (2010) and Brignell and colleagues (Brignell, Griffiths, Bradley & Mogg, 2009) reported an approach bias for food in restrained and external eaters, respectively; however,

two other studies found no such bias in these groups (Ahern, Field, Yokum, Bohon & Stice, 2010; Fishbach & Shah, 2006). A recent study demonstrated an approach bias for chocolate in a normal sample (Kemps, Tiggemann, Martin & Elliot, 2013). In other domains, approach biases have been shown for alcohol (Field, Mogg & Bradley, 2005; Field, Kiernan, Eastwood & Child, 2008; Palfai & Ostafin, 2003), tobacco (Bradley, Field, Mogg & De Houwer, 2004; Bradley, Field, Healy & Mogg, 2008; De Houwer, Custers & De Clercq, 2006; Mogg, Bradley, Field & De Houwer, 2003; Mogg, Field & Bradley, 2005) and drugs (Cousijn, Goudriaan & Wiers, 2011; Field, Eastwood, Mogg & Bradley, 2006).

To date, only three studies have investigated the existence of an approach bias for food among the obese. In the first such study, Craeynest, Crombez, Koster, Haerens and De Bourdeaudhuij (2008) reported an approach bias for high-fat food in overweight and obese children. Using an arousal variant of the implicit association task, they found that overweight and obese youngsters were faster to respond to trials that paired pictures of high-fat food with arousal words (e.g., 'energetic') and trials that paired pictures of low-fat food with sedation words (e.g., 'relaxed') than the converse pairings. However, a comparison group of normal weight youngsters showed the same pattern of results. This is likely because the task contrasted high-fat with low-fat food stimuli, rather than food with non-food stimuli. Furthermore, unlike studies in other domains, in particular smoking and alcohol consumption (De Houwer et al., 2006; Palfai & Ostafin, 2003), the food stimuli were paired with arousal versus sedation words rather than with approach versus avoidance words.

The second study by Mogg et al. (2012) used a stimulus response compatibility task to demonstrate an approach bias for food in overweight and obese adults. Specifically, participants were faster to move a manikin toward food pictures (e.g., pizza) and away from a selection of non-food control pictures (e.g., shampoo bottle) than the other way round. However, as the food and control pictures were not matched on hedonic value, it is possible

that the observed food-related approach bias not only reflects a motivational bias (wanting), but also a hedonic bias (liking). Moreover, the study did not include a comparison control group of normal weight adults. In addition, participants were required to fast for 15 hours before testing. Thus, the observed bias for food could well be due to food deprivation or hunger, which has been linked to an approach bias for food in normal weight individuals (Seibt, Hafner & Deutch, 2007).

In contrast to these two studies, Havermans, Giesen, Houben and Jansen (2011) did not find uniform support for a food-related approach bias among obese individuals. Using a similar stimulus response compatibility task, compared to normal weight controls, overweight and obese male students showed a stronger approach bias for food. In contrast, however, overweight and obese female students actually showed a weaker approach bias. In the context of this unexpected finding, Havermans et al. suggested that future research investigate approach biases for food in a larger and more representative sample of obese individuals than their homogenous undergraduate student sample.

Thus the present study aimed to investigate an approach bias for food in a relatively large community sample of obese individuals. As an extension of Mogg et al. (2012), we included a comparison group of normal weight controls, and tested participants under non-fasting conditions. Following previous studies of alcohol and tobacco (De Houwer et al., 2006; Palfai & Ostafin, 2003), we used an approach-avoidance variant of the implicit association task to measure approach bias for food. Specifically, participants were asked to categorise stimuli that belonged to one of two concept categories (food and non-food) or one of two attribute categories (approach and avoid). An approach bias for food is demonstrated by faster response times in the phase of the task that pairs food with approach and non-food with avoid words than the converse pairings. Importantly, unlike previous studies, we specifically chose a non-food concept category (animals) that, like food, is appealing in order

to equate the hedonic value (liking) of the two concept categories. We further examined the relationship between any such bias and indices of hunger.

