UNIVERSITY OF SOUTHAMPTON

FACULTY OF MEDICINE, HEALTH AND LIFE SCIENCES

School of Psychology

Eating behaviour and the role of emotions

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Thesis For The Degree of Doctorate in Clinical Psychology

May 2008

(18373 words)

Abstract

The thesis starts with a literature review looking at eating behaviour and the role of emotions. Different psychological views, which have attempted to explore the relationship between negative affect and overeating, are discussed. Trait individual differences (such as weight category, eating style and sensitivity to reward), along with other variables (such as type of food and stressor) and their impact on the stress-eating relationship are explored. The evidence suggests that eating style, sensitivity to reward, type of food and type of stressor are more important than weight category in moderating the stress-eating relationship. However the review concludes by highlighting the need for more theory-driven research to explore the underlying mechanisms, which are involved in the stress-eating relationship.

The empirical study investigated the influence of negative affect and emotional eating on selective attention to food related cues and subjective appetite. Baker, Piper, McCarthy, Majeskie and Fiore's (2004) negative reinforcement model suggests that negative affect increases the reward value of appetitive cues, which in turn increases urge to eat and enhances attentional biases for food cues. It goes on to suggest that individual differences in eating style might predispose certain people to become emotional eaters. The results found that negative mood did significantly increase both subjective appetite and attentional biases to food cues but that this effect was not significantly greater in emotional eaters. These findings are important in shedding light on the cognitive mechanisms that underlie normal and dysfunctional eating.

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Acknowledgements

I would like to express my thanks to Professor Karin Mogg, Dr. Catherine Brignell and Professor Brendan Bradley for their support throughout the dissertation. In addition I would like to thank all the participants who took part in the study and my fiancé and family for their unfailing support.

UNIVERSITY OF SOUTHAMPTON

Eating behaviour and the role of emotions

Literature Review

Prepared for submission to Appetite

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Doctoral Programme in Clinical Psychology

School of Psychology

May 2008

(8335 words)

Abstract

It is well recognised that emotions impact on eating behaviour and that negative affect in particular can lead to overeating (i.e. stress-induced overeating), which in turn, has been implicated in the onset of obesity. Different psychological views have attempted to understand this relationship and these are reviewed in this paper, with particular emphasis placed on understanding the role of negative affect in the maintenance of overeating. There is a growing body of research suggesting that trait individual differences such as weight category, eating style (emotional, external or restrained eating) and 'sensitivity to reward' are important in moderating this stress-eating relationship. This review therefore proposes to look at the empirical evidence in order to answer several key questions: Is there a general effect of mood on eating in obese and non-obese individuals? Do trait individual differences in eating style and reward sensitivity moderate the relationship between mood and eating? Do other variables (e.g. type of food or stressor) moderate the relationship between mood and eating? The evidence suggests that the findings are mixed with regards to the importance of weight category; i.e., obesity alone does not predict vulnerability to stress-induced eating, as there is a general effect of mood on eating in non-obese individuals. Research findings are discussed which suggest that eating style, sensitivity to reward, type of stressor and type of food consumed, have importance in moderating the stress-eating relationship. However, there is ambiguity surrounding the causal nature of these relationships and there is a lack of theory-driven research, which explores the underlying mechanisms, which might moderate and maintain these relationships. Future research and clinical implications are considered in light of these findings.

1. Introduction

"At times like this, continuing with ones life seems impossible and eating the entire contents of ones fridge seems inevitable." (Bridget Jones on the break-up of her relationship) (Bridget Jones Diary Script, 2001).

Eating behaviour and the role of emotions has been a longstanding area of interest to researchers as it is well recognised that human beings do not eat solely in response to their physiological needs. "Eating is as much a form of comfort, pleasure and reward as it is a means of achieving energy balance. This makes the drive to eat one of the most powerful urges of human behaviour" (Del Parigi, Chen, Salbe, Reiman & Tataranni, 2003, p493). The relationship between negative affect and overeating, which is often referred to as "stress-induced eating" (Greeno & Wing, 1994) is an important area of research because emotion-induced overeating has been identified as a major risk factor for obesity (Striegel-Moore et al. 1991), a condition that is known to predispose people to higher risks of cancer, hypertension, insulin resistance, diabetes, cardiovascular disease, cholesterol, stroke etc (Pi-Sunyer, 1991).

Attempts to understand the impact of emotions on eating behaviour have focused upon two different theoretical views. The first predicts that stress will have a *general* impact on all organisms and anyone exposed to a stressor will increase their food intake. This research has looked primarily for physiological pathways involved in the stress-induced eating relationship and has mainly been tested on animals (Greeno & Wing, 1994). The second theoretical view, which has only been tested in human beings, predicts that there will be *individual-differences* between people in how their eating behaviour will be affected by stress, i.e. some individuals will eat more in response to stress, whereas other individuals will not (Greeno & Wing, 1994). These individual differences between people will vary depending on their learning history,

attitudes, experiences etc. (Greeno & Wing, 1994.) Different psychological models have attempted to predict the underlying principles responsible for trait individual differences in eating behaviour. This literature review will focus on the most influential, which include: psychosomatic theory, externality theory, restraint theory, affect regulation models and 'sensitivity to reward' models, and how they may explain stress-induced eating.

The predominant trait individual differences, which have been implicated in moderating the relationship between stress and overeating, include (i) weight category, as individuals with obesity have been implicated in eating more in response to stress than normal weight individuals (Laitinen, Ek & Sovio, 2002). (ii) Eating style, which incorporates emotional eating (i.e. eating in response to negative affect); external eating (i.e. eating in response to external food cues) and restrained eating (i.e. restricting food intake for weight reasons). Emotional eaters have been found to eat more when stressed compared to non-emotional eaters (O'Connor, Jones, Conner, McMilan & Ferguson, 2008), this has also been found to be the case with external eaters compared to non-external eaters (Conner, Fitter & Fletcher, 1999) and restrained eaters compared to non-restrained eaters (Wardle, Steptoe, Oliver & Lipsey, 2000). (iii) Sensitivity to reward (including both high and low sensitivity to reward) has also been implicated in contributing to an individual's vulnerability to eating when stressed (Wang et al. 2000; Davis, Strachan & Berkson, 2004). In addition, other moderating variables have been implicated in the stress-induced eating relationship and these include the type of stressor (Heatherton, Herman & Polivy, 1992) and the type of food consumed (Gibson, 2006). All these variables will be reviewed in detail later.

1.1 Definitions and Scope

Emotions are notoriously difficult to define and operationalise. One definition, which has been put forward, is that emotions are "affective responses to appraisals of particular stimuli, situations or events, which have reinforcing potential" (Gibson, 2006, p54). Many

studies within the literature, refer to the emotional states of 'negative affect' or 'stress', it is therefore helpful to define these constructs. Negative affect (NA) has been defined as a "general dimension of subjective distress and unpleasurable engagement that subsumes a variety of aversive mood states, including anger, contempt, disgust, guilt, fear and nervousness, with low NA being a state of calmness and serenity" (Watson, Clark & Tellegen, 1988, p1063). Stress has been defined as "an aversive state in which the well-being of an organism is in jeopardy and demands outstrip, or threaten to outstrip, resources to cope" (Greeno & Wing, 1994, p444).

The experience of these emotions can either be temporary (*state* affect) or long term (*trait* affect). Terms denoting 'state' like emotions typically refer to brief and temporary experiences that occur sporadically and irregularly. In general, state affect arises as a result of situational pressures, social environmental conditions, cognitions, temporary physiological changes or a combination of the afore mentioned. Therefore state refers to 'now', transient emotions which vary from day to day (Lorr, 1989). Traits, on the other hand, are observed more frequently than states and occur across more situations (Lorr, 1989); trait affect therefore refers to long-term, more stable emotions that have lasted for a longer period of time, for instance, over the 'past few weeks'. This review will also look at whether emotions influence eating in non-eating disordered populations. Emotion-induced eating has been implicated in the development of eating disorders (Canetti, Bachar & Berry, 2002), but this is beyond the scope of this paper (for a review of this literature, see Stice, 2002).

In summary, the purpose of this review is to examine the relationship between negative affect and overeating, which is often termed "stress-induced eating" (Greeno & Wing, 1994). It will review psychological theories, which aim to explain this relationship and will evaluate such theories in light of the research into the effects of trait individual differences (e.g. weight category, eating style and sensitivity to reward) in moderating this

relationship. In addition this review will consider the role of other moderating variables, such as, the type of stressor and type of food consumed and their relevance to stress-induced eating. The review will identify the need for further theory-driven research, which explores the underlying mechanisms, which might moderate and maintain these relationships. Future research and clinical implications are put forward in light of these findings.

1.2 Study Selection Criteria

The literature review search strategy was limited to papers published in journals, peer reviewed e-journals, the internet and books. Literature searches were conducted on PsycINFO and MEDLINE databases using the following key words: emotional eating, restrained eating, external eating, sensitivity to reward, overeating; obesity; emotion; mood; stress; anxiety; depression; negative affect; food; addiction; negative reinforcement and eating behaviour.

2. Theoretical views linking eating behaviour and emotions

This review will focus on the dominant theoretical views of individual differences in eating style, which are currently influential in guiding research. These are emotional eating, external eating and restrained eating (Van Strien, Frijters, Bergers & Defares, 1986) and individual variations in sensitivity to reward (Wang et al. 2001). Each of these views emerge from a distinct psychological model of overeating, with each model proposing different predictions regarding the relationship between negative affect and overeating. These will therefore be reviewed in terms of the proposed motivational mechanisms in operation, paying particular attention to the role of negative affect and stress.

2.1 Psychosomatic Theories of overeating

An important cause of overeating for some individuals is emotional eating, that is, eating in response to negative emotional arousal (Wallis & Hetherington, 2004). Kaplan and Kaplan (1957) first investigated this phenomenon in individuals with obesity and noted that, when anxious, obese people overate to reduce feelings of anxiety. Kaplan and Kaplan's

(1957) view was developed further by Bruch (1973) who hypothesised that overeating occurred due to incorrect hunger awareness, probably as a result of early learning experiences. It was suggested that a normal response to emotional arousal states is a loss of appetite, as emotional arousal leads to physiological reactions that are similar to the state of satiety. It was further suggested that this may occur because emotional arousal inhibits gastric mobility and leads to the liberation of sugar from the liver into the blood stream, which leads to the sensation of feeling full and therefore it typically leads to decreased eating and subsequent weight loss (Van Strien & Ouwens, 2003). However, in some individuals emotional arousal leads to excessive eating due to a lack of 'interoceptive awareness' i.e. an inability to recognise whether they are hungry, full or suffering from a different discomfort (Van Strien & Ouwens, 2003). The term 'interoceptive awareness' was labelled by Bruch (1973) after she observed that women with anorexia nervosa appeared to have difficulty distinguishing between bodily sensations and the inner qualities of their emotions (De Groot, Rodin & Olmsted, 1995). Therefore, according to this theory, a person would overeat in response to 'uncomfortable sensations and feelings' and 'emotional tension' (Canetti et al. 2002).

Additionally, individuals who frequently resort to emotional eating are considered to be more poorly adjusted, to have difficulties in labelling emotional states and to have a deficient inner cognitive and affective structure (Van Strien, Schippers & Cox, 1995). Psychosomatic theory therefore provided the basis for the construct of 'emotional eating' that is, that certain individuals (irrespective of their weight) would overeat in response to uncomfortable states (Van Strein et al. 1986). However little is known about the cognitive mechanisms that occur to maintain this relationship between affective distress and overeating.

2.2. External theories of overeating

Schachter's 'internal/external' theory (Schachter, 1968; Schachter, 1971) of overeating makes different hypotheses to psychosomatic theory. This theory proposed that

individuals vary in the extent to which external and internal cues influence their eating behaviour. He suggested that obese people respond more to external cues of hunger, compared with non-obese people who tend to respond more to internal cues of hunger. Schachter (1968) further proposed that fear would typically lead normal weight people to hold back their consumption of food, but obese people, due to their insensitivity to internal cues, would not. Like psychosomatic theory, he hypothesised that the recognition of a set of physiological cues, including gastric contractions, as 'hunger' was a learned phenomenon and that normal weight people had learned to label these appropriately, whereas overweight people had not. However, in contrast to psychosomatic theory, Schachter (1968) predicted that as a consequence of poor understanding of internal physiological cues, obese people relied much more heavily on external cues to initiate and stop eating (Canetti et al. 2002).

