Journal of Experimental Psychology: Applied
2013, Vol. 19, No. 1, 30–38

1076-898X/13/$12.00 DOI: 10.1037/a0031626

Implicit Approach–Avoidance Associations for Craved Food Cues

Eva Kemps, Marika Tiggemann, Rachel Martin, and Mecia Elliott
Flinders University

Implicit approach associations are well documented for substances such as alcohol, tobacco, and illicit drugs. This study reports two experiments designed to establish and modify such associations specifically in the food craving domain. Experiment 1 used a pictorial implicit association task to examine approach–avoidance associations with chocolate cues in a sample of 48 undergraduate women. Participants were faster to respond to trials that paired chocolate pictures and approach words, and trials that paired pictures of highly desired food items not containing chocolate and avoid words, than the converse pairings. The magnitude of this approach bias was positively correlated with participants' reported chocolate craving. Experiment 2 examined whether chocolate-related approach associations can be modified. Using a modified implicit association task, 96 undergraduate women were trained to associate chocolate pictures either with approach or with avoid words. As predicted, chocolate–approach associations increased in the approach group and decreased in the avoid group. Additionally, the approach group reported stronger chocolate cravings after training; in contrast, cravings tended to decrease in the avoid group. These results are consistent with incentive- and cognitive-motivational accounts of craving, and support and extend reports of approach biases (and the retraining of those biases) for other substances, including alcohol and cigarettes, to the food domain. They also offer potential scope for curbing unwanted food cravings in the context of problem eating behavior.

Keywords: food craving, approach–avoidance association, approach bias, implicit association task, cognitive bias modification

The term "craving" refers to a motivational state in which an individual feels compelled to seek and ingest a particular substance (Baker, Morse & Sherman, 1986). Although it usually refers to alcohol, tobacco, and drugs, the term has become increasingly applied to food. Cravings are one of the main reasons why people fail to abstain from smoking, alcohol consumption, and drug use (Carter et al., 2008). Even in people who have quit substance use, they can often trigger a relapse (Shiffman et al., 1997). Food cravings, in contrast, are generally not pathological (Lafay et al., 2001). However, they can be maladaptive for some people, and even pose health risks (Kemps & Tiggemann, 2010). Specifically, food cravings can trigger binge-eating episodes (Gendall, Joyce, Sullivan & Bulik, 1998; McManus & Waller, 1995), which can, in turn, give rise to obesity (Schlundt, Virts, Sbrocco & Pope-Cordle, 1993) and bulimia nervosa (Mitchell, Hatsukami, Eckert & Pyle, 1985; Waters, Hill & Waller, 2001). Food cravings have also been linked to impaired cognition (Kemps, Tiggemann & Grigg, 2008) and have the potential to thwart motivations to diet in people who are trying to lose weight (Sitton, 1991), leading to feelings of guilt and shame (Macdiarmid & Hetherington, 1995).

One contemporary theory of craving that emphasizes appetitive motivational processes is Robinson and Berridge's (1993) incentive-sensitization account of addiction. According to this theory, craving-related cues, such as a beer or a cigarette, acquire motivational properties, or incentive salience, through a classically conditioned association between the cue and its subsequent consumption. Consequently, craving-related cues come to be perceived as attractive and 'wanted.' As a result of this attribution process, craving-related stimuli automatically capture attention and trigger an appetitive response that guides behavior toward target acquisition and consumption. This has come to be known as an approach bias. The activation of this incentive motivational process is regulated by the dopaminergic reward system and occurs implicitly, outside of conscious awareness. Approach biases are thought to be at the heart of (unwanted) cravings and (over) consumption.

Although Robinson and Berridge's (1993) model predicts a link between implicit approach associations and craving, it does not predict that these associations could be cognitively retrained or that such a change would be reflected in craving or consumption behavior. The latter prediction is, however, consistent with recent cognitive-motivational models of craving (Franken, 2003; Kavanagh, Andrade & May, 2005; Ryan, 2002). According to these models, an experimental manipulation of approach bias should produce a change in craving and consumption behavior.

Over recent years, a growing number of studies have demonstrated an approach bias for commonly craved substances such as alcohol, tobacco, and illicit drugs. For example, using a modified implicit association task, Palfai and Ostafin (2003) showed that heavy drinkers were faster to respond to trials that paired alcohol words (e.g., liquor) and approach words (e.g., advance) versus

This article was published Online First February 18, 2013.
Eva Kemps, Marika Tiggemann, Rachel Martin, and Mecia Elliott, School of Psychology, Flinders University, Adelaide, Australia.
We are grateful to Paul Douglas for developing the software for the computerized administration of the implicit association task. This research was supported under the Australian Research Council's Discovery Project funding scheme (project number DP0985729).
Correspondence concerning this article should be addressed to Eva Kemps, School of Psychology, Flinders University, GPO Box 2100, Adelaide SA 5001, Australia. E-mail: eva.kemps@flinders.edu.au

trials that paired control words (e.g., juice) and avoid words (e.g., withdraw) than the converse pairings. Cigarette smokers have similarly been found to show a stronger approach than avoid association with smoking cues (De Houwer, Custers & De Clercq, 2006). Using a different paradigm, the stimulus response compatibility task, several studies have shown that smokers are faster to move a manikin toward smoking-related pictures (e.g., a packet of cigarettes) and away from nonsmoking control pictures (e.g., a bowl of cereal) than the other way round (Bradley, Field, Mogg & De Houwer, 2004; Bradley, Field, Healy & Mogg, 2008; Mogg, Bradley, Field & De Houwer, 2003; Mogg, Field & Bradley, 2005). Likewise, Field, Eastwood, Mogg and Bradley (2006) reported an approach bias for drug cues in regular cannabis users on this task. Cousijn, Goudriaan, and Wiers (2011) recently extended this finding to heavy cannabis users, using an approach–avoidance task. Specifically, they found that heavy users were faster to pull (i.e., approach) than to push (i.e., avoid) a joystick in response to the angular orientation of drug-related pictures.

In addition to investigating an approach bias, many of these studies also examined its association with craving. Although a substantial number found no relationship between approach–avoidance associations and subjective craving (Bradley et al., 2008; Cousijn et al., 2011; Field et al., 2006; Mogg et al., 2003, 2005), several others did. In particular, Palfai and Ostafin (2003), and also Field and colleagues (Field, Mogg & Bradley, 2005; Field, Kiernan, Eastwood & Child, 2008), reported a positive correlation between heavy drinkers' approach bias for alcohol cues and their urge to drink alcohol.