## Method

### Participants

Participants were 112 healthy adult women, aged 18 to 60 years ( $M = 44.95$ ,  $SD = 11.82$ ), who spoke English as their first language. Half ( $N = 56$ ) were obese ( $BMI \geq 30$   $kg/m^2$ ); the other half were of normal weight ( $BMI$  in the range 18.5 to 24.9  $kg/m^2$ ). Only women were recruited as they have a greater tendency to overeat (Burton, Smit, & Lightowler, 2007). Participants were community-dwelling residents recruited from the Adelaide metropolitan area via an advertisement in the local newspaper, and received a \$20 honorarium in lieu of their time. All participants reported that they ate and liked most foods, and were not vegetarian. Table 1 presents participant characteristics for the obese and normal weight groups.

### Materials

**Implicit association task.** There were four sets of words, one for each of the two concept (food, non-food) and two attribute (approach, avoid) categories. The food words consisted of 10 high caloric (e.g., 'cake', 'hamburger') and 10 low caloric (e.g., 'salad', 'strawberry') food items. The non-food words comprised 20 animal species that are generally well-liked and are not commonly consumed in Western cultures (e.g., 'kitten', 'flamingo'). The food and animal word sets were carefully selected and matched on a range of indicators. In particular, words were individually matched to contain an equal number of letters and syllables (e.g., 'pizza', 'puppy'). The sets also did not differ significantly on 9-point Likert ratings of pleasure and arousal, obtained through pilot testing (pleasure: food ( $M = 5.97$ ,  $SD = .65$ ), animals ( $M = 5.61$ ,  $SD = .78$ ),  $t(38) = 1.68$ ,  $p > .05$ ; arousal: food ( $M = 5.59$ ,  $SD = .64$ ), animals ( $M = 5.33$ ,  $SD = .54$ ),  $t(38) = 1.43$ ,  $p > .05$ ). The approach and avoid words were

taken from Kemps et al.'s (2013) study of chocolate cues, and consisted of 10 approach-related words (e.g., 'proceed', 'toward') and 10 avoid-related words (e.g., 'evade', 'retreat') that clearly reflected the two semantically contrasting categories of approach and avoidance.

Following standard implicit association task procedures (Greenwald, McGhee & Schwartz, 1998), the task consisted of 5 blocks. During each block, the appropriate category labels were displayed in the top left and right hand corners of the computer screen. On each trial, a single stimulus was presented in the centre of the screen. Participants were asked to categorise the stimulus according to the designated concept and/or attribute category, by pressing the corresponding left ('z') or right ('/') key on the computer keyboard. They were instructed to respond as quickly and as accurately as possible. The stimulus remained on screen until a response was made. The inter-trial interval was 250 ms.

In Block 1, participants were instructed to categorise stimuli according to concept only (e.g., left = food, right = animal). In Block 2, participants categorised stimuli according to attribute only (e.g., left = approach, right = avoid). In Block 3, participants categorised stimuli according to both concept and attribute (e.g., left = food + approach, right = animal + avoid). In Block 4, participants were again instructed to categorise stimuli according to concept only, but with the location of category labels reversed (e.g., left = animal, right = food). Finally, in Block 5, participants again categorised stimuli according to both concept and attribute, but with the pairing of concept category labels reversed (e.g., left = animal + approach, right = food + avoid).

Blocks 1, 2 and 4 consisted of 40 trials (each concept stimulus presented once or each attribute stimulus presented twice), and Blocks 3 and 5 consisted of 80 trials (each concept stimulus presented once and each attribute stimulus presented twice). Within each block, stimuli were presented in a new randomly chosen order for each participant, with the constraints that (a) the same stimulus was not repeated on consecutive trials, and (b) the same



response (left or right) occurred on no more than 3 consecutive trials. The assignment of response keys to concept stimuli (left or right) and the order of the two mixed categorisation phases (i.e., food + approach versus animal + avoid, and animal + approach versus food + avoid) was counterbalanced, resulting in four task versions, each administered to one quarter of the participants.