While psychosomatic theory predicted that obese people would increase their eating when stressed in order to reduce anxiety, Schachter's theory predicted that they would show little effect of stress, because they would not eat in response to their internal physiological cues (Herman & Polivy, 1975), whereas normal weight people would decrease their eating when stressed. Therefore Schachter's theory predicted that emotional distress would not alter an obese individual's eating behaviour, but external food cues would. Schachter's theory therefore provided the basis for the construct of 'external eating' i.e. eating in response to external food cues, for instance, the sight or smell of food.

However, other researchers have generated different predictions from the theoretical construct of 'external eating' to those made by Schachter, proposing that stress can lead to overeating in external eaters (irrespective of their weight) as stress can lead to a change in attention towards environmental cues (Newman, O'Connor & Conner, 2008). Newman et al. (2008) suggested that Heatherton and Baumeister's (1991) escape theory (discussed in more detail later) may provide a possible explanation for why external eaters might overeat when

stressed. They proposed that, when stressed (particularly when experiencing an ego-threatening stressor e.g. failure on a task), this will result in an individual wanting to escape from 'self-awareness'. In order to do this the person becomes increasingly aware of their environment and less aware of themselves; thus their attention narrows to their immediate environment. Therefore, when external eaters experience stress, this may result in an increased attention shift towards the immediate environment, which in turn might be expected to increase food intake in these individuals, given that external eaters are driven to eat by environmental cues (Newman et al. 2008).

In summary, Schachter's 'internal/external' theory proposed that overeating occurred in response to food-related stimuli, irrespective of the internal states of satiety and hunger, whereas psychosomatic theory placed an emphasis on internal emotional factors. Schachter's theory provided the basis for the construct of 'external eating', that is, a heightened sensitivity to food cues such as the sight and smell of food (Van Strien et al. 1995). Alternative researchers have proposed a relationship between stress-induced eating and external eaters (irrespective of weight) and have used Heatherton and Baumeisters (1991) escape theory to explain this, predicting that when stressed external eaters change their attention towards environmental cues and therefore are more vulnerable to noticing food cues which in turn might lead to overeating.

2.3. Restraint theory of overeating

Restraint theory in contrast to psychosomatic theory and externality theory, attributes overeating to dieting. The restraint hypothesis was originally developed by Herman and Mack (1975) and elaborated by Herman and Polivy (1980). It proposes that the balance between the desire for food and the effort to resist that desire for food has an impact on eating behaviour. 'Restraint' is therefore the cognitive effort to resist that desire to eat (Canetti et al. 2002). Restraint theory therefore proposes that restrained eating is characterised by episodes of both

successful undereating and compensatory overeating (Herman, Polivy & Esses, 1987). It can be conceptualised as a desire to eat less; however this desire is only periodically achieved (Heatherton, Polivy & Herman, 1991).

Restrained eaters attempt to lower their body weight through conscious restriction of food; however, by doing this, physiological defences are activated, such as the lowering of an individual's metabolic rate and the production of feelings of persistent hunger (Van Strien, 2002). Restraint theory has identified that the cognitive resolve to diet can be abandoned as a result of 'disinhibition', leading to the 'what the hell effect,' which undermines an individual's self-control (Van Strien, 2002). Disinhibitors (i.e. triggers for disinhibited eating) have been found to include depression, anxiety, alcohol or even the consumption of high caloric foods (Ogden and Grevile, 1993). Counter-regulation may then occur, resulting in excessive food intake. In addition, continuous denial of hunger can lead to a loss of contact with feelings of hunger and satiety. Therefore, paradoxically, intense dieting can ultimately result in obese eating patterns (that is: emotional or external eating), since both arousal (e.g. negative affect) and external stimuli (e.g. the smell of food) can disrupt the cognitive restraint normally exercised by dieters faced with persistent hunger (Van Strien, 2002).

Heatherton and Baumeister's (1991) escape theory looked closer at disinhibited eating in restrained eaters and suggested that distress resulted in disinhibited eating in dieters by inducing an "escape from self". This theory predicted that threats to a dieter's self-image motivated that person to escape from self-awareness, especially when encountering negative information about the self, which is perceived as particularly aversive. To escape from this state, dieters tended to avoid broadly meaningful thought and instead narrowed their attention to the immediate stimulus situation. This cognitive shift redirected attention away from unpleasant thoughts about the self and towards food cues in the environment. The result for the dieter was disinhibited eating (Heatherton et al. 1992). Similar to psychosomatic theory,

restraint theory recognises that negative affect can lead to overeating, in the case of restrained eaters by acting as a disinhibitor (Ogden & Greville, 1993). Similarly, 'escape theory' recognises that stress can lead to increased attention towards external food cues, which has been attributed to possible overeating behaviour in both restrained and external eaters.

2.4. Affect Regulation Models

Affect regulation models are a more recent approach to explaining the stress-induced eating relationship. Similar to psychosomatic theory, affect regulation models suggest that individuals in a negative mood state eat in an effort to provide comfort or distraction from negative emotions (Stice, Presnell & Shaw, 2005). However the underlying principles are different with affect regulation models being based on the principles of negative reinforcement. That is, overeating is viewed as a learned maladaptive coping response designed to reduce unpleasant affect. Furthermore, overeating is maintained by the reinforcing experience of a temporary reduction of negative affect (Telch, 1997). However the mechanisms that operate to maintain this relationship between negative affect and overeating are not fully understood and the evidence, in the eating literature, of the underlying mechanisms is limited. However there is growing research interest in the parallels between overeating and other potentially addictive behaviours such as drug use, where negative reinforcement models have been influential (Volkow and Wise, 2005).

Addiction is defined as "a behaviour over which an individual has impaired control with harmful consequences" (West, 2001, p3). It "is a chronically relapsing disorder that is characterised by three major elements: (1) compulsion to seek and take the drug (or food), (2) loss of control in limiting intake, and (3) emergence of a negative emotional state (e.g. dysphoria, anxiety, irritability) when access to the drug (or food) is prevented (defined here as dependence)" (Koob, Sanna & Bloom, 1998, p467). There is evidence which supports the notion that foods (especially those that are highly palatable i.e. sweet, salty and fatty) can

regulate mood (Davis et al. 2004) in the same way the use of alcohol (Cooper, Russell, Skinner & Windle, 1992), cocaine (Jaffe & Kilbey, 1994), marijuana (Schafer & Brown, 1991) and tobacco (Ikard, Green & Horn, 1969) have been found to regulate mood in addicted individuals. Experts in the field of addiction have noted that feeding and drug use both involve learned habits that are maintained by the reinforcing properties of both powerful and repetitive rewards (Volkow & Wise, 2005). Therefore it is informative to look at negative reinforcement models in the addiction literature, to see how they can be applied to overeating in response to stress and negative affect.

Baker, Piper, McCarthy, Majeskie and Fiore's (2004, p.33) negative reinforcement model proposes that 'escape or avoidance of negative affect is the principal motive' for addictive behaviours. They state that when stressors or abstinence causes negative affect to grow, this biases an individual's information processing system in a way that encourages addictive behaviour. Response biasing occurs in the following ways: High levels of negative affect produces 'hot information processing' i.e. the individual is biased towards response options that have reduced the negative affect in the past (e.g. drug use; or consumption of food). At the same time the influence of the 'cool information processing system' decreases i.e. the influence of knowledge is reduced along with the ability to resist immediate relief in favour of long-term benefit, therefore high levels of negative affect leads to a devaluing of alternative re-enforcers. Therefore negative affect increases the incentive salience of drug (or food) cues and motivation to take drugs (or eat) (Baker et al, 2004). Baker et al's. (2004) model also predicts that individual differences in learning history would increase the likelihood of some people taking drugs, or eating, in response to negative affect (e.g. people who have repeatedly experienced negative affect in the past and who have learnt that this can be reduced by drug use or eating).

In summary, affect regulation models make similar predictions to those made from psychosomatic theory; that is, some individuals will overeat to alleviate negative affect. However the underlying assumptions of the two approaches are different; psychosomatic theory predicts that stress-induced eating occurs as a result of mislabelling internal states, whereas affect regulation models are based on the principles of negative reinforcement and predict that negative affect increases the incentive salience of food cues which in turn leads to overeating.

2.5 Sensitivity to Reward

Different to psychosomatic theory, externality theory, restraint theory and affect regulation models, another approach to overeating looks at how food is viewed as a reward. Similar to other addictive substances, food has been recognised as having rewarding properties (Volkow & Wise, 2005) and that brain circuits can be 'deranged' with natural rewards, such as food, just as they can with drugs (Davis et al. 2004). An individual's level of 'sensitivity to reward' (STR) is a key concept within the addiction literature at leaving a person vulnerable to addiction. In light of the similarities between overeating behaviour and addiction, research has begun to look at how STR can lead to people being vulnerable to overeating.

Sensitivity to Reward (STR) is a construct that addresses the ability to gain pleasure or reward from natural reinforcers (food) and pharmacologic rewards (drugs). It is viewed along a continuum with low STR (anhedonia) at one end, characterised by a diminished ability to experience pleasure from natural reinforcers (a key feature of depression) and high STR (hedonia) at the other end which is characterised by enhanced motivation to approach naturally pleasurable behaviours and to find them rewarding (Davis et al. 2004). STR is viewed as a personality trait strongly linked to the neurobiology of the mesolimbic dopamine system (Davis et al. 2004). That is, research suggests that the neurotransmitter, dopamine,

regulates food intake by modulating food reward by the meso-limbic circuitry of the brain (Wang et al. 2001).

There are two theoretical views on the role of STR in overeating. Firstly, Wang et al. (2001) suggested that, similar to other compulsive disorders such as drug addiction, overeating is the result of a 'reward deficiency syndrome'. That is, people who overeat or are drug addicts have "a low baseline activation of brain reward circuits" which is likely to foster overeating as a *compensatory* behaviour to increase dopamine stimulation to a more comfortable level, thus increasing an individual's feelings of pleasure. Eating floods the brain with dopamine (Del Parigi et al. 2003) and dopamine modulates motivation and reward circuits; hence dopamine deficiency in obese individuals might perpetuate pathological eating as a means to compensate for decreased activation of these circuits (Wang et al. 2001). Therefore people experiencing negative affect accompanied with a reward deficiency syndrome (i.e. low STR) are more likely to overeat to compensate for their reward deficiency, as a way of coping in order to increase their dopamine levels and feel better.

Alternatively, a second theoretical view of reward sensitivity is that put forward by Davis et al. (2004) who proposed that people with a *high* sensitivity to reward (STR) are more likely to approach and enjoy food, compared with those with a low sensitivity to reward. They predicted that high STR increases the likelihood of overeating during negative emotional states, in order to make a person feel better, which in turn leads to increased body mass index (BMI). Davis et al. (2004, p. 138) proposed that the fact that negative emotions enhance the desire for food in some people, though not in others, may be partly explained by "differential activation of the mesocortical DA pathway during moderate levels of stress".

2.6. Summary of theories linking eating behaviours and emotion

The construct of 'emotional eating' has been explained using ideas from psychosomatic theory (e.g. Bruch 1973) and affect regulation models (Stice et al. 2005; Baker

et al. 2004). These views propose different underlying mechanisms, with psychosomatic theory predicting that overeating is linked to an inability to identify one's internal physiological and emotional states, which can result in overeating to alleviate any feelings of discomfort. Whereas affect regulation models predict that emotional eaters overeat because they have learned that eating alleviates aversive mood states (i.e. through negative reinforcement). This occurs because negative affect increases the incentive salience of food cues, which increases an individual's urge to eat and subsequently their intake of food. Negative reinforcement models also recognise that individual differences in learning history make some people more vulnerable to eating in response to negative affect (Baker et al. 2004).

The construct of 'external eating' grew from Schachter's 'internal/external' theory, which attributed overeating to a general sensitivity to external cues, such as the sight and smell of food, irrespective of internal cues. This was because Schachter (1968) predicted that individuals with obesity were unable to label and identify their internal cues and therefore were unaffected by them, relying primarily on external cues. However more recent perspectives on 'external eating' suggest that stress can lead to external eaters paying more attention to environmental cues, including food cues, and thus leading to overeating (Newman et al. 2008). Both psychosomatic and external eating theories, however, do agree that emotion and external eating behaviour, precede obesity and dieting, rather than being caused by dieting. This is in contrast with the theory of restrained eating behaviour, which suggests that overeating is caused by dieting (Van Strien et al. 1995). Restraint theory also suggests that negative affect can act as a 'disinhibitor' leading to a loss of self-control and overeating in restrained eaters (Ouwens, Van Strien & Van der Staak, 2003). Escape theory also recognises the influence of environmental cues on restrained and external eaters when stressed (Heatherton & Baumeister, 1991).