Although not focusing on craved foods, a number of studies have investigated approach–avoidance associations in relation to food in general (Brignell, Griffiths, Bradley & Mogg, 2009; Havermans, Giesen, Houben & Jansen, 2011; Veenstra & de Jong, 2010). These have shown that overweight and obese individuals, as well as restrained (individuals who intentionally restrict their food intake for the purpose of weight control) and external (individuals who eat in response to external cues [e.g., the sight or smell of food] rather than internal feelings of hunger) eaters, show a heightened food approach bias. In the only study to date to investigate an approach bias specifically in the context of food craving, Van Gucht, Vansteenwegen, Van den Bergh, and Beckers (2008) showed that participants were faster to move a manikin toward a picture of a serving tray that had previously been associated with eating chocolate, and away from a picture of another serving tray that had previously been associated with not eating chocolate, than vice versa. They interpreted this finding as evidence of an approach bias for a cue-induced food craving. However, as their design did not include a comparison food as a control, this result could be a function of an appetitive response for food in general, rather than chocolate. Further, it does not speak to the distinction between an actual craving and a more general appetitive response (Pelchat, 2002). A food craving refers to an intense desire or urge to eat a *specific* food (Weingarten & Elston, 1990), for which there is no substitute (Weingarten & Elston, 1991).

Thus the present experiments were designed to examine implicit approach–avoidance associations in the food craving domain. Experiment 1 aimed to investigate an approach bias for a specific craved food, as distinct from an appetitive response more generally. To this end, we used an implicit association task to examine approach–avoidance associations with regard to one particular highly craved food, namely chocolate, relative to that of comparison control foods. Chocolate was chosen because it is the most commonly craved food in Western cultures (Hetherington & Macdiarmid, 1993). Importantly, the control foods were also highly craved foods (e.g., French fries), as opposed to foods that are not typically craved (e.g., broccoli). If stronger implicit chocolate–approach (relative to chocolate–avoid) associations are successfully demonstrated under these circumstances, this would provide a very strong test of the *specificity* of food cravings.

Given the potentially adverse effects of food cravings, Experiment 2 examined whether chocolate-related approach–avoidance associations can be modified. Emerging evidence shows that it is possible to influence approach biases. In fact, using an approach–avoidance retraining paradigm, Wiers and colleagues (Wiers, Rinck, Kordts, Houben & Strack, 2010; Wiers, Eberl, Rinck, Becker & Lindenmeyer, 2011) showed that training hazardous drinkers and alcoholics to avoid alcohol cues attenuated their approach bias for alcohol. Experiment 2 investigated whether approach–avoidance associations in the food craving domain can similarly be modified.

These aims gave rise to a number of specific hypotheses. In Experiment 1, we predicted that (a) performance on the implicit association task would show a stronger chocolate–approach than chocolate–avoid association, and (b) the magnitude of this association would correlate positively with chocolate craving. In Experiment 2, we predicted that (a) experimental manipulation of chocolate-related approach–avoidance associations would produce group differences in approach bias scores, such that participants trained to associate chocolate with the concept of approach would show a heightened chocolate–approach association, and participants trained to associate chocolate with the concept of avoid would show a chocolate–avoidance association. We further predicted that (b) this retraining would produce changes in chocolate craving, such that cravings would increase in the approach group and decrease in the avoid group.

Experiment 1

Experiment 1 investigated approach–avoidance associations in relation to chocolate-related stimuli relative to other highly desired food stimuli. Following Palfai and Ostafin (2003), we used an implicit association task. Participants were asked to categorize stimuli that belonged to one of two concept categories (chocolate and nonchocolate) or one of two attribute categories (approach and avoid). An approach bias for chocolate would be demonstrated by faster categorization times in the congruent (pairing chocolate and approach vs. nonchocolate and avoid) than in the incongruent (pairing chocolate and avoid vs. nonchocolate and approach) phase of the task. We further examined whether this approach bias for chocolate cues correlated positively with participants' self-reported craving for chocolate.

Method

Participants. Participants were 48 female undergraduate students at Flinders University who took part for course requirements and credit. They were aged between 18 and 25 years (M = 19.58, SD = 1.91). We specifically recruited a sample of young women, because food cravings are more prevalent in women than in men

(Weingarten & Elston, 1991) and decrease in frequency and intensity with age (Pelchat, 1997). Because hunger has been linked to cognitive biases for food (Mogg, Bradley, Hyare & Lee, 1998), participants were instructed to eat something two hours before their testing session to ensure they were not hungry. All participants reported having complied with this instruction. Additionally, all participants reported that they liked chocolate, in response to the yes/no question "Do you like chocolate?", and consumed on average 2.03 ($SD = 1.75$) chocolate bars and 3.49 ($SD = 3.46$) chocolate-containing food items per week.

Materials.

Implicit association task. There were four sets of stimuli, one for each of the two concept and two attribute categories, comprising 10 items each. Thus there were 10 pictures of chocolate or chocolate-containing food items (e.g., chocolate bar, brownie), 10 pictures of highly desired food items not containing chocolate (e.g., cake, pizza), 10 approach-related words (e.g., forward, advance), and 10 avoid-related words (e.g., escape, withdraw).

The chocolate and nonchocolate pictures were digital colored photographs and measured 100 × 100 mm. These were obtained on the basis of a pilot study in which 18 women aged 20 to 23 years ($M = 21.39$, $SD = .85$) rated 74 pictures of chocolate and other highly desired foods on 9-point valence and arousal scales. Importantly, the selected chocolate and nonchocolate picture sets were carefully matched on both valence (chocolate $M = 5.99$, $SD = .50$, nonchocolate $M = 5.82$, $SD = .89$, $t(18) = .54$, $p > .05$) and arousal (chocolate $M = 5.72$, $SD = .47$, nonchocolate $M = 5.51$, $SD = .88$, $t(18) = .67$, $p > .05$). The approach- and avoid-related words were adapted from Palfai and Ostafin (2003). These were constructed to clearly reflect 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. In Block 1, participants were instructed to categorize stimuli according to concept only (e.g., left = chocolate, right = nonchocolate). In Block 2, participants categorized stimuli according to attribute only (e.g., left = approach, right = avoid). In Block 3, participants categorized stimuli according to both concept and attribute (e.g., left = chocolate + approach, right = nonchocolate + avoid). In Block 4, participants were again instructed to categorize stimuli according to concept only, but with the location of category labels reversed (e.g., left = nonchocolate, right = chocolate). Finally, in Block 5, participants again categorized stimuli according to both concept and attribute, but with the pairing of concept category labels reversed (e.g., left = nonchocolate + approach, right = chocolate + avoid).

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 (picture or word) was presented in the center of the screen. Participants were asked to categorize 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 intertrial interval was 250 ms.

Blocks 1, 2, and 4 consisted of 40 trials (each concept or attribute stimulus presented twice), and Blocks 3 and 5 consisted of 80 trials (each concept and 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. Before commencing the critical mixed categorization phases (i.e., Blocks 3 and 5), participants were given eight practice trials using words and pictures that did not feature in the actual task. The assignment of response keys to concept stimuli (left or right) and the order of congruent (i.e., chocolate + approach vs. nonchocolate + avoid) and incongruent (i.e., nonchocolate + approach vs. chocolate + avoid) mixed categorization phases was counterbalanced, resulting in four task versions, each administered to one quarter of the participants.