**Hunger.** Hunger was assessed by two measures derived from the Hunger Scale (Grand, 1968). First, participants were asked to indicate how long since they had last eaten, estimated to the nearest 15 min. Second, they were asked to rate their level of hunger on a 100-mm visual analogue scale ranging from ‘not at all hungry’ to ‘extremely hungry’.

### **Procedure**

Participants were tested individually in a quiet room in the Applied Cognitive Psychology Laboratory at Flinders University in a single session of 30 min. duration. They were seated approximately 50 cm in front of an IBM compatible computer with a 22-inch monitor. After giving informed consent, participants completed a brief demographics questionnaire, which included the hunger measures. They then performed the implicit association task. Finally, participants’ height and weight were measured from which body mass index (BMI) was calculated as the ratio of weight in kilograms to height in meters squared.

## **Results**

### **Statistical considerations**

An alpha level of .05 was used to determine significance. Cohen’s *d* was used as the effect size measure, with cut-off values of .20, .50, and .80, for small, medium and large effects, respectively.

### **Approach bias**

Only response times of correct trials in the critical mixed categorisation phases (Blocks 3 and 5) were included in the analysis. The proportion of correctly categorised stimuli in these blocks was high and did not differ between groups (obese: 94%, normal weight: 95%,  $t(110) = .19, p > .05$ ). Following previous protocols (e.g., Palfai and Ostafin, 2003), response times of less than 300 ms or more than 3000 ms were considered anticipatory and delayed respectively, and eliminated as outliers. Outliers accounted for 3.67% of the data. An approach bias score was calculated by subtracting the mean reaction time of the food + approach vs animal + avoid trials from that of the animal + approach vs food + avoid trials. Hence, a positive score represents an approach bias for food.

As can be seen in Figure 1, an independent samples t-test showed a significantly greater approach bias score for the obese individuals ( $M = 89.37, SD = 184.13$ ) than those of normal weight ( $M = 3.93, SD = 182.91$ ),  $t(110) = 2.46, p < .05, d = .47, 95\% CI [16.71, 154.18]$ . In fact, one sample t-tests against zero clearly showed an approach bias for food in the obese,  $t(55) = 3.63, p < .001, d = .98, 95\% CI [40.06, 138.68]$ , but not in the normal weight individuals,  $t(55) = .87, p > .05$ . Separate analyses conducted for high and low caloric food words replicated the overall findings (high caloric food:  $t(110) = 2.20, p < .05, d = .42, 95\% CI [8.37, 159.26]$ ; low caloric food:  $t(110) = 2.63, p < .01, d = .50, 95\% CI [24.31, 172.06]$ ). The obese showed a strong approach bias for both high ( $M = 83.23, SD = 192.37$ ),  $t(55) = 3.240, p < .01, d = .87, 95\% CI [31.71, 134.74]$ , and low caloric food ( $M = 91.89, SD = 193.12$ ),  $t(55) = 3.56, p < .001, d = .96, 95\% CI [40.18, 143.61]$ , which the normal weight group did not share (high caloric food: ( $M = -.59, SD = 210.13$ ),  $t(55) = .98, p > .05$ ; low caloric food: ( $M = -6.29, SD = 201.32$ ),  $t(55) = .82, p > .05$ ).

### **Hunger**

Most participants had eaten 1 to 2 hours before testing. There was no difference between the obese ( $M = 1.88, SD = 1.21$ ) and normal weight ( $M = 1.70, SD = .99$ ) individuals

on how long since they had last eaten,  $t(110) = .88, p > .05$ . In addition, hunger ratings were relatively low, and did not differ between groups (obese:  $M = 24.88, SD = 21.31$ ; normal weight:  $M = 25.61, SD = 26.45$ ),  $t(110) = .16, p > .05$ .