In contrast to the theories mentioned earlier, a different school of thought is that food is viewed as a reward and an individual's level of sensitivity to reward can make them vulnerable to overeating. It has been proposed that people experiencing negative affect with a low STR are more likely to overeat to compensate for this 'reward-deficiency syndrome', in order to increases dopamine stimulation and activate the pleasure pathways and so reinforcing the use of food (Wang et al. 2001). However Davis et al. (2004) proposes that the opposite occurs and that people with a high STR are more likely to approach and enjoy food, compared with those with a low STR, and so overeat when experiencing negative affect.

All these theories attempt to understand what motivates people to overeat, each proposing different processes. Most acknowledge the impact of negative affect and suggest different ways in which negative affect is involved in influencing overeating behaviour in different individuals (e.g. obese individuals; external, emotional and restrained eaters). However what empirical evidence is there to support these views?

3. Eating behaviour and the influence of emotions

The psychological views outlined earlier propose that trait individual differences (e.g. weight category, eating style and sensitivity to reward) are important variables in moderating the relationship between negative affect and overeating. It is therefore informative to now evaluate these theories in light of empirical research to see which assumptions are supported.

3.1 Relationship between mood and obesity

Psychosomatic theory and externality theory predict that there will be an interaction between weight category and effect of stress on eating behaviour. Psychosomatic theory predicts that obese people will be more vulnerable to eat when stressed. Externality theory predicts that obese people will not change the amount they eat when stressed and that normal weight people will decrease how much they eat. Therefore it is informative to look at obese

and non-obese samples to see the impact of stress on eating and whether weight category is important in moderating the relationship betweens stress and eating?

3.2 Obese subjects versus normal weight subjects

The research findings regarding the influence of weight category on the relationship between mood and overeating are mixed. Research has found that depression predicts future increases in weight in adults (McGuire, Wing, Klem, Lang, & Hill, 1999) and future increases in body mass and onset of obesity in adolescents (Goodman & Whitaker, 2002). In a large sample of adolescent girls, Stice et al. (2005) found for each additional depressive symptom reported, there was more than a fourfold increase in risk for obesity onset. Scott et al. (2008) conducted an epidemiological study looking to see if there was an association between obesity and mental disorders in the general populations of 13 different countries. The sample consisted of over 60 thousand adults. Results showed a modest significant association between obesity and depressive disorders, and between obesity and anxiety disorders. These associations were mainly among those with severe obesity (BMI 35+) and among females.

Laitinen et al. (2002) conducted a longitudinal population-based study and found evidence to suggest a relationship between stress, eating and obesity. (This relationship has also been reported by Ganley, 1989; Geliebter & Aversa, 2003; Rasheed, 1998; Van Strien et al. 1986). However Patel and Schlundt (2001) found that in individuals with obesity, meals eaten in positive and negative moods were significantly larger than meals eaten in a neutral mood and that positive moods had a stronger impact than negative moods on food intake. Other studies have shown weak associations between work stress and BMI. Kouvonen, Kivimaki, Cox, Cox and Vahtera (2005) conducted a questionnaire study on 45,810 employees in Finland and found that higher job strain was associated with higher BMI but that the overall association between work stress and BMI was weak. However some studies have found no relationship at all between food intake, obesity and stress (Lowe & Fisher, 1983). These findings suggest

associations between negative affect and obesity, but the evidence is mixed and many of the results are correlational, so do not demonstrate the direction of causality (e.g. negative affect may lead to overeating and obesity; or obesity may result in negative affect). One relevant question in clarifying these associations is whether there is a general effect of mood on eating in non-obese individuals?

3.3 Is there a general effect of mood on eating in non-obese individuals?

Stone and Brownell (1994) found healthy weight participants were more likely to eat less than usual when encountering daily problems. As severity of stress increased so the likelihood of eating less increased, thus supporting Schachter's (1968) prediction that normal weight individuals would decrease the amount they ate when stressed. However a lot of research *has* found the opposite; i.e. evidence of stress-induced eating in healthy weight individuals. For example, Macht, Haupt and Ellgring (2005) conducted a field study in a student population, examining changes in eating in response to a real life stressor (taking an exam) compared to a control group. They found that students awaiting an exam reported higher emotional stress and an increased tendency to eat in order to distract themselves from the stress, compared to control subjects (see also Macht & Simons, 2000; Macht, 2008). Experimental research also supports this link between negative mood and increased food craving and intake in healthy participants. For example, Willner et al. (1998) conducted a laboratory study on healthy volunteers and found that a depressive mood induction procedure increased craving for sweet rewards. Research has also found that stress (e.g. tail pinching) can lead to overeating behaviour and obesity in rats (e.g. Teskey, Kavaliers & Hirst, 1984; Vaswani, Tejwani & Mousa, 1983). Providing support for the view that stress has a general effect on increasing eating behaviour (irrespective of weight).

3.4 Conclusion

This research suggests that weight category alone is not the main variable in moderating the stress-eating relationship. This is similar to the conclusion made by Greeno and Wing (1994) after they conducted a review looking at the impact of stress on eating behaviour. They stated "obesity alone does not itself predict vulnerability to stress-induced eating but rather that obesity interacts with, or could even be replaced by another dimension of importance" (Greeno & Wing, 1994, p453). It is therefore informative to look at other potential moderating variables.

3.5 Do trait individual differences in eating style and reward sensitivity moderate the relationship between mood and eating?

Psychosomatic theory, externality theory, restraint theory, affect regulation models and STR models suggest that trait individual differences in eating style (emotional, external and restrained eating styles) and sensitivity to reward are important variables in moderating the relationship between stress and overeating. Does the empirical research support these assumptions? Each variable shall be looked at in turn.

(i) Emotional eating

Recent research supports the prediction that emotional eaters will eat more when stressed in both obese and non-obese samples (Kubiak, Vogele, Siering, Schiel & Weber, 2008; O'Connor et al. 2008). Kubiak et al. (2008) conduced a diary study in a sample of adolescents with obesity and found emotional eaters' urge to eat increased when experiencing an increase in daily hassles. O'Connor et al. (2008) conducted a diary study in a large (N > 400) non-obese sample to assess the relationship between daily hassles and eating behaviour, and found that emotional eating was the predominant moderating variable in the relationship between hassles and snacking (greater than restrained or external eating). Correlational evidence, in a non-clinical sample, also supports the prediction that, when stressed, food

craving is significantly correlated with emotional eating, susceptibility to hunger, and only weakly correlated with dietary restraint (Hill, Weaver & Blundell, 1991). However, not all diary studies have found this relationship (e.g. an earlier study by O'Connor and O'Connor, 2004, did not detect a relationship between emotional eating and self-reported snacking, although it had a smaller sample).

Experimental research has also found support of the relationship between stress and eating in emotional eaters. Oliver, Wardle & Gibson (2000) conducted an experimental study comparing healthy, non-obese men and women volunteers. They were randomly assigned into either a stress (anticipation of public speaking) or control condition. The results found that stressed emotional eaters ate more sweet high-fat foods and a more energy-dense meal than unstressed and non-emotional eaters. Dietary restraint showed no effect. Overall, there is increasing evidence to suggest emotional eating style is an important moderating variable in the stress-eating relationship (irrespective of weight category).

(iI) External eating

There is evidence to suggest that emotional eaters are susceptible to increased food intake when stressed; however the impact of the trait of external eating on stress-induced eating has been relatively neglected within the research literature (Newman et al. 2008). However some research has supported a link between external eaters and stress-induced eating. Conner et al. (1999) looked at a range of moderating variables (restraint, emotional eating, external eating and gender) in a diary study. They found that external eating moderated the relationship between stress (self-reported daily hassles) and eating, i.e. external eaters reported consuming significantly more between meal snacks during periods of high stress. In addition, they did not find that restrained or emotional eating moderated the stress-eating relationship. Therefore their results seem compatible with the suggestion that stress increases attention to external cues (e.g. sight of food), thus leading to overeating when

stressed. Newman et al. (2008) examined the effects of external eating and a stress condition on attentional biases for food cues, using a Stroop task. They found that stressed high external eaters had a greater attentional bias for snack words than stressed low external eaters, and suggested that this could contribute to stress-induced eating in high external eaters.

(iii) Restrained eating

It has also been proposed that stressors influence eating behaviours in restrained eaters (for review see Greeno & Wing, 1994); however the findings have been mixed. Wardle et al. (2000) found that stress resulted in an increase in eating in restrained eaters compared to unrestrained eaters. Experimental research also supports this assumption. Heatherton et al. (1991) conducted an experimental study and found that ego-threatening stress (i.e. failure on an easy task) was significantly correlated to an increase in food intake in restrained eaters, but had no effect on unrestrained eaters (this finding was replicated by Wallis & Hetherington, 2004). Rotenberg and Flood (1999) examined the effect of a neutral, sad or loneliness mood induction procedure (MIP) in students, who then ate biscuits under the pretext that they were participating in a taste test. Results found that dieters tended to consume more food in the loneliness than neutral mood condition, whereas non-dieters displayed the opposite pattern. (See also Rutledge & Linden, 1998; Heatherton, Striepe & Wittenberge, 1998).

Diary studies however have produced mixed results. For example, O'Connor and O'Connor (2004) found that dietary restraint did not have a clear-cut moderating effect on the stress-eating relationship. They found restrained eaters only ate more between-meal snacks when stressed, if they also had low conscientiousness. Conner et al. (1999) found no relationship between stress, increased food intake and restrained eating in their diary study. Pollard, Steptoe, Canaan, Davies & Wardle (1995) examined the effects of exam stress and self-reported eating (assessed by interview) and found that this relationship was not moderated by dietary restraint. Therefore, the relationship between restrained eating and

stress-induced eating is unclear, with Lowe and Karl (2006, p16) in their review concluding that "an adequate explanation for stress-induced eating in restrained eaters remains elusive".

(iv) Sensitivity to reward (STR)

Research suggests that STR may have an important moderating role in the relationship between stress and overeating. Evidence to support the prediction that low STR and negative affect can lead to overeating has been supported by Wang et al. (2001). Their research found that females with obesity (BMI>40) had fewer dopamine receptors compared to a control group of non-obese individuals. In addition, the number of dopamine receptors was negatively associated with BMI in the obese group. They concluded that, because dopamine modulates motivation and reward circuits, a dopamine deficiency in obese individuals may perpetuate pathological eating as a means of compensating for decreased activation of these reward circuits. Therefore, these results are consistent with the view that obese individuals have a 'reward deficiency syndrome' (lower STR), which may make them more likely to eat more when stressed.

In contrast, Davis et al. (2004) looked at self-reported sensitivity to reward in normal weight, overweight and obese female students, and found overweight women reported significantly more STR than normal weight students (i.e. greater responsiveness to reward, which would be more consistent with higher dopamine availability). They also found that STR was positively correlated with increased eating when in a depressed mood. Interestingly however they found that the women with obesity (BMI>30) were more anhedonic on the measure of STR than the overweight women, although they were not significantly different from the normal weight group. Davis et al. (2004) concluded that an individual's STR may serve as a risk factor for overeating and variations in an individual's desire to eat when experiencing negative affect may be due to differential activation of the mesocortical dopamine pathway.

Davis et al.'s (2004) findings have also been supported by other researchers who have found that individual differences in reward sensitivity are related to food craving and relative body weight in healthy women, with a positive association between STR and weight (Franken & Muris, 2005). In a neuroimaging study, Beaver et al. (2006) found that individual differences in trait STR were highly correlated with neural responses to pictures of appetizing foods (e.g. chocolate cake, pizza). That is, those high in STR had greater activation of the fronto-striatal-amygdala-midbrain network in response to the sight of appetizing food cues. In other words, this heightened responsiveness of this network to food cues may be a mechanism for translating reward drive into increased vulnerability to overeating in certain individuals. This research highlights that there is personality-linked variability in the neural responses to food cues in healthy participants (Beaver et al. 2006). This view seems to be supported by Davis et al. (2007), who has also found a link between high STR and external eating (i.e. eating in response to external food cues). Thus, these findings provide evidence for the prediction that negative affect and high STR could lead to increased awareness of external food cues and subsequent overeating (although there is some mixed evidence regarding reward system sensitivity and dopamine functioning in obese individuals, Wang et al., 2001; Davis et al., 2004; 2007). The underlying mechanisms would need to be explored further to clarify this.

3.6 Do other variables moderate the relationship between mood and overeating?

The evidence reviewed so far has raised two important questions with regards to the relationship between stress and eating. Firstly, what impact does the type of stressor have on eating behaviour? Secondly, what impact does the type of food have on urge to eat and food consumption?