Chocolate craving. Chocolate craving was assessed using a 100-mm visual analogue scale. Participants indicated their current level of chocolate craving by placing a vertical mark on the scale, ranging from "no desire or urge to eat chocolate" to "extremely strong desire or urge to eat chocolate." Such self-report is argued to provide the most appropriate measure of chocolate craving (Pelchat, 2002).

Procedure. Participants were tested individually in a quiet room in the Applied Cognitive Psychology laboratory at Flinders University (South Australia) in a session of 30-minute duration. All participants were tested in the afternoon, because food cravings occur more frequently after midday (Hill, Weaver & Blundell, 1991). Participants were seated approximately 50 cm in front of an IBM compatible computer with a 17-inch monitor. After giving informed consent, participants completed a brief demographics questionnaire. They then performed the implicit association task, and rated their level of chocolate craving.

Results

Implicit association task. Only response times of correct trials in the critical mixed categorization phases (i.e., congruent [chocolate + approach vs. nonchocolate + avoid] and incongruent [nonchocolate + approach vs. chocolate + avoid] trials of Blocks 3 and 5) were included in the analysis. The proportion of correctly categorized stimuli in these blocks was high (95.45%). Following previous protocols (e.g., Palfai & Ostafin, 2003), response times of less than 300 ms or more than 3000 ms were considered anticipatory and delayed, respectively, and eliminated as outliers. Response times more than 3 SDs above or below the individual mean were also excluded. Outliers accounted for 3.27% of the data.

Mean RTs of the mixed categorization phases were analyzed by a 2 (phase: congruent, incongruent) × 2 (block order: congruent phase first, incongruent phase first) mixed model ANOVA. There was a significant main effect of phase, $F(1, 46) = 51.56$, $p < .001$, partial $\eta^2 = .53$. As predicted, RTs were faster in the congruent ($M = 698$ ms, $SD = 100$ ms) than the incongruent ($M = 808$ ms, $SD = 153$ ms) phase, indicative of a stronger chocolate–approach than chocolate–avoid association. As can be seen in Table 1, both faster chocolate–approach pairings and faster nonchocolate avoid pairings contributed to this effect. There was also a significant main effect of block order, $F(1, 46) = 5.52$, $p < .05$, partial $\eta^2 = .11$, whereby RTs were faster in the second ($M = 715$ ms, $SD = 110$ ms) than in the first ($M = 790$ ms, $SD = 110$ ms) mixed categorization

Table 1
Mean Reaction Times (and Standard Deviations) for the Concept and Attribute Stimuli in the Mixed Categorisation Phases in Experiment 1

	Attribute stimulus	
Concept stimulus	Approach	Avoid
Chocolate	695 (114)	803 (148)
Nonchocolate	814 (169)	702 (103)

block. Furthermore, as is often found (e.g., Greenwald et al., 1998), there was a significant phase × block order interaction, $F(1, 46) = 13.40$, $p < .001$, partial $\eta^2 = .23$. As can be seen in Table 2, the approach–avoidance associations were stronger when the congruent phase came first. In addition, paired samples *t* tests comparing the categorization of approach and avoid attributes for chocolate and nonchocolate cues separately, showed an approach association for chocolate (chocolate avoid—chocolate approach = 108 ms), $t(47) = 5.48$, $p < .001$, $d = .82$, and an avoidance association for nonchocolate (nonchocolate avoid—nonchocolate approach = −112 ms), $t(47) = 5.91$, $p < .001$, $d = .87$.

Relationship between approach bias and chocolate craving. Mean chocolate craving scores were moderate, around the midpoint of the scale ($M = 52.20$, $SD = 29.72$). A correlational analysis was performed to investigate whether the stronger chocolate–approach than chocolate–avoid association was a function of chocolate craving. An approach bias score was calculated by subtracting the mean RTs in the congruent phase from those in the incongruent phase. As predicted, there was a significant positive correlation between participants' approach bias scores and their chocolate craving ratings, $r = .30$, $p < .05$. Additionally, analyses conducted for chocolate (chocolate avoid—chocolate approach) and nonchocolate (nonchocolate avoid—nonchocolate approach) bias scores separately showed a positive correlation between chocolate craving ratings and chocolate bias scores, $r = .29$, $p < .05$, but no such correlation for nonchocolate bias scores, $r = -.19$, $p > .05$.

Discussion

As predicted, performance on the implicit association task indicated an approach bias for chocolate (i.e., a stronger approach than avoid association with chocolate). Participants were faster to categorize stimuli in the congruent (i.e., chocolate + approach vs. nonchocolate + avoid) than in the incongruent (i.e., nonchocolate + approach vs. chocolate + avoid) phase of the task. This finding is consistent with reports of approach biases for other craved substances, in particular those for alcohol (Field et al., 2005, 2008; Palfai & Ostafin, 2003), cigarettes (Bradley et al., 2004, 2008; De Houwer et al., 2006; Mogg et al., 2003, 2005) and cannabis (Cousijn et al., 2011; Field et al., 2006).

Importantly, the approach bias for chocolate was obtained in comparison with other highly desired food. Thus, unlike Van Gucht et al. (2008), the approach bias for craving-related chocolate cues observed here cannot be construed as a general appetitive response. This provides a clear test of the specificity of chocolate cravings. Moreover, the observed approach bias for chocolate could not be attributed to differences in valence or arousal between the two concept categories, as the chocolate and nonchocolate pictures were carefully matched on these appetitive qualities. As in the original study on the implicit association task (Greenwald et al., 1998), the approach–avoidance associations were stronger when the congruent phase came first.

Interestingly, the stronger approach than avoid association with chocolate reflected both an approach association with chocolate and an avoidance association with nonchocolate. The latter is perhaps somewhat surprising as the nonchocolate pictures also portrayed highly desired foods and were matched to the chocolate pictures. One possible explanation could be the unique position chocolate occupies in the Western diet. Because of its hedonic appeal and its ambivalent status as both naughty and nice (Rogers & Smit, 2000), it is by far the most commonly and intensely craved food in Western cultures (Hetherington & Macdiarmid, 1993). Consequently, compared with chocolate, all other foods, including other highly craved foods, would be perceived to be less attractive. Another related explanation could be the inherent nature of the implicit association task. This task looks at relative comparisons between pairings of concept and attribute categories, in this case chocolate + approach versus nonchocolate + avoid, and nonchocolate + approach versus chocolate + avoid. Thus, relative to chocolate, it appears that participants formed an avoidance association with the nonchocolate pictures; however, this would have been unlikely if the comparison category had been other foods that are not typically craved or nonfood items.