Table 1 presents correlations between these hunger measures and approach bias scores. As shown, neither time since last eaten or hunger rating was significantly correlated with approach bias for food in either of the obese or normal weight groups ( $-.08 \leq r \leq .09, ps > .05$ ).

### Discussion

The present study used an approach-avoidance implicit association task to investigate an approach bias for food in obese individuals under non-fasting conditions. The obese participants did indeed demonstrate such a bias. This finding is consistent with previous reports of a food-related approach bias in overweight and obese children (Craeynest et al., 2008) and adults (Havermans et al., 2011; Mogg et al., 2012). However, our study extends those results by showing within the same protocol that this bias is specific to obese individuals and does not apply to individuals of normal weight.

Importantly, the observed bias in our obese sample cannot be explained by a state of deprivation or feelings of hunger. Unlike Mogg et al. (2012), we did not instruct participants to fast before testing, and self-report data indicate that most participants had eaten 1 to 2 hours before their scheduled testing session and were clearly not very hungry. Importantly, these hunger measures did not differ between the obese and normal weight participants and thus cannot explain the difference in approach bias between the groups. In addition, the correlations show that approach bias for food was not related to when either group of participants had last eaten or how hungry they felt. Thus, in contrast to normal weight people who show an approach bias for food only when they are hungry (Seibt et al., 2007), the results demonstrate that obese individuals show such a bias even when they are not hungry.

While a food-related approach bias in individuals of normal weight who are hungry presumably reflects a biologically driven need for food, the observation of such a bias in obese individuals in the absence of hunger clearly does not. It demonstrates instead that obese people are motivated toward food for reasons other than hunger. This lends support to a number of different theories (e.g., externality theory; Schachter, 1971, goal conflict theory; Stroebe, Mensink, Aarts, Schut & Kruglanski, 2008) that propose that obese individuals are driven by non-homeostatic eating motives.

Interestingly, the obese participants showed an approach bias for both high and low caloric food. This suggests that obese individuals display a heightened motivation toward food in general, not specifically to high caloric food. It further suggests that the motivational attractiveness of food for obese people is not in its caloric content. However, there are other possible explanations for the lack of differential bias for high and low caloric foods in the obese group. It may be a function of the use of words as stimuli, which are more abstract and have weaker motivational effects than images (Simmons, Martin & Barsalou, 2005).

Alternatively, it may reflect the nature of the implicit association task, which measures associations at the category level (i.e., food) rather than at the individual or sub-category (i.e., high caloric and low caloric) level (De Houwer, 2001, 2003). Consequently, we cannot draw firm conclusions about approach biases to high versus low caloric food. To this end, future research might usefully replicate the current findings with separate categories for high and low caloric food.

Because the two concept stimulus sets were drawn from semantic categories that are equally appealing (food, animals), the demonstrated food-related approach bias in the obese group likely reflects a motivational bias (wanting), as distinct from a hedonic one (liking). Nevertheless, it remains to be determined whether the use of positive and negative words as attribute stimuli, as in the original attitudinal implicit association task, instead of the approach

and avoid words used here, would have yielded the same results. Future research could usefully compare results of attitudinal and approach-avoidance variants of the implicit association task among obese individuals in the same study. In addition, future research could seek to replicate the current study with other comparison concept categories to determine whether the findings depend on stimulus choice.

Theoretically, the results lend support to recent neuro-cognitive perspectives of obesity (Berridge, Ho, Jocelyn & DiFeliceantonio, 2010; Volkow & Wise, 2005). These attribute the observed food approach bias to increased motivation toward food, due to an excessive release of dopamine in the brain's reward system. They further predict that the enhanced motivation to eat among the obese guides behaviour toward food acquisition and consumption. In support, studies of other appetitive targets have demonstrated a link between approach bias and consumption. For example, approach bias for alcohol has been associated with greater weekly alcohol consumption (Field et al., 2008) and higher frequency of binge drinking (Palfai & Ostafin, 2003) in heavy drinkers. Similarly, approach bias for cannabis has been shown to predict increased cannabis use six months later in heavy cannabis users (Cousijn et al., 2011). Future research will need to determine whether there exists a similar link between approach bias for food and measured food intake.