(i) Type of stressor

Heatherton & Baumeister's (1991) escape theory, as mentioned earlier, predicts that the type of stressor is important in influencing eating behaviour, and suggests that high aversive self-awareness (i.e. ego threats) will lead to stress-related eating in restrained eaters but not in unrestrained eaters. Heatherton et al. (1992) found support for this suggestion i.e. this found that ego-threat stressors disinhibited restrained eaters, but that physical stressors did not. Interestingly however, Tanofsky-Kraff, Wilfley & Spurrell (2000) found that the impact of an interpersonal stressor (social alienation and being felt to feel interpersonally ill-equipped) led to greater food consumption amongst restrained eaters than ego-threat stressors (e.g. failure on a task and anticipation of a speech). Ego-threat stressors have also been found to induce motivation to eat and food consumption in emotional eaters (Wallis & Hetherington, 2004). Wallis & Hetherington (2004, p45) conducted an experimental study on female students and found that emotional eaters ate more (chocolate) *only* after an ego-threatening Stroop colour naming task and concluded that, "high aversive self-awareness may be *necessary* to induce stress-related eating in emotional eaters".

O'Connor et al. (2008) found that ego-threatening, interpersonal and work-related hassles were associated with increased self-reported snacking (in particular high-fat snacks), whereas, physical stressors were associated with decreased snacking. Lattimore (2001) also found that a frightening film did not have an impact on increased food intake, but that an ego-threat stressor did. In later research, Lattimore and Caswell (2004) examined the effects of different types of stressors (a reaction time task and cold-presser test versus a relaxation control condition) in female restrained and non-restrained eaters, and found that restrained eaters consumed more food after a reaction time task compared to non-restrained eaters. This suggested that disinhibited eating could be triggered by a cognitively demanding task. These

results lend support to the notion that the *type* of stressor may serve as a mediating variable in the stress-eating relationship, affecting individual groups differently.

(ii) Type of food

It has been extensively researched whether the type of food consumed can affect mood state. Gibson (2006) hypothesised that sweet and high fat foods improve mood and mitigate effects of stress via brian opioidergic and dopaminergic neurotransmission. Sweet, fatty foods may also provide alleviation from stress in vulnerable people via enhanced function of the serotonergic system. It has been suggested that individuals with disturbances in serotonin regulation (which characterises depression) may consume excessive amounts of carbohydrate-rich foods in an effort to regulate their serotonin levels (Wurtman, 1985), as it has been found that dietary or pharmacological serotonin administration leads to normalised eating and decreased depression (Lieberman, Wutman, & Chew, 1986).

Experimental evidence supports the prediction that sugary foods alleviate negative affect. Macht and Muller (2007) conducted two experiments looking at the effects of chocolate on experimentally induced mood states (positive, negative and neutral moods induced by film clips) in normal weight healthy men and women. They found that eating chocolate reduced negative mood, compared to drinking water (marginal effects were found for the positive and neutral moods). Negative mood was also improved after eating palatable chocolate, compared to unpalatable chocolate or nothing. They therefore concluded that mood effects of palatable food may contribute to the habit of eating to cope with stress. Hill & Heathon-Brown (1994) found, in a non-clinical sample, that chocolate cravings accounted for 49% of all the food cravings, and overall the food that was craved the most was highly palatable food. Macht (1999) conducted a questionnaire study and found that an increase of impulsive eating (fast, irregular and careless eating directed at any food type available) was associated with anger; and that an increase of hedonic eating (tendency to eat because of the

pleasant taste or health value of the food) was associated with joy. Lyman (1982) researched the type of food being consumed and found an increased likelihood for participants to consume healthy foods during positive emotions and junk food during negative emotions.

The tendency to choose high fat foods when stressed has also been linked to eating style, such as emotional eating (Oliver et al. 2000) and restrained eating (Gibson, 2006). Burton, Hendrick & Lightowler (2007) conducted a questionnaire study and found that external eaters reported craving more high fat foods compared to emotional and restrained eaters, when unstressed. It would therefore be interesting to see if this relationship is still found when individuals are exposed to stress, particularly in light of recent research which suggests a relationship between stress, external eating and snack-eating (Newman et al. 2008). These studies therefore support the suggestion that stress can lead to specific food types being craved in certain groups of people.

3.7 Overall conclusion

There is strong evidence of individual differences in eating behaviour and that eating style and sensitivity to reward are better predictors of overeating than weight category. However, the research has also suggested that various eating styles (emotional, external and restrained eating) can moderate stress-induced eating, with no one particular eating style appearing to have a unique influence. The evidence has also highlighted that the type of stressor and type of food consumed may impact on the stress-eating relationship.

4. Methodological considerations

It is important to note several methodological factors within the research literature. Firstly, comparisons between studies are complicated by differing definitions of key variables (e.g. stress) (Wallis & Hetherington, 2004). Also, in light of recent research findings that the type of stressor impacts on the stress-eating relationship, can comparisons be made between studies when different stressors have been used? Should negative affect, anxiety and stress be

treated as equivalent? What is a "stressor" (e.g. is a stressful social situation similar to watching an aversive movie?) The research literature also has varying definitions and measurements of 'cravings'. For instance, whether a food is intensely desired (a definition of craving) is rarely considered, with some studies using the term 'craving' if the food has simply been eaten, thinking this is sufficient to class it as having been craved.

Secondly as, Allison and Heshka (1993) highlight in their review, many studies lack a control group, have small sample sizes and rely on self-reports. For instance, the empirical support for the notion that obese people eat more when distressed comes mainly from self-report studies (e.g. Geliebter & Aversa, 2003). Therefore these limitations need to be considered when reviewing the literature.

5. Linking theory and research to practice, treatment implications

Despite the methodological considerations, the evidence highlights that there is a relationship between stress and eating behaviour. This finding has implications for treatment. For instance, those that overeat in response to emotion, as predicted by affect regulation models, may need a treatment approach that focused on teaching patients to respond to their emotions in a more adaptive way, so that their affect was not regulated by (over) eating (Van Strien, 2002). The underlying mechanisms moderating stress-induced eating would need to be explored further, but a treatment approach that is growing in popularity with emotional eaters is Dialectical Behaviour Therapy (DBT) as it focuses on developing emotion regulation skills, (e.g. mindfulness, cognitive and behavioural self-monitoring and distraction) an area of key deficit for these individuals (Van Strien, 2002). In terms of recommended psychological treatment the NICE (2006) guidelines on obesity suggest behavioural interventions (e.g. stimulus control, problem solving and self monitoring of behaviour) and cognitive restructuring, however they do not stress the importance of also learning skills to regulate

emotions, and therefore greater research into the impact of negative affect and stress on eating behaviour would help inform current treatment approaches.

The similarities between addictive behaviours and overeating (which can lead to obesity) could have important implications for obesity treatment programmes. This relationship would need to be explored further but if the underlying mechanisms were the same, as proposed by Volkow and Wise (2005) similar treatment approaches could be used. For instance, increasing knowledge of the multiple brain circuits (reward, motivation, learning, cortical inhibitory control) involved in addiction as well as obesity would suggest a multi-modal approach to treatment is taken for both conditions. This approach would also suggest that pharmacological interventions may play an important role in both addiction and obesity treatments (Volkow & Wise, 2005). It would also suggest that behavioural treatments designed around negative reinforcement models of addiction, that have been successful in treating addiction, could be adapted and used to treat obesity (Volkow & Wise, 2005).

6. Summary of empirical evidence and implications

In summary, several studies indicate a relationship between overeating and negative affect and this relationship seems to be moderated by eating style and sensitivity to reward, as opposed to weight category. In addition, the type of stressor and type of food consumed seems to have importance. However, there is a lack of research testing the underlying mechanisms proposed by various theoretical models (e.g. the role of negative affect in increasing the incentive salience of appetitive cues, as suggested by Baker et al. (2004), and whether this is specific to emotional eaters). Greeno and Wing (1994, p461) concluded from their review that, "it is important that work continue on the development of specific hypotheses to explain stress-induced eating". They went on to say that "the link between stress and overeating may develop through a negative reinforcement paradigm in which eating is reinforced by cessation of the stress. Such conditioning models could be tested in the

laboratory and would provide a more compelling rationale for why some people engage in stress-induced eating and others do not". Although there has been progress since Greeno and Wing's (1994) review, there still remains a need for more theory-driven research. In particular there is a need for research, which is based on recent models of negative reinforcement and individual differences in reward system functioning and their roles in stress-induced eating.

7. Conclusion

The aim of this paper was to examine the growing literature indicating that emotions (in particular negative affect and stress) play an important motivational factor in overeating. Current psychological models of eating in response to stress have been reviewed and these highlight the role of negative affect in the maintenance of overeating. Much research has focused upon identifying the presence of a relationship between affective distress and overeating. Research should now centre upon exploring the underlying mechanisms, which moderate and maintain this relationship. Enhanced understanding of the mechanisms underlying emotional eating will undoubtedly shape more effective obesity treatments and prevention initiatives, which are extremely important given the high physical and psychological cost for individuals and the cost to society.

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The influence of negative affect and emotional eating style on selective attention to food-related cues and subjective appetite.

Empirical Paper

Prepared for submission to Appetite

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May 2008

(10038 words)

Abstract

Mood and individual differences in eating style such as emotional eating (i.e. eating in response to negative affect) influence motivation to eat. The current study examined the influences of negative affect and emotional eating on subjective appetite and attentional biases for food cues. Participants were 80 female university students (40 high emotional eaters, 40 low emotional eaters). Participants were randomly allocated into either a neutral or negative Mood Induction Procedure (MIP). Biases in attention were assessed on a pictorial visual probe task; subjective appetite was assessed using Visual Analogue Scales (VASs). Results found that negative mood increased both subjective appetite and attentional bias for food cues, supporting the view that negative mood increases motivation to eat. This effect of mood on subjective appetite and attentional bias was not significantly greater in high than low emotional eaters. Subjective appetite and attentional bias were significantly associated with each other, suggesting a common underlying mechanism i.e. activation of a food reward system. Attention bias was not uniquely associated with any one eating style, and was associated with a combined index of emotional, external and restrained eating. The combination of these three eating styles may be important in determining cognitive and behavioural responses to food cues and overeating. Results suggest that mood and eating style each influence motivation to eat (as reflected by self-reported hunger and objective measures of attention bias). These findings have relevance for models of the cognitive mechanisms that underlie normal and dysfunctional eating.

Keywords: attentional bias, cognitive bias, mood induction procedure, negative affect, emotional eating, food cues.

Introduction

There is growing research interest into the cognitive mechanisms that determine eating behaviour because dysfunctional eating, specifically overeating, has been identified as a major contributor to obesity. Recent research suggests that various emotion-related factors may predispose people to overeat, such as 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 (Stice et al. 2005; Spoor et al. 2007). 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, which underlie the effect of negative mood on addictive behaviours (Baker, Pier, 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, Strachan & Berkson, 2004; Davis et al. 2007, Volkow & Wise, 2005).

Baker et al. (2004) put forward a negative reinforcement model of drug addiction, in which they propose that 'escape or avoidance of negative affect is the principal motive' for addictive behaviour (p.33). Their model proposes that when stressors or deprivation (e.g. hunger) cause negative affect to increase, this biases an individual's information processing system 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. Negative affect also 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 elicits increased urge to eat, and enhanced attentional biases for food cues.

Such a model also predicts that trait individual differences in eating style might predispose certain people to become emotional eaters depending on their learning history, 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 reward for engaging in an unpleasant activity such as going to the doctors; therefore, through operant conditioning, eating became a negatively reinforced coping strategy in response to negative affect).

Various sources of evidence have indicated a relationship between negative mood and obesity. For example Stice et al. (2005) conducted a prospective study of adolescents and found that for each additional depressive symptom reported by the adolescent there was more than a fourfold increase in risk of obesity onset, suggesting negative affect may be a general risk factor for obesity. (This relationship was also found by Goodman & Whitaker, 2002; Pine, Goldstein, Wolk & Weissman, 2001, & Scott et al. 2008). Research also supports a positive association between emotional eating and obesity (Striegel-Moore et al. 1999; Braet & Van Strien, 1997). However, while such research suggests associations between negative mood, emotional eating and obesity, it does not clarify whether negative mood and emotional eating are a cause or consequence of overeating and obesity.