Finally, in line with previous studies on approach biases for alcohol cues (Field et al., 2005, 2008; Palfai & Ostafin, 2003), participants' bias to approach chocolate cues was associated with subjective chocolate craving. Specifically, participants who reported stronger chocolate cravings showed a stronger approach bias for chocolate. Separate correlational analyses for chocolate and nonchocolate bias scores showed that this relationship was attributable to an association between chocolate craving and chocolate bias scores. In fact, nonchocolate bias scores did not correlate with chocolate craving. This speaks to the specificity of chocolate cravings, that is, there is no substitute for chocolate when it is craved. The correlation between approach bias scores and chocolate craving ratings was, however, rather small. This fits with previous reports of low correlations between approach bias and craving (Field et al., 2005, 2008; Palfai & Ostafin, 2003), and likely accounts for the mixed findings across the literature (Bradley et al., 2008; Cousijn et al., 2011; Field et al., 2006; Mogg et al., 2003, 2005).

Table 2
Mean Reaction Times (and Standard Deviations) for the Congruent and Incongruent Phases as a Function of Block Order in Experiment 1

	Phase		
Block order	Congruent	Incongruent	Approach–avoidance association
Congruent first	707 (95)	873 (149)	166
Incongruent first	689 (106)	742 (130)	53

Experiment 2

Experiment 1 demonstrated a stronger approach than avoid association specifically with regard to a craved food, namely chocolate. Experiment 2 investigated whether this association can be modified. To this end, we used a modified implicit association task to train participants to associate chocolate either with approach or with avoidance. We further examined the effect of this manipulation on participants' level of chocolate craving and thus tested the causal role of the bias in craving (MacLeod, Rutherford, Campbell, Ebsworthy & Holker, 2002). In the only two studies to date to examine effects of approach bias retraining on craving, specifically alcohol craving, one found an effect (Wiers et al., 2011) but the other did not (Wiers et al., 2010).

Finally, we also measured participants' awareness of the experimental contingencies used during the training (i.e., the pairing of chocolate pictures and approach/avoid words to response keys) to examine its potential role on training effects. Findings from previous cognitive bias modification studies on alcohol and cigarette cravings have been mixed. Although some have found that training effects were restricted to participants who were aware of the experimental contingencies (Attwood, O'Sullivan, Leonards, Mackinstosh & Munafo, 2008; Field et al., 2007), others found that contingency awareness did not influence training effects (Field et al., 2005; Field, Duka, Tyler & Schoenmakers, 2009).

Method

Participants. Participants were 96 female undergraduate students at Flinders University, aged 18 to 25 years ($M = 20.51$, $SD = 1.84$). None had taken part in Experiment 1. As in Experiment 1, participants ate something two hours before testing. Again, all participants reported that they liked chocolate. They consumed on average 1.62 ($SD = 1.52$) chocolate bars and 2.95 ($SD = 2.64$) chocolate-containing food items per week.

Design. The experiment used a 2 (training condition: approach, avoid) × 2 (time: pretraining assessment, posttraining assessment) between-subjects pretest posttest design. Participants were randomly assigned to the training conditions, subject to equal numbers per condition.

Materials.

Modified implicit association task. The same four sets of stimulus materials (chocolate and nonchocolate pictures, approach- and avoid-related words) were used as in Experiment 1. Following standard cognitive bias modification protocols (Field & Eastwood, 2005), the modified implicit association task consisted of three phases: (1) a pretraining baseline assessment of participants' approach–avoidance associations with regard to chocolate, (2) a training stage in which half the participants were trained to associate chocolate with approach, and the other half were trained to associate chocolate with avoidance, and (3) a posttraining assessment of participants' approach–avoidance associations akin to the pretraining assessment.

Pretraining assessment. In the pretraining assessment stage, participants completed a recoding-free version of the implicit association task (Houben, Rothermund & Wiers, 2009; Rothermund, Teige-Mocigemba, Gast & Wentura, 2009). This not only shortened the task (from the standard 5 blocks to 3 blocks) but also made the critical phase (Block 3) more similar to the training stage. In Block 1, participants categorized stimuli according to attribute only (i.e., approach and avoid). As in Experiment 1, the response assignment of the attribute categories (left or right) remained constant, and was counterbalanced. In Block 2, participants categorized stimuli according to concept only (i.e., chocolate and nonchocolate). Here the response assignment of the concept categories (left or right) switched randomly between trials. In Block 3, participants categorized stimuli according to both attribute and concept, with response assignment of the concept categories switching between trials. In so doing, the critical congruent (i.e., chocolate + approach vs. nonchocolate + avoid) and incongruent (i.e., nonchocolate + approach vs. chocolate + avoid) categorization phases were randomly intermixed in this combined block.

On each trial, the appropriate category labels were displayed in the top left and right hand corners of the computer screen 1500 ms before stimulus onset. This ensured that participants were aware of the correct response key assignment. As in Experiment 1, a single stimulus (picture or word) was then presented in the center of the screen. Participants categorized the stimulus according to the designated attribute and/or concept 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 intertrial interval was 250 ms.

As in Experiment 1, Blocks 1 and 2 consisted of 40 trials (each attribute or concept stimulus presented twice), and Block 3 consisted of 80 trials (each attribute and concept 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. An additional constraint in Blocks 2 and 3 was that each concept was presented once for each response assignment. Furthermore, in Block 3 half the trials were congruent (i.e., chocolate + approach vs. nonchocolate + avoid) whereas the other half were incongruent (i.e., nonchocolate + approach vs. chocolate + avoid).

Training. In the training stage, participants were trained to associate chocolate either with approach or with avoidance. The task essentially involved a modification of Block 3 of the pretraining assessment. Specifically, for participants in the approach condition, 90% of trials were congruent (i.e., chocolate + approach vs. nonchocolate + avoid) and 10% were incongruent (i.e., nonchocolate + approach vs. chocolate + avoid). For participants in the avoid condition, these contingencies were reversed, that is 10% congruent trials and 90% incongruent trials. Following Wiers et al. (2010), a 90–10 distribution was used, as opposed to a 100–0 one, to make responses less predictable, and thus reduce the obviousness of the contingency. The training phase consisted of 240 trials, with each attribute and concept stimulus presented six times.

Posttraining assessment. The posttraining assessment was identical to Block 3 of the pretraining assessment.

Chocolate craving. As in Experiment 1, participants rated their current level of chocolate craving on a 100-mm visual analogue scale ranging from "no desire or urge to eat chocolate" to "extremely strong desire or urge to eat chocolate."