If such a link can be established, approach bias for food presents a potential target for intervention. Emerging evidence from the alcohol domain suggests that it is possible to experimentally manipulate approach bias to reduce alcohol consumption. In particular, Wiers, Rinck, Kordts, Houben and Strack (2010) showed that re-training heavy drinkers to avoid alcohol cues reduced not only their approach bias for alcohol, but also their beer intake. Modification of approach bias for food cues might similarly benefit obese individuals to reduce their food intake. In normal weight samples, changing approach reactions to food cues by means of a stop signal task has recently been shown to decrease participants' preference

for, and consumption of, unhealthy snacks (Veling, Aarts & Papies, 2011; Veling, Aarts & Stroebe, 2013; Veling, van Koningsbruggen, Aarts & Stroebe, 2014). It will be important in future studies to test such interventions in obese people who, because of their strong drive to eat, are particularly vulnerable to the continual food exposure in our contemporary food-rich environment.

In conclusion, using an approach-avoidance variant of the implicit association task, the present study has clearly demonstrated an approach bias for food in specifically obese individuals. In so doing, it adds to our theoretical understanding of the cognitive drivers of obesity, highlighting a key role for motivational processes, as distinct from hedonic ones. At a practical level, approach biases for food present a potential target for modifying (excessive) food intake.

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Table 1

*Participant characteristics for the obese and normal weight groups*

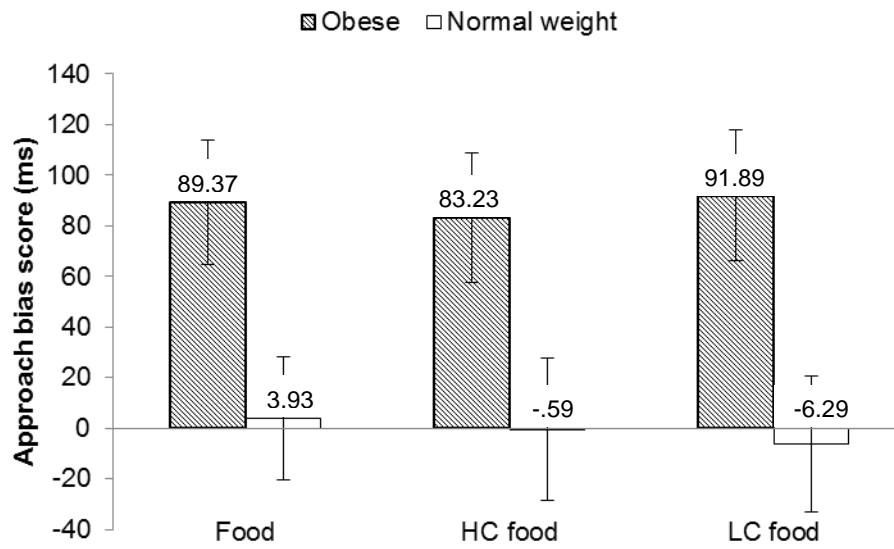
	Obese		Normal weight	
	<i>M</i>	<i>SD</i>	<i>M</i>	<i>SD</i>
Age (years)	46.59	10.38	43.30	12.99
BMI (kg/m <sup>2</sup> )	36.70	6.43	22.23	1.42

Table 2

*Correlations between approach bias scores and hunger measures for obese and normal weight individuals*

	Approach bias score			
	Obese		Normal weight	
	<i>r</i>	<i>p</i>	<i>r</i>	<i>p</i>
Time since last eaten (hours)	-.08	.57	.05	.69
Hunger rating (out of 100)	.09	.52	-.06	.65





*Figure 1.* Mean approach bias scores (with standard errors) for obese and normal weight individuals; HC = high caloric, LC = low caloric.