Greeno and Wing (1994) reviewed evidence of stress-induced eating from both animal and human studies. They noted several animal studies, which indicated that stressors (e.g. tail-pinching, isolation) increased eating behaviour in rats (e.g. Teskey, Kavaliers & Hirst, 1984; Vaswani, Tejwani & Mousa, 1983), thus suggesting a *general* effect model of stress on eating

i.e. stress increases eating due to neuro-physiological changes within the individual. In their review of the human literature, Greeno and Wing (1994) also proposed an *individual* differences model, as they noted that the effect of stress on eating appeared to be associated with various individual differences. For instance, stress-induced eating seemed more likely to occur in women than men, and in restrained eaters (i.e. people who report that they chronically restrain their eating in an attempt to control their weight or lose weight). However, Greeno and Wing (1994) concluded that, "it is too early to consider the relationship between retrained eating and stress-induced eating an established fact" (p. 460). Indeed, recent research suggests that the self-reported trait of emotional eating may be more important in moderating the effect of negative affect on motivation to eat.

Van Strien, Cleven & Schippers (2000) examined which eating styles predicted consumption of ice cream in healthy female volunteers and found that self-reported tendency towards overeating, rather than restraint, was a better predictor of ice cream consumption. Van Strien (2000) conducted a more detailed regression analysis of the data from the latter study and concluded that emotional eating was the most important predictor of ice cream consumption; with a near-significant trend for external eating (i.e. eating in response to food cues) also to be a predictor.

In further support of the moderating effect of emotional eating on motivation to eat a recent diary study examined the effects of daily hassles on eating behaviour in healthy volunteers (O'Connor, Jones, Conner, McMilan & Ferguson, 2008). Individuals who were high on emotional eating showed a significantly stronger positive association between daily hassles and meal snacking, with emotional eating reliably emerging as the pre-eminent moderating variable of the relationship between stress and meal snacking. These results support the view that trait individual differences in emotional eating are important in influencing the effect of negative mood on motivation to eat.

Experimental studies have also been conducted which manipulate negative affect in order to investigate the relationship between mood and motivation to eat. Willner et al. (1998) conducted an experiment in healthy volunteers and found that self-reported craving for sweet rewards was increased by a depressive mood induction procedure (MIP). Their results suggested that negative affect enhanced the reward value of food, which in turn increased food craving. Laboratory studies on healthy volunteers also support the finding that stressed emotional eaters eat more sweet high fat foods than unstressed and non-emotional eaters (Oliver, Wardle & Gibson, 2000). Further studies have also found an association between emotional eaters and greater food intake (consumption of chocolate) after an ego-threat task (Wallis & Hetherington, 2003).

Thus, several studies suggest a link between negative mood, the self-reported trait of emotional eating and motivation to eat. However, there is a need for further research into the mechanisms that might mediate these relationships. As noted earlier, a negative reinforcement model predicts that negative affect increases the reward (or incentive) value of appetitive cues (Baker et al. 2004). If so, negative mood should not only increase self-reported urge to eat (as indicated by Willner et al. 1998), but it should also increase attention to food cues (i.e. enhanced attentional bias for food cues) as appetitive stimuli with high incentive 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. Moreover, the predicted affect of negative mood on attentional biases for food cues may be particularly strong in emotional eaters (i.e. those who have had repeated learning experiences of eating food in order to reduce negative mood). Thus attentional biases for food cues may be an important factor in

understanding the cognitive mechanisms that operate in eating behaviour (i.e. they are an implicit measure of motivational state) (Mogg & Bradley, 1998).

No previous research has tested the predictions derived from a negative reinforcement model that negative affect increases selective attention for food cues and urge to eat, and that these responses should be stronger in emotional eaters. These predictions will be tested in the present study. However before describing this it is helpful to consider (as mentioned earlier) that 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 elicit increased attentional biases for food cues. Thus, it is informative to take account of research, which has investigated the effect of deprivation (and subjective hunger) on selective attention to food cues.

Much of this research has used the modified Stroop Colour naming task, which typically compares reaction times (RTs) for colour naming of food-related stimuli (e.g. "sweets") with the colour-naming of control words (e.g. "pencil"). Participants take longer to name the colour of the item when the items are antagonistic and associated with concerns relevant to them, thus demonstrating an attentional bias (Lee & Shafran, 2004). Channon and Hayward (1990) found that healthy students who had fasted for 24 hours showed greater colour-naming interference for food-related words than controls, which is consistent with a hunger-related processing bias (see also Green, Elliman & Rogers, 1996). However this task has been criticised as having several weaknesses as a measure of selective attention (Faunce, 2002). For example, it has been suggested that other mechanisms, such as interference in response selection, may contribute to the colour-naming interference effects (Mogg, Bradley, Hyare & Lee, 1998). It is also not clear whether the colour-naming interference effect reflects selective attention towards or away from the stimulus (Rieger et al. 1996). Thus, researchers have used the visual probe task, which provides a more direct measure of the allocation of

visual attention (Mogg et al. 1998). This task involves a series of word (or picture) pairs being 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 quicker to a stimulus that appears in an attended to, rather than unattended, region of a visual display, therefore RTs to probes provide a measure of allocation of attention to the food-related cues, relative to control cues (i.e. attentional bias). Mogg et al. (1998) studied the effect of food deprivation on attentional bias using a visual probe task in healthy volunteers. Results indicated that hungry participants showed an enhanced attentional bias towards food related cues, compared with participants who reported low hunger ratings (see also Placanica, Faunce & Soames, 2002). These studies suggest that subjective appetite is associated with increased attention towards food cues.

The main aims of this study were to test predictions from the affect regulation and negative reinforcement models described earlier (Baker et al. 2004, Stice et al. 2005) and to examine the effect of negative affect on subsequent appetite and attentional responses to food cues in high versus low emotional eaters. Mood was manipulated experimentally and participants were randomly allocated to a negative (MIP) or a neutral (MIP) (following a similar procedure used in Willner et al. 1998 and Bradley, Garner, Hudson & Mogg, 2008). Attentional bias for pictorial food related cues was measured using a visual probe task. The picture pairs (consisting of food and non-food cues) were displayed at two different durations (500 ms vs 2000 ms) in order to explore the time course of attentional bias. When the picture pairs are shown comparatively briefly (e.g. 500 ms), this is likely to reflect a bias in initial orienting of attention, as previous research indicates that this bias measure positively correlates with the initial shift in gaze (Bradley, Mogg & Millar, 2000, Bradley, Field, Mogg

& De Houwer, 2004). When the picture pairs are presented for longer durations (e.g. 2000 ms), there is 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.

This study therefore tested the following predictions (1) Increased negative mood would be associated with increased subjective appetite (as reflected by increased self-reported hunger and urge to eat). (2) This predicted effect of negative mood on subjective appetite would be greater in high emotional eaters compared with low emotional eaters. (3) Increased negative mood would be associated with increased attentional bias towards food cues. (4) This predicted effect of negative mood on attentional bias to food cues would be greater in high emotional eaters compared with low emotional eaters.

Method

Design

This study examined the effects of two between-subject independent variables: emotional eating group (low vs. high emotional eaters) and MIP (negative vs. neutral), on subjective appetite (i.e. hunger/urge to eat) and attentional bias for food cues. Subjective hunger/urge and negative mood were assessed using visual analogue scales (VASs) at six time points during the session; so analyses of these measures included a within-subjects independent variable of time (1-6). For the attentional task, there was a within-subjects independent variable of picture duration (500 vs. 2000 ms) and the dependent variable was the attentional bias score. There was also a picture-rating task assessing the palatability of the food cues ('deliciousness').

Participants

Participants were student volunteers from the University of Southampton who were recruited by poster advertisements, online booking system and online screening questionnaire. The screening questionnaire included the emotional eating scale of the Dutch Eating Behaviour Questionnaire (DEBQ, Van Strien, Frijters, Bergers & Defares, 1986) and recruitment favoured those with high or low scores to minimise the proportion of the final sample with mid-range scores. 246 people completed the screening scale, of which 84 were recruited to take part in the study[1]. Selection criteria included being female and omnivorous (vegetarians, or those having religious beliefs, which influenced their eating behaviour, were excluded so that the sample was homogenous and unlikely to be responding atypically to pictures of meat). Four volunteers were excluded due to having BDI-II scores greater than 13 (so as to not expose dsyphoric individuals to a negative MIP). They were invited to complete the attentional task, so that they remained unaware of their failure to meet the study selection criteria, but their data was subsequently excluded from the analyses.

The final sample consisted of 80 women (mean age 20.7 years, $SD = 4.5$). Participants were allocated to high and low emotional eating groups using a median split on the DEBQ emotional eating scores (see Appendix B for box-plot graph), which were obtained at the beginning of the first test session prior to the MIP (median=2.6, n= 40 in each group). This score was used as the primary emotional eating index as it was obtained under standardised conditions (unlike the screening measure) and was independent of the MIP. Participants were allocated randomly to the neutral MIP (n= 37) and negative MIP (n= 43) conditions, resulting in 23 high and 20 low emotional eaters in the negative MIP, and 17 high and 20 low emotional eaters in the neutral MIP condition.

[1] Please see appendix A for power calculations.

Stimulus materials and equipment

Experimental tasks. The computer tasks were presented using Presentation 10.2 software on a PC with a two-button response box and a standard keyboard.

Pictorial stimuli. These were used in a previous study (Brignell, Griffiths, Bradley & Mogg, 2008) and included 20 colour photographs of food-related pictures. Each food-related picture was paired with a non-food related (control) picture, which was matched as closely as possible for shape and colour (See Appendix C). This produced 20 food-control picture pairs. An additional 20 non-food-related pictures were used as fillers, and a further 12 picture pairs were used in practice trials. The pictures were 1600 x 1200 pixels stored in jpeg format.

Questionnaires

Dutch Eating Behaviour Questionnaire (DEBQ; Van Strien, Frijters, Bergers & Defares, 1986). The DEBQ is a 33 item self-report questionnaire that has 3 separate scales on emotional eating (13 items), external eating (10 items) and restrained eating (10 items). DEBQ responses range on a 5-point Likert scale from never (1) to very often (5). The DEBQ has good factorial, concurrent and discriminative validity and good reliability, with Cronbach's Alpha coefficients greater than 0.80. (Van Strien et al, 1986).

Beck Depression Inventory-II (BDI-II; Beck, Steer, Ball & Ranieri, 1996). This is a 21-item self-report measure. Each item is rated on a 4-point scale ranging from 0 to 3. BDI-II scores ranging from 0 to 13 are categorised as 'minimal depression', from 14 to 19 as 'mild depression', from 20 to 28 'moderate depression' and from 29-63 'severe depression'. The BDI-II has high internal consistency of 0.91, retest-reliability of 0.93 and good convergent validity (Beck et al. 1996).

Visual Analogue Scales (VASs). There were five VAS labelled as follows: 'sad', 'happy', 'anxious', 'hungry' and 'urge to eat'. Each scale consisted of a continuous line, with the end-anchor points ranging from 0 ('not at all') to 100 ('extremely'), with intermediate

labels underneath each line of 'slightly', 'moderately' and 'strongly'. The VASs were used to assess variation in mood and hunger over the course of the session. Participants were asked to mark a cross on each line to indicate how they were feeling right now.

Modified Hunger Questionnaire (MHQ). The Hunger Questionnaire (Friedman, Ulrich & Mattes, 1999) was combined with one item ('how much of your favourite food would you eat right now?') from the Grand Hunger Scale (Grand, 1968). The modified scale therefore consisted of 5-items, which assessed participants' hunger levels. Responses were rated on a 9-point scale. The MHQ was used to supplement the VAS measures of hunger and urge to eat.

Shortened Profile of Mood States- Tension/Anxiety (POMS-A) and Depression ((POMS-D) scales (McNair, Lorr & Droppleman, 1971). The POMS-A and POMS-D were given at the beginning of the session to investigate any possible between group differences in anxious or depressed state mood (how you feel right now). This questionnaire comprised of 12 items (6 anxiety and 6 depression) selected from the original POMS giving scores for 2 subscales (McNair et al. 1971). It has good internal consistency ranging from 0.76 to 0.95, test-retest reliability was 0.74 for depression (McNair et al. 1971).

Perceived Stress Scale (PSS; Pinaquy, Chabrol, Simon, Louvet & Barbe, 2003). This is a 4-item scale assessing trait perceived stress. For example, in the last month how often have you felt that you were unable to control the important things in your life? Responses ranged on a 5-point scale from, never (0) to, very often (4). Pinaquy et al. (2003) reported that perceived stress was a major predictor of emotional eating in individuals without eating disorders.

Behaviour Inhibition System/Behavioural Activation System (BIS/BAS) Scales (Carver & White, 1994). The BAS scale is a trait measure related to reward sensitivity. The BAS system is seen as controlling appetitive motivation and is mainly responsive to

environmental incentives (Leone, Perugini, Bagozzi, Pierro & Mannetti, 2001). The BIS scale measures behavioural inhibition/anxiety; the BIS system is seen as controlling aversive motivation (Leone et al. 2001). The BIS/BAS scales have good validity and reliability (Leone et al. 2001).

