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Research report

Negative mood increases selective attention to food cues and subjective appetite

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ABSTRACT

Following negative reinforcement and affect-regulation models of dysfunctional appetitive motivation, this study examined the effect of negative mood on objective and subjective cognitive indices of motivation for food; i.e., attentional bias for food cues and self-reported hunger/urge to eat, respectively. The study extended previous research on the effect of mood on food motivation by using (i) an experimental mood manipulation, (ii) an established index of attentional bias from the visual-probe task and (iii) pictorial food cues, which have greater ecological validity than word stimuli. Young female adults ($n = 80$) were randomly allocated to a neutral or negative mood induction procedure. Attentional biases were assessed at two cue exposure durations (500 and 2000 ms). Results showed that negative mood increased both attentional bias for food cues and subjective appetite. Attentional bias and subjective appetite were positively inter-correlated, suggesting a common mechanism, i.e. activation of the food-reward system. Attentional bias was also associated with trait eating style, such as external and restrained eating. Thus, current mood and trait eating style each influenced motivation for food (as reflected by subjective appetite and attentional bias). Findings relate to models of cognitive mechanisms underlying normal and dysfunctional appetitive motivation and eating behaviour.

Introduction

There is growing research interest in the cognitive mechanisms that determine eating behaviour because overeating is a major contributor to obesity. Both state and trait emotion-related variables may predispose people to overeat, for instance, negative mood (e.g. Greeno & Wing, 1994; Stice, Presnell, Shaw, & Rohde, 2005) and trait individual differences in eating style, such as emotional eating, which is conceptualised as eating in response to negative affect (e.g. Spoor, Bekker, Van Strien, & Van Heck, 2007).

According to affect-regulation models, individuals in a negative mood state eat in an effort to provide comfort or distraction from negative emotions (Spoor et al., 2007; Stice et al., 2005). The psychological mechanisms, which mediate the effect of negative mood on urge to eat and eating behaviour, are not fully understood. However, there has been detailed consideration of the cognitive mechanisms underlying the effect of negative mood on addictive behaviours (Baker, Piper, McCarthy, Majeskie, & Fiore, 2004). It is informative to consider these as it has been proposed that overeating may be a form of addictive behaviour, mediated by similar mechanisms, such as those involved in determining the reward value of appetitive cues (Davis et al., 2007; Davis, Strachan, & Berkson, 2004; Volkow & Wise, 2005).

Baker et al.'s (2004) negative reinforcement model of drug addiction proposes that 'escape or avoidance of negative affect is the principal motive' for addictive behaviour (p. 33). When negative affect is increased (e.g. by stressors or deprivation), this may bias information processing in ways that encourage addictive behaviour. According to their model, negative affect increases the incentive value of appetitive stimuli (e.g. food or drug cues), which results in increased craving and in attention being captured by the stimuli. Preliminary support for the latter proposal comes from studies reporting that laboratory stressors increase attention to drug cues under certain conditions (Bradley, Garner, Hudson, & Mogg, 2007; Field & Quigley, 2009). Baker et al.'s model also predicts that negative affect reduces the person's ability to use rational processes (e.g. influence of knowledge, reflective information processing) in order to resist immediate relief in favour of long-term benefit.

Thus, in relation to eating, a negative reinforcement model would predict that negative affect increases the reward value of food cues, which in turn increases urge to eat and attentional biases for food cues. This theoretical view also suggests that learning experiences shape the development of the trait eating style of emotional eating. For instance, a child might have inappropriately learnt to eat in response to negative affect through negative reinforcement (e.g. their parents gave them sweets as a

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reward for engaging in an unpleasant activity such as going to the doctor; therefore, through operant conditioning, eating became a negatively reinforced coping strategy in response to negative affect).

Correlational evidence indicates a relationship between negative mood and obesity. For example, in a prospective study of adolescents, Stice et al. (2005) found that for each additional depressive symptom there was more than a fourfold increase in risk of obesity onset, suggesting negative affect is a general risk factor for obesity. (This relationship was also found by Goodman & Whitaker, 2002; Pine, Goldstein, Wolk, & Weissman, 2001; Scott et al., 2008.) However, experimental research is required to establish whether negative mood plays a causal role in overeating and obesity. Indeed, animal studies provide experimental evidence of stress-induced eating, as various stressors (e.g. tail-pinching, isolation, social defeat) increase eating behaviour in rats and hamsters (e.g. Greeno & Wing, 1994; Solomon, Foster, Bartness, & Huhman, 2007). Experimental research in humans showed that a depressive mood induction procedure (MIP) increased self-reported craving for sweet rewards in healthy volunteers (Willner et al., 1998), consistent with negative affect enhancing the reward value of food, which in turn increases food craving. Such findings reflect a *general* effect model of stress on eating (Greeno & Wing, 1994).