Awareness of experimental contingencies. Following Field and Eastwood (2005), awareness of experimental contingencies was first assessed by an open-ended recall question and then by a multiple-choice recognition question. The open-ended question asked participants to describe the relationship between the pairings of the chocolate pictures and the approach/avoid words to the response keys during the training phase. The multiple-choice question asked participants to choose the correct statement from five different statements that described relationships between the pairings of the chocolate pictures and the approach/avoid words to the response keys (e.g., "chocolate pictures and approach words were paired to the same response key most of the time").

Procedure. As in Experiment 1, participants were tested individually in a quiet room in the Applied Cognitive Psychology laboratory at Flinders University. All participants were tested in the afternoon in a session of 45 minutes duration. Participants performed the modified implicit association task on an IBM compatible computer with a 17-inch monitor. Chocolate craving was assessed at two time points, just before as well as immediately after the training phase. The contingency awareness measures were administered at the end of the testing session.

Results

Modified implicit association task. To assess the effect of the training, we compared approach–avoid associations from the posttraining assessment with the Block 3 data of the pretraining assessment. Response times of incorrect trials were discarded. Additionally, response times of less than 300 ms or more than 3000 ms were excluded as outliers, as were response times more than 3 *SD*s above or below the individual mean. Errors and outliers accounted for 5.63% and 4.39% of the data, respectively. Descriptive statistics for the concept and attribute stimuli at pre- and posttraining assessment for each training condition are shown in Table 3. For each assessment phase, an approach bias score was calculated by subtracting the mean reaction time (RT) of the congruent (chocolate + approach vs. nonchocolate + avoid) trials, from the mean RT of the incongruent (nonchocolate + approach vs. chocolate + avoid) trials.

Approach bias scores were analyzed by a 2 (training condition: approach, avoid) × 2 (time: pretraining assessment, posttraining assessment) mixed model ANOVA. There were no significant main effects of training condition, $F(1, 94) = 1.26$, $p > .05$, or time, $F(1, 94) = .07$, $p > .05$. However, as predicted, there was a significant training condition × time interaction, $F(1, 94) = 8.32$, $p < .01$, partial $\eta^2 = .08$. Independent samples *t* tests showed that the two training conditions did not differ at pretraining assessment, $t(94) = 1.42$, $p > .05$. However, at posttraining assessment, there was a significant group difference, $t(94) = 2.84$, $p < .01$, $d = .58$, with the approach group showing a chocolate–approach association and the avoid group showing a chocolate–avoid association. In addition, as can be seen in Figure 1, paired samples *t* tests, conducted for each training condition separately, showed a significant increase in approach bias scores from pre- to posttraining assessment in the approach group, $t(47) = 2.08$, $p < .05$, $d = .43$, and a significant decrease in the avoid group, $t(47) = 2.03$, $p < .05$, $d = .45$. Furthermore, as can be seen in Figure 2, analyses of variance conducted for chocolate (chocolate avoid—chocolate approach) and nonchocolate (nonchocolate avoid—nonchocolate approach) bias scores separately, showed that training specifically affected the approach–avoidance associations for chocolate, $F(1, 94) = 10.42$, $p < .01$, partial $\eta^2 = .10$ (training condition × time interaction), but not for nonchocolate cues, $F(1, 94) = .23$, $p > .05$.

Chocolate craving. Chocolate craving ratings were also analyzed by a 2 (training condition: approach, avoid) × 2 (time: pretraining assessment, posttraining assessment) mixed model ANOVA. The pattern of results was the same as for the approach bias scores. There were no significant main effects of training condition, $F(1, 94) = .00$, $p > .05$, or time, $F(1, 94) = .30$, $p > .05$, but there was a significant interaction between training condition and time, $F(1, 94) = 4.41$, $p < .05$, partial $\eta^2 = .05$. As can be seen in Figure 3, paired samples *t* tests, conducted for each training condition separately, showed that chocolate cravings increased significantly from pre- to posttraining assessment in the approach condition, $t(47) = 2.08$, $p < .05$, $d = .16$. Although cravings decreased from pre- to posttraining assessment in the avoid condition as expected, this change was not statistically significant, $t(47) = 1.01$, $p > .05$.

Awareness of experimental contingencies. Thirty-nine participants (41%) correctly recalled or recognized the relationship between the pairings of the chocolate pictures and the approach/avoid words to the response keys during the training phase; the other 57 participants (59%) were not aware of (or at least did not report) the experimental contingencies. To examine the effect of contingency awareness on approach bias scores and chocolate craving ratings, the previous ANOVAs were repeated with awareness (aware, unaware) as an additional between-subjects factor. Across analyses, there was no main effect of awareness, nor, most importantly, any interactions involving awareness (all *F*s < 1,

Table 3
Mean Reaction Times (and Standard Deviations) for the Concept and Attribute Stimuli in the Approach and Avoid Conditions at Pre- and Post-Training Assessment in Experiment 2

	Training condition			
	Approach		Avoid	
	Approach	Avoid	Approach	Avoid
Pre-training assessment				
Chocolate	1059 (198)	1085 (213)	1067 (277)	1123 (358)
Nonchocolate	1123 (193)	1187 (243)	1182 (299)	1211 (291)
Post-training assessment				
Chocolate	809 (160)	905 (159)	925 (248)	881 (236)
Nonchocolate	906 (184)	949 (208)	945 (264)	980 (252)

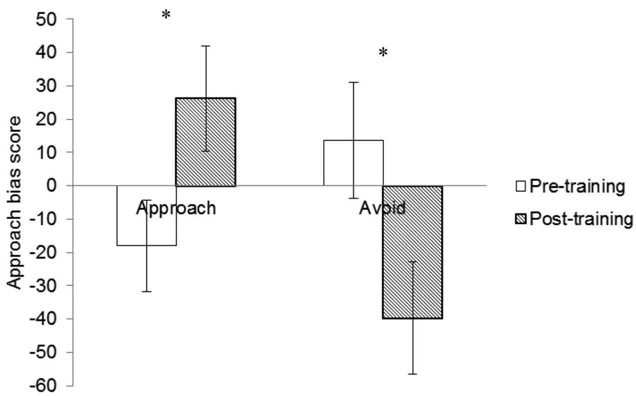

Figure 1. Mean approach bias scores (with standard errors) for the approach and avoid conditions at pre- and post-training assessment in Experiment 2; $^* p < .05$.

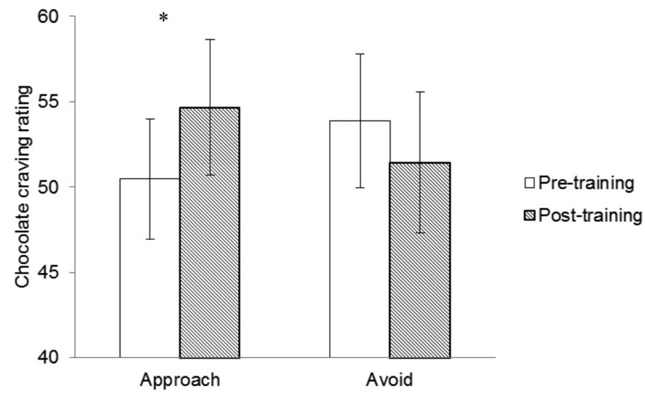

Figure 3. Mean chocolate craving ratings (with standard errors) for the approach and avoid conditions at pre- and post-training assessment in Experiment 2; $^* p < .05$.