Social Desirability Scale – short form (SDS; Strahan & Gerbasi, 1972). This is a 10-item version of the Social Desirability Scale (Crowne & Marlowe, 1960). It was included because defensiveness can have a confounding effect on measures of negative mood and attentional bias (e.g. Eysenck, 1997). The short-form (X1) correlates .96 with the full version, (Fischer & Fick, 1993), which has good internal consistency (0.88), test-retest reliability (0.89) and convergent validity (Crowne & Marlowe, 1960.)

Supplementary questions. These included questions about participant characteristics, including age, religious and specific eating behaviours (e.g. vegetarian), and recent food intake (e.g. time since last eating).

Procedure

The study was conducted in accordance with ethics approval, which was granted by the University of Southampton School of Psychology Ethics Committee (see Appendix D). Participants were tested individually in a small, dimly lit room. Prior to testing, participants were asked to eat as usual (i.e. no more or less than they would usually eat). On arrival, they received an information sheet (Appendix E) and completed the consent form (Appendix F). They then completed questionnaires including the DEBQ Emotional Eating Scale, BDI-II, PSS, POMS-A, POMS-D, VASs (Time 1) and MHQ (Time 1).

MIP. Participants in the negative MIP were instructed to get into a miserable or sad mood by recalling unhappy memories from their past whilst listening to a sad piece of music (Prokofiev's 'Russia under the Mongolian Yoke' played at half speed for seven minutes). Participants in the neutral MIP were instructed to get into a neutral mood by recalling routine

journeys from the past whilst listening to neutral music (The Mystic from Holst's The Planets). Similar music selections and instructions have been successfully used in previous MIP studies (e.g. Clark and Teasdale, 1985; Bradley, Mogg & Lee 1997; Bradley et al. 2008; Willner et al. 1998; Gerrards-Hesse, Spies & Hesse, 1994). After the MIP participants were asked to complete the VASs and MHQ (Time 2), followed by the visual probe task.

Visual probe task. Participants sat at a desk approximately 800mm from the monitor. The task was similar to one used in Brignell et al. (2008), which had been modelled on that used by Bradley, Mogg, Wright and Field, (2003, Experiment 2). Each trial started with a fixation cross shown for 500 ms, which was replaced by two pictures presented at the same time, side by side, on the computer screen (e.g. food-related picture and control picture). The picture pair was presented for either 500 or 2000 ms. Once the pictures disappeared, a probe (a small dot) appeared in the location of one of the pictures. Participants were asked to press a left or right button as quickly as possible in order to indicate the location of the probe. The inter-trial interval varied between 500 and 1500ms. Each picture was 90 mm high by 120 mm wide when displayed on the screen. The distance between their inner edges was 60 mm and the distance between the two probe positions was 185mm (visual angle of 8.58 degrees). There were 12 practice trials, followed by two blocks of trials. Each block consisted of two buffer trials and 120 experimental trials. The 240 experimental trials comprised 160 critical trials, which presented food-control picture pairs, and 80 filler trials, which presented pictures unrelated to food. During the critical trials, each of the 20 food-related picture pairs was presented eight times. Each food-related picture was presented at each stimulus duration (500 or 2000 ms) and picture location (left, or right side of screen), and was replaced by the probe (probe in same or different location), with equal frequency. The 20 filler picture pairs were presented four times each. Critical and filler trials were presented in a new, random order for

each participant. After the first block of trials, participants completed the VASs (Time 3) and then had a booster MIP.

Booster MIP. Participants were asked to repeat what they had done before for another 3 minutes: i.e. in the negative MIP, to recall sad memories from their past while listening to sad music; whereas in the neutral MIP to recall a routine journey from their past while listening to neutral music. Then they completed the VASs again (Time 4), followed by the second block of trials of the visual probe task. They then repeated the VASs (Time 5).

Picture rating task. It consisted of two practice trials, followed by 20 test trials in which each food-related picture from the visual probe task was presented, one at a time, in the centre of the screen in a new random order for each participant. Each picture (90 mm by 120 mm) was presented for 2000 ms and, after a pause of 500 ms, a 10-point anchored rating scale was displayed on the screen until the participant's response. They gave their rating by pressing one of 10 labelled keys on the keyboard. The inter-trial interval was 500ms. Participants rated each picture according to how delicious they found the depicted food using a rating scale, which ranged from 'not at all delicious' (1) to 'extremely delicious' (10). The pictures were rated on another variable to obtain pilot data for an unrelated research question and so this is not reported here. After the rating task, participants completed the VASs again (Time 6).

Participants were then weighed using standard scales and their height recorded, in order to establish their Body Mass Index (BMI) which was calculated using the formula: weight (kg)/ height (m^2). Next, they completed questionnaires including the DEBQ, SDS and BIS/BAS scales and MHQ (Time 3). Participants who had taken part in the negative MIP were offered a positive MIP, so that they did not leave the session in a low mood. The positive MIP involved recalling happy memories whilst listening to Delibes 'Coppelia', a piece of music which has been successfully used to induce a positive mood in past studies

(Clark & Teasdale 1985). Participants were thanked and debriefed (Appendix G) and awarded course credits.

Data preparation

- **Visual Analogue Scales.** A composite negative mood measure was calculated for each participant and each time point (1 to 6) by calculating the mean of sad, anxious and reflex of happy VAS scores (i.e. reflex = 100- happy VAS score). Therefore higher values reflected greater negative mood. A composite hunger-urge to eat measure was calculated for each participant by calculating the mean of hunger and urge-to-eat VASs, for each time point (1 to 6). Higher values reflected greater hunger and urge to eat.

Visual probe task. RT data from trials with incorrect responses were excluded. RTs were also excluded as outliers if they were less than 200 ms, or over 2000 ms, or more than 3 SDs above each participant's mean. The percentage of trials with errors (1%) and outliers (1%), and overall mean RT (392 ms) did not significantly vary across the groups (MIP or emotional eating). Attentional bias scores were calculated for each participant and picture duration (500 and 2000 ms) by subtracting the mean RT to probes replacing food pictures from the mean RT to probes replacing control pictures. Thus, positive values of the bias scores reflected relative speeding of RTs to probes replacing food pictures, i.e. an attentional bias to food cues (0 = no bias).

Manipulation checks

Effect of MIP on mood. A 2 x 2 x 6 mixed design ANOVA was carried out on the composite VAS negative mood measure across the six time points to assess the effectiveness of the MIP. The ANOVA included two between-subject IVs of MIP (negative, neutral) and emotional-eating group (high, low), and one within-subjects IV of Time (Time 1=before MIP, Time 2=after MIP, Time 3= after first part of attentional task, Time 4= after mood booster,

Time 5= after second part of attentional task, Time 6= after rating task). (See Appendix H for the means for each group).

Results showed significant main effects of MIP, $F(1,76) = 21.16, p < .01$, and Time $F(5,380) = 41.68, p < .01$, and a significant MIP x Time interaction, $F(5,380) = 35.75, p < .01$ (Figure1). Post hoc t-test contrasts were used to clarify the MIP x Time interaction. These showed no significant difference in mood between the two MIP groups before the MIP (time 1) or after the rating task, near the end of the session (time 6). However, the negative MIP group reported significantly more negative mood than the neutral MIP group at each intermediate time point: i.e. after the MIP (time 2), $t(78) = 8.14, p < .01$, after the first part of the attentional bias task (time 3), $t(78) = 2.77, p < .01$, after the mood booster (time 4), $t(78) = 7.75, p < .01$ and after the second part of that attentional bias task (time 5), $t(78) = 2.90, p < .01$. These results confirm that the MIP was effective in manipulating mood during the session. There were no other significant results.

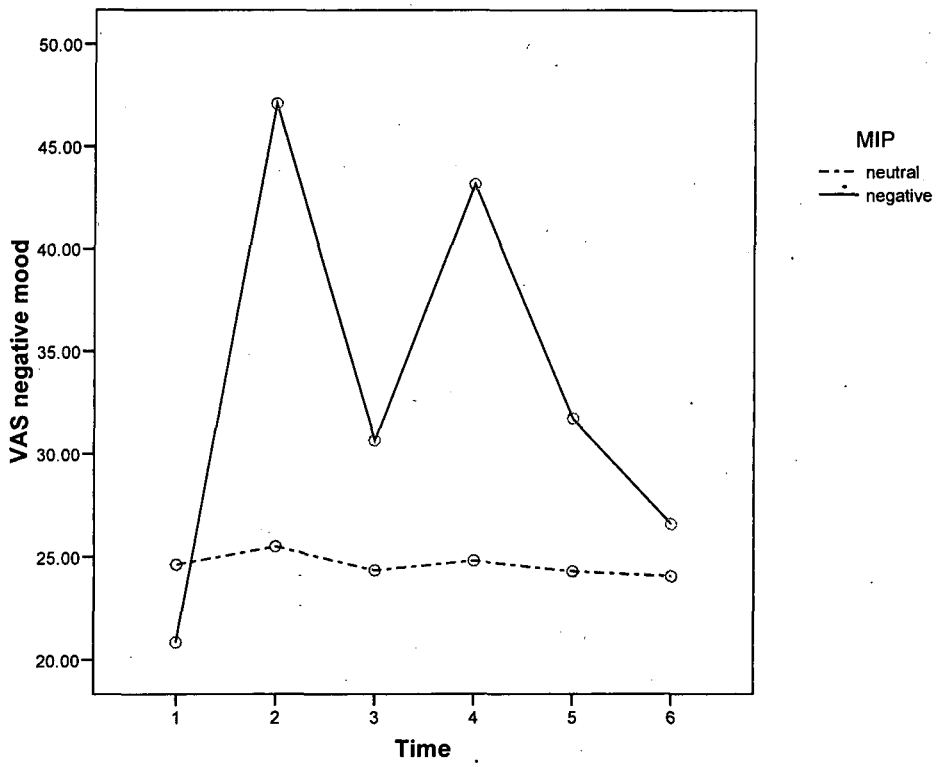

Figure 1. Effect of MIP on negative mood over time (Time 1=before MIP, Time 2=after MIP, Time 3= after first part of attentional task, Time 4= after mood booster, Time 5= after second part of attentional task, Time 6= after rating task).

Results

Group characteristics.

See Table 1 for descriptive statistics for questionnaire measures, BMI, age and time since last meal for each group. POMS depression scores, age and time since last meal were skewed, so these were log transformed prior to analyses. A 2 x 2 univariate analysis of variance (ANOVA) was carried out on each measure with two between-subject independent variables (IVs) of MIP (negative, neutral) and emotional-eating group (high, low). There was no significant main effect of the MIP on any of these measures. That is, the neutral and negative MIP groups did not differ significantly on any trait mood or eating-related variable (DEBQ scores, BIS, BAS, POMS-D, POMS-A, BDI, PSS, SDS), age or the number of hours since they last ate.

However, there was a significant main effect of emotional eating on several measures. That is, the high emotional eating group had significantly higher scores than the low emotional eating group not only on emotional eating $F(1,76) = 86.40, p < .01$, but also on external eating, $F(1,76) = 22.40, p < .01$; restrained eating, $F(1,76) = 5.51, p < .05$; overall DEBQ score, $F(1,76) = 52.89, p < .01$; POMS-Anxiety, $F(1,76) = 5.44, p < .05$; BAS, $F(1, 76) = 5.77, p < .05$; PSS, $F(1,76) = 5.20, p < .05$ and BMI, $F(1,76) = 12.80, p < .01$, and lower scores on the SDS, $F(1,76) = 4.03, p < .05$. There was no significant interaction between the emotional eating and MIP groups for any of the variables.