Research in humans also suggests that individual differences in eating style may moderate the effect of negative affect on motivation to eat. For example, diary studies of the effects of daily hassles on eating behaviour in healthy volunteers indicate that the relationship between stress and snacking was greater in individuals who were high in emotional, external or restrained eating (O'Connor, Jones, Conner, McMillan, & Ferguson, 2008; see also Conner, Fitter, & Fletcher, 1999, and review by Macht, 2008). Laboratory studies on healthy volunteers have also found that stressed emotional eaters eat more sweet high-fat foods than unstressed and non-emotional eaters (Oliver, Wardle, & Gibson, 2000; see also Wallis & Hetherington, 2003; Macht, 2008).

Thus, several studies suggest a link between negative mood, trait eating style (e.g. emotional eating), and motivation to eat. However, there is a need to clarify the mechanisms that mediate these relationships. If negative mood increases the reward value of appetitive cues (as predicted by a negative reinforcement model, Baker et al., 2004), negative mood should increase not only self-reported urge to eat (Willner et al., 1998), but also attention to food cues, as appetitive stimuli with high incentive value are assumed to have attention-grabbing properties (Robinson & Berridge, 2001). In addition, such incentive-based models predict that urge to eat and attentional bias for food cues will be closely associated with each other, given that they are controlled by a common underlying mechanism, i.e. activation of the food reward system. Thus, attentional biases for food cues may shed light on the cognitive mechanisms involved in eating behaviour (i.e. attentional biases provide an objective index of motivational state, Mogg & Bradley, 1998). Thus, the primary aim of the present study was to investigate the effect of negative mood on attentional bias for food cues and subjective appetite. We also examined whether the effect of negative mood on attentional bias was influenced by trait individual differences, particularly in emotional eating (given that it reflects repeated learning experiences of eating food in response to negative mood).

As mentioned earlier, a negative reinforcement model also predicts that food-deprivation (as well as negative affect) increases the reward value of food cues, which in turn should increase attention to food cues. Much previous research into attentional biases for food cues has used the modified Stroop task, which compares the time taken to colour-name food-related (e.g. "sweets") and control (e.g. "pencil") words. Such research has shown that food-deprived healthy students have greater colour-naming interference for food words than controls, consistent with a hunger-related processing bias (Channon & Hayward, 1990; see also Green, Elliman, & Rogers, 1996). Newman, O'Connor, and Conner (2008) also used this task to investigate the effect of social stress (anticipation of public speaking) on attentional bias and unexpectedly found that low-external eaters showed enhanced interference for snack words when unstressed, whereas high-external eaters showed enhanced interference for snack words when stressed. Newman et al. noted that results from modified Stroop studies can be difficult to interpret, as interference effects may reflect either a bias towards or away from food words (Faunce, 2002), and recommended that further research should use the visual-probe task.

The visual-probe task provides a more direct measure of the allocation of visual attention to food cues (e.g., Mogg, Bradley, Hyare, & Lee, 1998). In this task, a series of word (or picture) pairs are presented. Each pair consists of a food-related stimulus (e.g. picture of chocolate) and a control stimulus (e.g. picture unrelated to food, such as a book). On each trial, a probe (e.g. a small dot) replaces the display of one of the stimuli and participants press a response button to indicate where the probe occurred. People generally respond more quickly to a stimulus that appears in an attended, rather than unattended, region of a visual display, therefore response times (RTs) to probes provide a measure of attentional bias to food cues, relative to control cues. Using this task, Mogg et al. (1998) found that increased subjective hunger in healthy volunteers was associated with an enhanced attentional bias towards food-related words (see also Placanica, Faunce, & Soames, 2002).

The present study used a pictorial version of the visual-probe task to examine the effect of negative affect on attentional responses to food cues in healthy volunteers. An advantage of pictorial stimuli is that they are more naturalistic than single words as food cues. The picture pairs were displayed at two different durations (500 and 2000 ms) as these have been previously used to assess the time course of attentional bias in both appetitive and aversive motivational states (e.g., Bradley, Field, Mogg, & De Houwer, 2004; Mogg & Bradley, 1998; Mogg, Bradley, Miles, & Dixon, 2004). Of these durations, the attentional bias at 500 ms is more likely to reflect processes involved in initial orienting, as there is evidence that this bias measure positively correlates with the direction of initial shift in gaze (Bradley, Mogg, & Millar, 2000). The longer duration (2000 ms) provides greater opportunity for attention to shift between the pictures, so this bias measure is more likely to reflect maintained attention (Bradley et al., 2004). Subjective appetite was measured by self-report ratings of hunger and urge to eat. Participants were also asked to rate the food pictures used in the attentional task for palatability in order to explore whether this influenced attentional bias.

Mood was manipulated experimentally, and participants were randomly allocated to a negative or neutral MIP (following a similar procedure as in Bradley et al., 2007; Willner et al., 1998). The primary hypothesis was that negative mood will increase attentional bias towards food cues. We also predicted that negative mood will increase subjective appetite (Willner et al., 1998). In addition, we examined whether the effect of negative mood on attentional bias to food cues is influenced by trait eating style, in particular, emotional eating, and also external and restrained eating (as these traits may moderate the effect of negative affect on eating behaviour, e.g., Conner et al., 1999; Macht, 2008; O'Connor et al., 2008).

Method

Design

The study used a mixed factorial design to test the main hypothesis that induced negative mood increases attentional bias