*p*s > .05). It needs to be noted, however, that the reduced sample size is small and thus lacking in power.

Discussion

Experiment 2 showed that approach–avoidance associations for craving-related food cues can be modified. Specifically, participants demonstrated changed chocolate-related associations in accordance with their training condition, such that the approach group showed an increased chocolate–approach association from pre- to posttraining assessment, whereas the avoid group showed an increased chocolate–avoidance association. These changes were entirely attributable to alterations in approach–avoidance associations for the chocolate cues. The altered approach–avoidance associations found here are consistent with recent studies that have found similar changes in approach bias for alcohol cues following a retraining protocol in hazardous drinking students (Wiers et al., 2010) and alcoholic inpatients (Wiers et al., 2011).

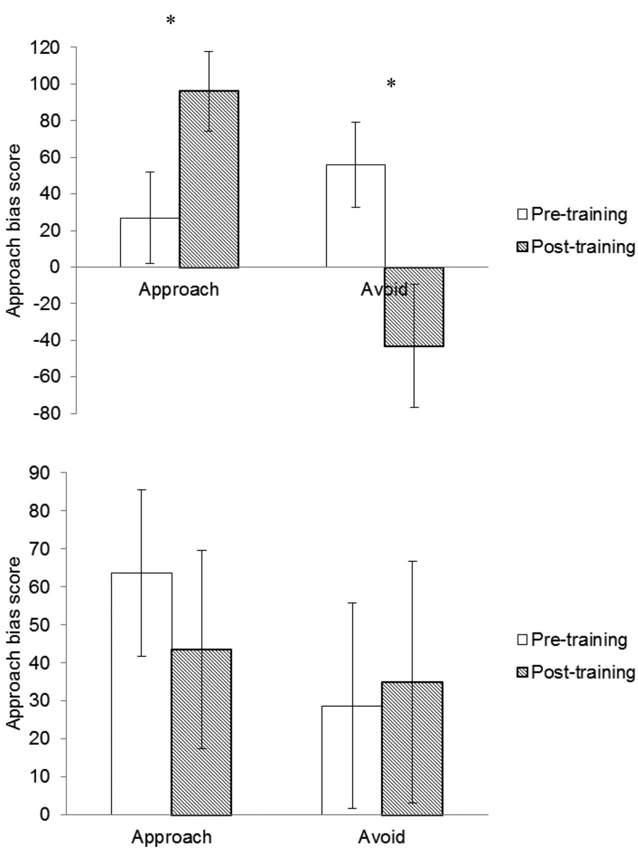

Figure 2. Mean approach bias scores (with standard errors) for the approach and avoid conditions at pre- and post-training assessment for chocolate (top) and non-chocolate (bottom) cues in Experiment 2; $^* p < .05$.

The training manipulation produced a similar pattern of effects on craving ratings. Participants in the approach group reported significantly stronger chocolate cravings after the training; in contrast, participants in the avoid group reported less intense cravings, although not significantly so. The training effects on chocolate craving observed here are in line with those of Wiers et al. (2011) on alcohol craving. However, Wiers et al. (2010) found no effect of approach bias retraining on alcohol craving. Other cognitive bias modification paradigms likewise have produced mixed results, with some showing effects of attentional retraining on craving (Attwood et al., 2008; Field et al., 2005, 2007), and others not (Field et al., 2009; Schoenmakers, Wiers, Jones, Bruce & Jansen, 2007; Schoenmakers et al., 2010). Nevertheless, the finding here that the manipulation of chocolate-related approach–avoidance associations did produce a corresponding change in chocolate craving supports a causal relationship between approach bias and craving.

Finally, the training effects on approach–avoidance associations and craving were observed across the board, regardless of whether participants were aware of the experimental contingencies. This suggests that participants need not be consciously aware of the retraining to show its intended effects.

General Discussion

The present experiments investigated implicit approach–avoidance associations in the food craving domain. Experiment 1 established the existence of an approach bias specifically for one particular craved food, namely chocolate. Experiment 2 demonstrated for the first time that this bias can be modified.

Our results are broadly consistent with reports of approach biases for other craved substances, such as alcohol (Field et al., 2005, 2008; Palfai & Ostafin, 2003), cigarettes (Bradley et al., 2004, 2008; De Houwer et al., 2006; Mogg et al., 2003, 2005), and drugs (Cousijn et al., 2011; Field et al., 2006). They also support recent findings of approach bias retraining to avoid alcohol (Wiers et al., 2010, 2011) and thus extend the application of approach bias modification to food cravings.

Theoretically, the current findings fit well into aspects of incentive- and cognitive-motivational accounts of craving. The findings of Experiment 1 are consistent with Robinson and Berridge's (1993) predicted link between implicit approach associations and craving. The chocolate-related pictures used in the implicit association task would have had high incentive salience for our sample of young Western women who regularly consume chocolate. These stimuli were therefore perceived as attractive and 'wanted,' and could not be ignored. This in turn elicited the stronger chocolate–approach than avoid association and accounts for the observed correlation with self-reported chocolate craving. Experiment 2 took the further step of testing predictions of more recent cognitive–motivational models of craving (Franken, 2003; Kavanagh et al., 2005; Ryan, 2002). These posit a causal effect of cognitive bias on subjective craving. Specifically, they predict that approach biases can be cognitively retrained, and that such a change can influence subsequent craving. In support, Experiment 2 showed that chocolate-related approach–avoidance associations can indeed be modified, and that this modification produced a change in self-reported chocolate craving.

The results of Experiment 2 also have clinical implications. The finding that approach associations, and accompanying cravings, for food can be modified offers potential scope for curbing unwanted food cravings in vulnerable populations. In particular, future research should aim to extend the present findings obtained in an undergraduate sample with moderate chocolate cravings to individuals for whom such cravings are problematic, that is, "chocoholics," as well as binge eaters, overweight or obese individuals who are trying to lose weight, and individuals affected by eating disorders (Gendall, Joyce, Sullivan & Bulik, 1998; McManus & Waller, 1995; Sitton, 1991). Manipulating approach–avoidance associations might thus ameliorate some of the potentially adverse consequences of food craving.

Another avenue for further research would be to include a measure of consumption. It is widely accepted that craving drives consumption (Robinson & Berridge, 1993), although see Tiffany and Carter (1998) for an alternative view. Thus the effects of approach–avoidance retraining should extend to consumption behavior. In support, Wiers et al. (2010) found an effect of such retraining on alcohol consumption in heavy drinkers. In particular, heavy drinkers trained to avoid alcohol consumed less beer on a subsequent taste test than those trained to approach alcohol.