Table 1. Descriptive statistics for study variables for high and low emotional eaters, in negative and neutral MIP

	Low Emotional Eaters				High Emotional Eaters			
	Neutral MIP		Negative MIP		Neutral MIP		Negative MIP	
	M	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*
DEBQ Emotional Eating Scale	2.04	0.44	2.05	0.44	2.98	0.56	2.99	0.37
DEBQ External Eating Scale	3.06	0.62	3.03	0.60	3.72	0.63	3.65	0.58
DEBQ Restraint Eating Scale	2.53	0.84	2.54	0.89	2.92	0.76	3.04	0.88
DEBQ overall	2.58	0.49	2.55	0.37	3.21	0.38	3.26	0.39
POMS depression	1.05	2.48	.85	1.14	2.41	3.94	0.74	1.39
POMS anxiety	2.25	2.17	1.95	2.72	4.41	3.61	2.74	2.72
BDI	4.95	3.72	4.50	3.50	6.53	4.76	6.22	4.42
BIS	22.35	2.90	22.35	2.70	23.06	4.34	23.09	2.86
BAS	38.90	3.95	38.80	2.98	40.41	5.09	41.65	4.05
PSS	4.70	1.56	4.75	2.29	5.94	2.63	5.74	2.16
SDS	4.75	1.74	5.85	2.46	4.35	1.93	4.48	1.65
Age	19.10	2.05	22.10	6.84	20.83	3.53	20.05	4.26
BMI	21.21	2.18	21.55	2.61	24.76	4.49	22.94	2.83
Hours since last meal	2.02	1.56	3.40	3.53	2.69	3.31	3.05	3.68

Note. DEBQ=Dutch Eating Behaviour Questionnaire; POMS= Profile of Mood States; BDI= Beck Depression Inventory; BIS= Behaviour Inhibition Scale; BAS= Behaviour Activation Scale; PSS= Perceived Stress Scale; SDS= Social Desirability Scale; BMI= Body Mass Index.

Effects of MIP and emotional eating on hunger/urge to eat

A 2 x 2 x 6 mixed design ANOVA was carried out on the composite hunger/urge VAS scores to assess the effects of the MIP and emotional eating status. The ANOVA included emotional eating (high, low), MIP (negative, neutral) and Time (1 - 6) as IVs. See Appendix I for means. Results showed a significant main effect of Time, $F(5,380) = 40.47, p < .01$, and a significant MIP x Time interaction, $F(5,380) = 2.80, p < .05$ (Figure 2). Post hoc contrasts were used to clarify the MIP x Time interaction. These showed that the negative MIP group had significantly higher hunger/urge scores than the neutral MIP group after the second part of the attentional task (time 5), $t(78) = 2.02, p < .05$, and after the picture rating task (time 6), $t(78) = 2.56, p < .01$, but not earlier in the session (times 1-4 inclusive). These results indicate that the negative MIP group reported more hunger than the neutral MIP group in the latter part of the session (after the attentional task) providing support for the prediction that increased negative mood would be associated with subjective appetite (hypothesis one).

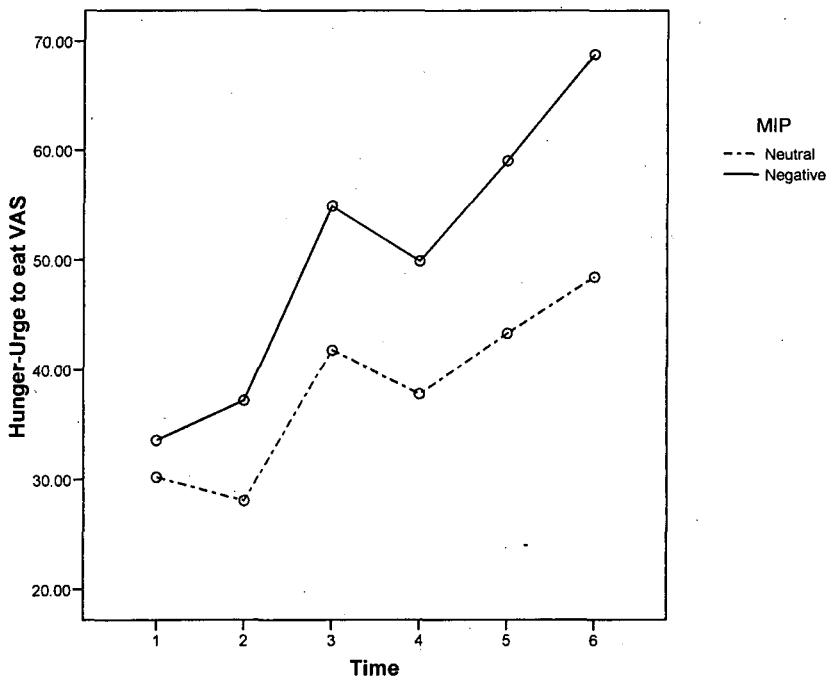

Figure 2. Effect of MIP on hunger/urge to eat (Time 1=before MIP, Time 2=after MIP, Time 3= after first part of attentional task, Time 4= after mood booster, Time 5= after second part of attentional task, Time 6= after rating task).

There was also a significant interaction effect of emotional eating and time on hunger/urge ratings, $F(5,380) = 3.31, p < .01$. This was qualified by a near significant three way interaction between MIP x Time x Emotional eating, $F(5,380)=2.10, p=.06$ (Figure 3). Post hoc analyses were subsequently conducted for each emotional eating group separately, in order to clarify the MIP x Time x Emotional eating interaction. These showed that the MIP x Time interaction was not significant in high emotional eaters, $F < 1$, their hunger increased during the session (irrespective of the MIP) as time alone had a significant main effect, $F(5,190) = 29.58, p < .01$ (see Figure 3a). Low emotional eaters also showed a significant main effect of time, $F(5, 190) = 12.65, p < .01$. However in contrast to high emotional eaters, low emotional eaters showed there was a significant interaction effect of MIP x Time on hunger/urge to eat, $F(5,190) = 5.33, p < .01$ (see Figure 3b). Post hoc t-tests showed that low

emotional eaters in the negative MIP were significantly more hungry than low emotional eaters in the neutral MIP after the attentional task (time 5), $t(38)=2.18$, $p<.05$ and after the rating task (time 6), $t(38)=2.76$, $p<.01$. These results do not support the prediction that negative mood would increase hunger/urge more strongly in high than low emotional eaters (hypothesis 2). The reverse was actually found that negative mood increased hunger/urge to eat in low emotional eaters.

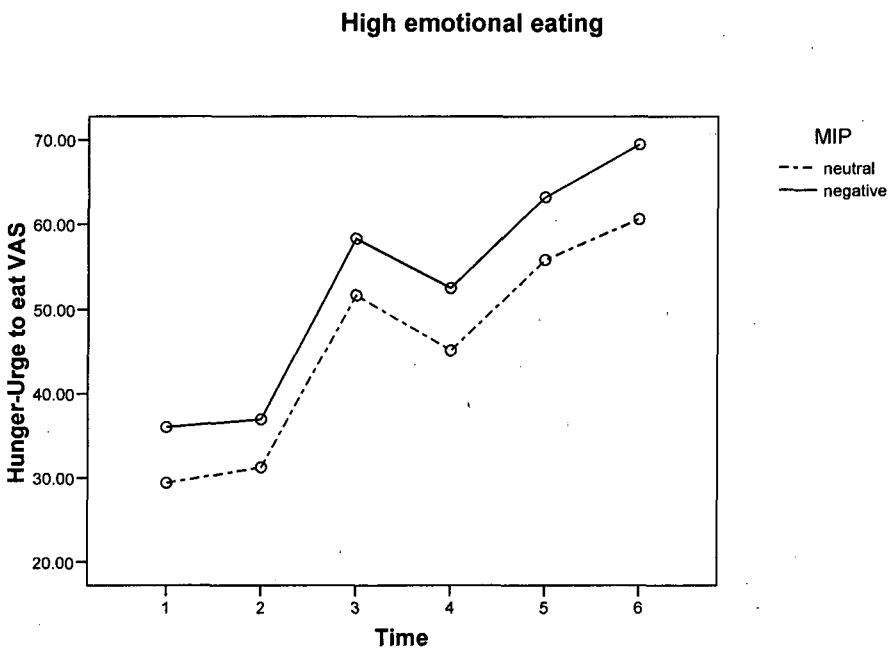

Figure 3a. Effect of MIP on hunger/urge to eat in high emotional eaters.

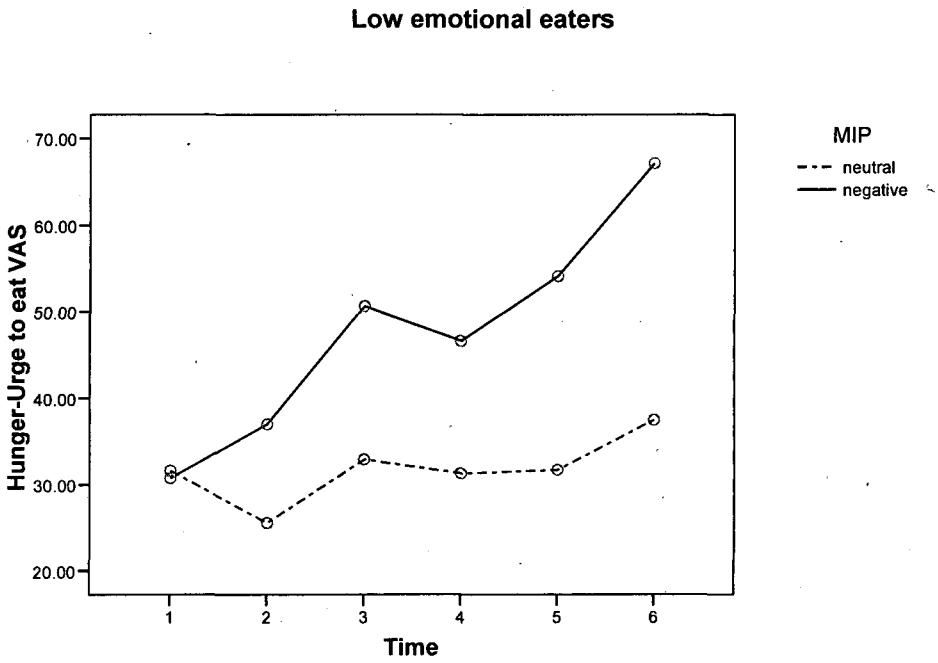

Figure 3b. Effect of MIP on hunger/urge to eat in low emotional eaters

The supplementary hunger measure (MHQ) was also analysed, this was only assessed at three time points (1 = before MIP, 2= after MIP, 3 = end of the session). A 2 x 2 x 3 ANOVA of MHQ scores with MIP, emotional eating and time as IVs, showed only a significant main effect of time, $F(2,152) = 22.39$, $p < .01$, as participants were generally hungrier at the end of the session ($M = 4.98$, $SD = 1.76$), compared with before ($M = 4.18$, $SD = 1.93$) or after ($M = 4.01$, $SD = 1.58$) the MIP. This measure showed no other significant results.

Effect of MIP and emotional eating on attentional bias for food cues

Attentional bias scores were entered into a 2 x 2 x 2 ANOVA with picture duration as the within-subjects IV (500 ms, 2000 ms), and MIP (negative, neutral) and emotional eating (high, low) as between-subjects IVs (see Table 2 for mean attentional bias scores in each condition and group). Results show a significant main effect of MIP, $F(1,76) = 5.50$, $p < .05$,

as the negative MIP group showed a greater overall attentional bias for food cues ($M = 23.9$, $SD = 34.5$) than the neutral MIP group ($M = 8.1$, $SD = 20.5$) (see figure 4). There was also a significant main effect of emotion group $F(1,76) = 4.01$, $p < .05$ as high emotional eaters showed a greater overall attentional bias for food cues ($M = 23.8$, $SD = 34.9$) than the low emotional eaters ($M = 9.4$, $SD = 21.8$). There were no other significant results (e.g. MIP x emotional eating, $F(1, 76) = 1.64$, $p = .20$).

The results illustrated in Figure 4 support the prediction that increased negative mood would be associated with increased attentional bias towards food cues (hypothesis 3). Although there was a significant effect of emotional eating group on attentional bias there was no significant interaction between MIP and emotional eating and therefore the prediction that attentional bias for food-related stimuli would be relatively greater in high than low emotional eaters when exposed to a negative mood induction was not supported (hypothesis 4).

Table 2. Mean attentional bias scores (in ms) in high and low emotional eaters, in negative and neutral MIP conditions for each food picture duration.