In conclusion, the present study adds to a growing body of research on craving-related approach–avoidance associations. We have clearly demonstrated an approach bias specifically for craving-related food cues, and have also shown that this bias can be modified.

References

Attwood, A. S., O'Sullivan, H., Leonards, U., Mackintosh, B., & Munafo, M. R. (2008). Attentional bias training and cue reactivity in cigarette smokers. *Addiction, 103,* 1875–1882. doi:10.1111/j.1360-0443.2008.02335.x

Baker, T. B., Morse, E., & Sherman, J. E. (1986). The motivation to use drugs: A psychobiological analysis of urges. In P. C. Rivers (Ed.), *The Nebraska symposium on motivation: Alcohol use and abuse* (pp. 257–323). Lincoln, NE: University of Nebraska Press.

Bradley, B. P., Field, M., Healy, H., & Mogg, K. (2008). Do the affective properties of smoking-related cues influence attentional and approach biases in cigarette smokers? *Journal of Psychopharmacology, 22,* 737–745. doi:10.1177/0269881107083844

Bradley, B., Field, M., Mogg, K., & De Houwer, J. (2004). Attentional and evaluative biases for smoking cues in nicotine dependence: Component processes of biases in visual orienting. *Behavioural Pharmacology, 15,* 29–36. doi:10.1097/00008877-200402000-00004

Brignell, C., Griffiths, T., Bradley, B. P., & Mogg, K. (2009). Attentional and approach biases for pictorial food cues. Influence of external eating. *Appetite, 52,* 299–306. doi:10.1016/j.appet.2008.10.007

Carter, B. L., Lam, C. Y., Robinson, J. D., Paris, M. M., Waters, A. J., Wetter, D. W., Cinciripini, P. (2008). Real-time craving and mood assessments before and after smoking. *Nicotine & Tobacco Research, 10,* 1165–1169. doi:10.1080/14622200802163084

Cousijn, J., Goudriaan, A. E., & Wiers, R. W. (2011). Reaching out towards cannabis: Approach-bias in heavy cannabis users predicts changes in cannabis use. *Addiction, 106,* 1667–1674. doi:10.1111/j.1360-0443.2011.03475.x

De Houwer, J., Custers, R., & De Clercq, A. (2006). Do smokers have a negative implicit attitude toward smoking? *Cognition and Emotion, 20,* 1274–1284. doi:10.1080/02699930500484506

Field, M., Duka, T., Eastwood, B., Child, R., Santarcangelo, M., & Gayton, M. (2007). Experimental manipulation of attentional biases in heavy drinkers: Do the effects generalise? *Psychopharmacology, 192,* 593–608. doi:10.1007/s00213-007-0760-9

Field, M., Duka, T., Tyler, E., & Schoenmakers, T. (2009). Attentional bias modification in tobacco smokers. *Nicotine & Tobacco Research, 11,* 812–822. doi:10.1093/ntr/ntp067

Field, M., & Eastwood, B. (2005). Experimental manipulation of attentional bias increases the motivation to drink. *Psychopharmacology, 183,* 350–357. doi:10.1007/s00213-005-0202-5

Field, M., Eastwood, B., Mogg, K., & Bradley, B. P. (2006). Selective processing of cannabis cues in regular cannabis users. *Drug and Alcohol Dependence, 85,* 75–82. doi:10.1016/j.drugalcdep.2006.03.018

Field, M., Kiernan, A., Eastwood, B., & Child, R. (2008). Rapid approach responses to alcohol cues in heavy drinkers. *Journal of Behavior Therapy and Experimental Psychiatry, 39,* 209–218. doi:10.1016/j.jbtep.2007.06.001

Field, M., Mogg, K., & Bradley, B. P. (2005). Craving and cognitive biases for alcohol cues in social drinkers. *Alcohol and Alcoholism, 40,* 504–510. doi:10.1093/alcalc/agh213

Franken, I. H. A. (2003). Drug craving and addiction: Integrating psychological and neuropsychopharmacological approaches. *Progress in Neuro-Psychopharmacology & Biological Psychiatry, 27,* 563–579. doi:10.1016/S0278-5846(03)00081-2

Gendall, K. A., Joyce, P. R., Sullivan, P. F., & Bulik, C. M. (1998). Food cravers: Characteristics of those who binge. *International Journal of Eating Disorders, 23,* 353–360. doi:10.1002/(SICI)1098-108X(199805)23:4<353::AID-EAT2>3.0.CO;2-H

Greenwald, A. G., McGhee, D. E., & Schwartz, J. L. K. (1998). Measuring individual differences in implicit cognition: The implicit association test. *Journal of Personality and Social Psychology, 74,* 1464–1480. doi:10.1037/0022-3514.74.6.1464

Havermans, R. C., Giesen, J. C. A. H., Houben, K., & Jansen, A. (2011). Weight, gender, and snack appeal. *Eating Behaviors, 12,* 126–130. doi:10.1016/j.eatbeh.2011.01.010

Hetherington, M. M., & Macdiarmid, J. I. (1993). "Chocolate addiction": A preliminary study of its description and its relationship to problem eating. *Appetite, 21,* 233–246. doi:10.1006/appe.1993.1042

Hill, A. J., Weaver, C. F., & Blundell, J. E. (1991). Food craving, dietary restraint and mood. *Appetite, 17,* 187–197. doi:10.1016/0195-6663(91)90021-J

Houben, K., Rothermund, K., & Wiers, R. W. (2009). Predicting alcohol use with a recoding-free variant of the Implicit Association Test. *Addictive Behaviors, 34,* 487–489. doi:10.1016/j.addbeh.2008.12.012

Kavanagh, D. J., Andrade, A., & May, J. (2005). Imaginary relish and exquisite torture: The elaborated intrusion theory of desire. *Psychological Review, 112,* 446–467. doi:10.1037/0033-295X.112.2.446

Kemps, E., & Tiggemann, M. (2010). A cognitive experimental approach to understanding and reducing food cravings. *Current Directions in Psychological Science, 19,* 86–90. doi:10.1177/0963721410364494

Kemps, E., Tiggemann, M., & Grigg, M. (2008). Food cravings consume limited cognitive resources. *Journal of Experimental Psychology: Applied, 14,* 247–254. doi:10.1037/a0012736

Lafay, L., Thomas, F., Mennen, L., Charles, M. A., Eschwege, E., Borys, J., & Basdevant, A. (2001). Gender differences in the relation between food cravings and mood in an adult community: Results from the fleurbaix laventie ville sante study. *International Journal of Eating Disorders, 29,* 195–204. doi:10.1002/1098-108X(200103)29:2<195::AID-EAT1009>3.0.CO;2-N

Macdiarmid, J. I., & Hetherington, M. M. (1995). Mood modulation by food: An exploration of affect and cravings in 'chocolate addicts'. *British Journal of Clinical Psychology*, *34,* 129–138. doi:10.1111/j.2044-8260.1995.tb01445.x

MacLeod, C., Rutherford, E., Campbell, L., Ebsworthy, G., & Holker, L. (2002). Selective attention and emotional vulnerability: Assessing the causal basis of their association through experimental manipulation of attentional bias. *Journal of Abnormal Psychology, 111,* 107–123. doi:10.1037/0021-843X.111.1.107

McManus, F., & Waller, G. (1995). A functional analysis of binge-eating. *Clinical Psychology Review, 15,* 845–863. doi:10.1016/0272-7358(95)00042-9

Mitchell, J. E., Hatsukami, D., Eckert, E. D., & Pyle, R. L. (1985). Characteristics of 275 patients with bulimia. *The American Journal of Psychiatry, 142,* 482–485.

Mogg, K., Bradley, B. P., Field, M., & De Houwer, J. (2003). Eye movements to smoking-related pictures in smokers: Relationship between attentional biases and implicit and explicit measures of stimulus valence. *Addiction, 98,* 825–836. doi:10.1046/j.1360-0443.2003.00392.x

Mogg, K., Bradley, B. P., Hyare, H., & Lee, S. (1998). Selective attention to food-related stimuli in hunger: Are attentional biases specific to emotional and psychopathological states, or are they also found in normal drive states? *Behaviour Research and Therapy, 36,* 227–237. doi:10.1016/S0005-7967(97)00062-4

Mogg, K., Field, M., & Bradley, B. P. (2005). Attentional and evaluative biases for smoking cues in smokers: An investigation of competing theoretical views of addiction. *Psychopharmacology, 180,* 333–341. doi:10.1007/s00213-005-2158-x

Palfai, T. P., & Ostafin, B. D. (2003). Alcohol-related motivational tendencies in hazardous drinkers: Assessing implicit responses tendencies using the modified-IAT. *Behaviour Research and Therapy, 41,* 1149–1162. doi:10.1016/S0005-7967(03)00018-4

Pelchat, M. L. (1997). Food cravings in young and elderly adults. *Appetite, 28,* 103–113. doi:10.1006/appe.1996.0063

Pelchat, M. L. (2002). Of human bondage: Food craving, obsession, compulsion, and addiction. *Physiology & Behavior, 76,* 347–352. doi:10.1016/S0031-9384(02)00757-6

Robinson, T. E., & Berridge, K. C. (1993). The neural basis of craving: An incentive-sensitization theory of addiction. *Brain Research Reviews, 18,* 247–291. doi:10.1016/0165-0173(93)90013-P

Rogers, P. J., & Smit, H. J. (2000). Food craving and food "addiction": A critical review of the evidence from a biopsychosocial perspective. *Pharmacology, Biochemistry and Behavior, 66,* 3–14.

Rothermund, K., Teige-Mocigemba, S., Gast, A., & Wentura, D. (2009). Minimizing the influence of recoding in the Implicit Association Test: The Recoding-Free Implicit Association Test (IAT-RF). *The Quarterly Journal of Experimental Psychology, 62,* 84–98. doi:10.1080/17470210701822975

Ryan, F. (2002). Detected, selected, and sometimes neglected: Cognitive processing of cues in addiction. *Experimental and Clinical Psychopharmacology, 10,* 67–76. doi:10.1037/1064-1297.10.2.67

Schlundt, D. G., Virts, K. L., Sbrocco, T., & Pope-Cordle, J. (1993). A sequential behavioural analysis of craving sweets in obese women. *Addictive Behaviors, 18,* 67–80. doi:10.1016/0306-4603(93)90010-7

Schoenmakers, T. M., de Bruin, M., Lux, I. F. M., Goertz, A. G., Van Kerkhof, D. H. A. T., & Wiers, R. W. (2010). Clinical effectiveness of attentional bias modification training in abstinent alcoholic patients. *Drug and Alcohol Dependence,* Advance online publication.

Schoenmakers, T., Wiers, R. W., Jones, B. T., Bruce, G., & Jansen, A. T. M. (2007). Attentional re-training decreases attentional bias in heavy drinkers without generalization. *Addiction, 102,* 399–405. doi:10.1111/j.1360-0443.2006.01718.x

Shiffman, S., Engberg, J. B., Paty, J. A., Perz, W. G., Gnys, M., Kassel, J. D., & Hickcox, M. (1997). A day at a time: Predicting smoking lapse from daily urge. *Journal of Abnormal Psychology, 106,* 104–116. doi:10.1037/0021-843X.106.1.104

Sitton, S. C. (1991). Role of craving for carbohydrates upon completion of a protein-sparing fast. *Psychological Reports, 69,* 683–686.

Tiffany, S. T., & Carter, B. L. (1998). Is craving the source of compulsive drug use? *Journal of Psychopharmacology, 12,* 23–30. doi:10.1177/026988119801200104

Van Gucht, D., Vansteenwegen, D., Van den Bergh, O., & Beckers, T. (2008). Conditioned craving cues elicit an automatic approach tendency. *Behaviour Research and Therapy, 46,* 1160–1169. doi:10.1016/j.brat.2008.05.010

Veenstra, E. M., & de Jong, P. J. (2010). Restrained eaters show enhanced automatic approach tendencies towards food. *Appetite, 55,* 30–36. doi:10.1016/j.appet.2010.03.007

Waters, A., Hill, A., & Waller, G. (2001). Internal and external antecedents of binge eating episodes in a group of women with bulimia nervosa. *International Journal of Eating Disorders, 29,* 17–22. doi:10.1002/1098-108X(200101)29:1<17::AID-EAT3>3.0.CO;2-R

Weingarten, H. P., & Elston, D. (1990). The phenomenology of food cravings. *Appetite, 15,* 231–246. doi:10.1016/0195-6663(90)90023-2

Weingarten, H. P., & Elston, D. (1991). Food cravings in a college population. *Appetite, 17,* 167–175. doi:10.1016/0195-6663(91)90019-O

Wiers, R. W., Eberl, C., Rinck, M., Beckers, S., & Lindenmeyer, J. (2011). Retraining automatic action tendencies changes alcoholic patients' approach bias for alcohol and improves treatment outcome. *Psychological Science, 22,* 490–497. doi:10.1177/0956797611400615

Wiers, R. W., Rinck, M., Kordts, R., Houben, K., & Strack, F. (2010). Retraining automatic action-tendencies to approach alcohol in hazardous drinkers. *Addiction, 105,* 279–287. doi:10.1111/j.1360-0443.2009.02775.x

Received March 30, 2012
Revision received October 30, 2012
Accepted November 26, 2012 ■