	Low Emotional Eaters				High Emotional Eaters			
	Neutral MIP		Negative MIP		Neutral MIP		Negative MIP	
	M	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*
Picture Duration 500ms	11.8	23.8	10.6	24.9	13.1	26.1	33.8	45.2
Picture Duration 2000ms	0.2	28.5	14.8	25.7	8.0	20.5	33.3	38.7

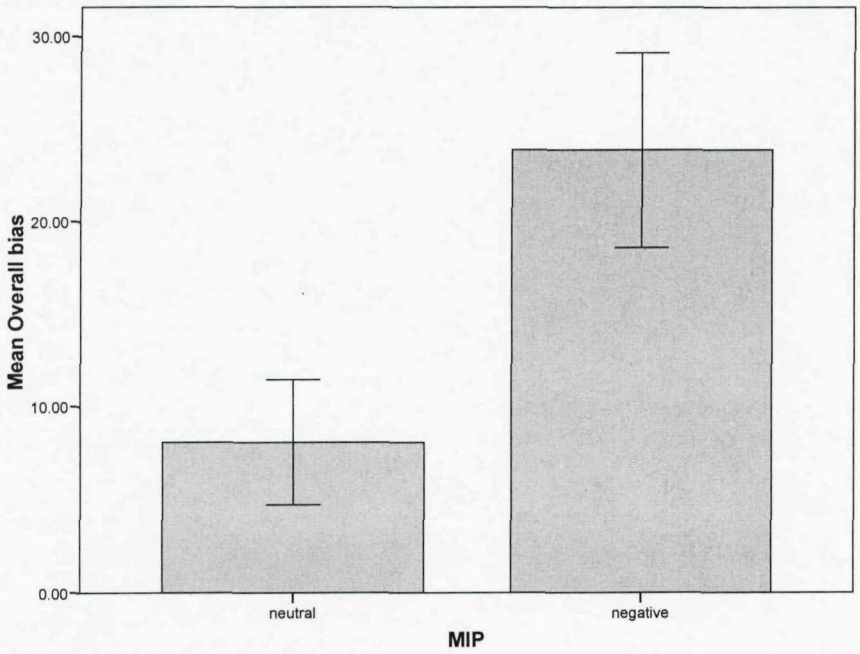

Figure 4. Mean attentional bias scores for negative and neutral MIP groups (error bar indicates +/- 1 standard error).

Correlations

Relationship between hunger/urge and other variables. Pearsons correlations were calculated between the composite VAS hunger/urge score and the other variables (attentional bias, DEBQ, BIS, BAS, POMS-D, POMS-A, BDI, PSS and SDS scores). High levels of hunger/urge correlated significantly not only with higher scores of attentional bias (as noted earlier) but also with emotional eating, external eating, POMS depression (*ps* < .05) and near-significantly with perceived stress (*p*=.06). See Table 3.

Relationship between attentional bias and other variables. Greater attentional bias for food (averaged across both stimulus durations) correlated significantly with greater overall DEBQ scores, emotional eating, external eating, restrained eating, perceived stress and the composite VAS hunger/urge scores (averaged across time points 2-5 inclusive, i.e. before, during and after the attentional task). See Table 3.

Table 3: Correlations between the following variables: attentional bias, DEBQ overall score, DEBQ emotional, external and restraint, POMS depression, PSS, VAS negative mood and VAS hunger/urge to eat.

	1	2	3	4	5	6	7	8	9
1. Attentional bias	-	.40**	.31**	.37**	.23*	-.03	.30**	.08	.35**
2. DEBQ Overall Score		-	.80**	.74**	.70**	.05	.32**	.04	.22
3. DEBQ emotional			-	.66**	.27*	.17	.33**	.07	.26*
4. DEBQ external				-	.12	.11	.25*	.13	.32**
5. DEBQ restraint					_	-.10	.17	-.07	-.02
6. POMS depression						-	.36**	.19	.25*
7. PSS							-	.19	.21
8. VAS negative mood								-	.22
9. VAS hunger/ urge to eat									-

*$p < .05$, **$p < .01$

Regression.

Relationship between hunger/urge and other variables. A hierarchical regression analysis was used to test the associations between mood, attentional bias and urge to eat testing a mediation model where the dependent variable was hunger/urge to eat and mood was the independent variable added at step 1 and attentional bias was the independent variable added at step 2. The results revealed that at step 1, negative mood predicted a significant

proportion of variance in hunger scores (*R square* = .05, $F(1, 78) = 3.97$, $p = .05$). At step 2, when attentional bias was added to the equation, there was a significant increase in the amount of variance of hunger scores that was accounted for by the model (*R square change* = .11, $F(1, 77) = 10.48$, $p < .01$). At step 2, the combination of negative mood and attentional bias accounted for 16% of the variance in hunger scores (*R square* = .16, $F(2, 77) = 7.46$, $p < .01$); with hunger significantly associated with attentional bias (see Table 4 for Beta scores) and near-significantly with negative mood ($\beta = .19$, $p = .07$).

Table 4: Hierarchical regression analysis with hunger/urge to eat as the dependent variable

	B	SE B	β
Step 1			
Negative mood	.62	.31	.22*
Step 2			
Negative mood	.54	.29	.19
Attentional bias	.36	.11	.34**

Note. *R square* = .05 for Step 1: ΔR *square* = .11 for Step 2 ($p < .05$).

* $p = .05$, ** $p < .01$.

Relationship between attentional bias and other variables. A hierarchical regression analysis was used to test the association between overall DEBQ, hunger/urge to eat, PSS and attentional bias, where attentional bias was the DV. Given that each of the DEBQ scale scores significantly correlated with the attention bias score, and the three DEBQ scale scores were significantly intercorrelated with each other (i.e. emotional eating correlated significantly with both external eating (r=.66, p<.001) and restrained eating (r=.27, p<.001), the overall DEBQ

score[2] was used as an IV at step 1 in the regression analysis (in preference to the three intercorrelated DEBQ scale scores). Hunger/urge to eat was the IV added at step 2 and PSS was the IV added at step 3.

The results revealed that at step 1, overall DEBQ predicted a significant proportion of variance in attentional bias (*R square* = .16, $F(1, 78) = 14.87$, $p < .001$). At step 2, when hunger/urge to eat was added to the equation, there was a significant increase in the amount of variance of attentional bias scores that was accounted for by the model (*R square change* = .07, $F(1, 77) = 7.45$, $p < .01$). At step 2, the combination of DEBQ overall and hunger/urge to eat accounted for 23% of the variance in attentional bias scores (*R square* = .23, $F(2, 77) = 11.78$, $p < .001$); with DEBQ and hunger/urge to eat each significantly associated with attentional bias (see Table 5 for Beta scores). At step 3, when PSS was added to the equation, there was no significant change in the amount of variance of attentional bias scores that was accounted for by the model (*R square change* = .02, $F(1, 76) = 2.00$, $p = .16$) and PSS was not significantly associated with attentional bias score ($\beta = .15$, $p = .16$). (See appendix J for similar results with partial correlations).

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[2] Studies that support the use of the DEBQ total score include Halvarsson & Sjoden, (1998); Wardle, (1987).

Table 5: Hierarchical regression analysis with attentional bias as the dependent variable

	B	SE B	β
Step 1			
DEBQ overall	22.73	5.90	.40***
Step 2			
DEBQ overall	19.26	5.81	.34**
Hunger/urge to eat	0.26	0.10	.28**
Step 3			
DEBQ overall	16.81	6.02	.30**
Hunger/urge to eat	0.24	0.10	.26*
PSS	2.02	1.43	.15

Note. *R square* = .16 for Step 1 ($p < .001$); *ΔR square* = .07 for Step 2 ($p < .01$): *ΔR square* = .02 for Step 3 ($p = .16$).

* $p = .05$, ** $p < .01$, *** $p < .001$.

Relationship between BMI and other measures. Higher BMI was significantly associated with higher levels of emotional eating (r=.22, p=.05), restrained eating (r = .29, p < .01), overall DEBQ (r=.24, p<.05), and near-significantly with lower levels of POMS depression (r = -.21, p = .06). These findings were similar when correlations were calculated with non-obese participants only (i.e. after excluding three participants with BMI > 30).

Picture ratings. A 2 x 2 ANOVA of palatability ratings ("deliciousness") was carried out with emotional eating and MIP as IVs. There were no significant results. Mean palatability rating was 5.7 (SD = 1.3) on a 1 – 10 scale. A median split on palatability ratings (median = 5.9) was used to divide the stimuli into separate sets of low and high palatable foods. The attentional bias scores were reanalysed after including stimulus palatability as an

additional within-subjects IV. Results showed a significant main effect of palatability, $F(1,76) = 19.65$, $p < .01$, as participants showed a greater attentional bias for high ($M = 21$ ms, $SD = 35$) than low ($M = 11$ ms, $SD = 27$) palatable foods. However, this effect did not interact with any other variable, e.g. MIP x Emotional eating x palatability, $F < 1$.

Discussion

Results summary

In summary the results showed that negative mood increased both subjective appetite and attentional bias to food cues. These findings provide support for hypothesis one: that is, increased negative mood would be associated with increased hunger/urge to eat (as reflected by increased self-reported hunger and urge to eat). These results also support hypothesis three: that is, increased negative mood would be associated with increased attentional bias towards food cues. However, this effect of mood on subjective appetite and attentional bias was not significantly greater in high than low emotional eaters (therefore, the results did not support hypotheses 2, which predicted that the effect of negative mood on subjective appetite would be greater in high emotional eaters compared with low emotional eaters; or hypothesis 4, which predicted that the effect of negative mood on attentional bias to food cues would be greater in high emotional eaters compared with low emotional eaters). Indeed, there was an unexpected near significant trend ($p = .06$) for the negative MIP to influence subjective appetite to a greater extent in non-emotional eaters than emotional eaters, which will be discussed later.

Also, high emotional eaters showed a greater attentional bias for food cues than low emotional eaters (irrespective of the mood induction procedure). However, when interpreting these results it is important to note that the emotional eating groups differed not only in emotional eating, but also in external and restrained eating, baseline anxiety (POMS),

behavioural approach tendencies (BAS), perceived stress (PSS), social desirability and BMI. Correlations showed that the attentional bias was significantly associated not only with emotional eating, but also with external and restrained eating, perceived stress and subjective appetite. Thus the attention bias was not uniquely associated with any one eating style, and was associated with a combined index of emotional, external, and restrained eating. Regression results indicated that the attention bias was associated with both the latter index of overall eating style and subjective appetite. The main significant findings will be discussed in turn below.

Effect of negative mood on subjective appetite and attentional bias

The present finding that negative mood increased subjective appetite is consistent with previous research, e.g. Willner et al. (1998). However the predicted effect of the MIP on subjective appetite was only found for VAS measures, but not for the Modified Hunger Questionnaire (MHQ). One possible explanation for this is that the VAS provided a more sensitive measure of within-subject variations in hunger/urge to eat compared with the MHQ. Also the supplementary MHQ was only used at three time points (1 = before MIP, 2= after MIP, 3 = end of the session) and therefore the VAS and MHQ measures were taken at different time courses, with the MHQ being taken less frequently.

A novel feature of the present results is that they indicate not only that negative mood increases subjective appetite (assessed on the VAS), but also increases attentional bias for food cues. In addition, subjective appetite and attentional bias were closely associated, consistent with the idea that they are both controlled by a common underlying mechanism – i.e. activation of a food reward system. Thus, results support earlier research that has found a positive association between subjective appetite and attentional bias (Mogg et al., 1998). These results also support the view that negative mood increases the reward value of food cues, which is consistent with Baker et al's. (2004) negative reinforcement model and the

affect regulation models (Stice et al. 2005). That is, negative affect increases the reward value of food cues and activates the food reward system. This in turn, increases motivation to eat, as reflected by subjective appetite and attention being captured by food cues i.e. attentional bias towards food stimuli. Adams and Epel (2007), in their review, suggest a possible mechanism for this effect, whereby stress (or negative affect) increases cortisol levels in the brain, which in turn activates the reward system and increases the incentive value of appetitive stimuli (i.e. increases in cortisol levels can stimulate hunger). It has also been suggested that 'stress-induced cortisol' may impair right prefrontal cortex activity, which may interfere with rational cognitive control of eating behaviour (Alonso-Alonso & Pascual-Leone, 2007). The latter proposal is compatible with Baker et al's. (2004) suggestion that negative affect impairs rational processes, thus reducing the ability to resist immediate relief in favour of long term benefits. Thus, the effect of negative mood on cognitive and behavioural responses to food cues may depend on more than one system, which includes activation of the reward system and regulatory control of it by cortical mechanisms, and that these systems influence appetitive responses (including eating and addictive behaviours).

Relationship between eating styles and attentional bias for food cues

The present findings did not support the prediction that the effect of the MIP on subjective appetite and attentional bias would be greater in emotional eaters (hypotheses 2 and 4). Instead, high emotional eaters showed a greater attentional bias for food cues than low emotional eaters (which was not significantly influenced by the mood induction procedure). However, correlations indicated that the attentional bias was associated with all three eating styles (emotional eating, external eating and restrained eating). Previous research has reported mixed evidence of relationships between these eating styles and attentional bias. For instance, Newman, O'Connor and Conner (2008) assessed the effects of external eating and a social stressor (anticipation of public speaking) on selective processing of food words using a

modified Stroop task in a student sample. They found that stress was associated with reduced bias for meal-related words (e.g. sausages). There was also a significant interaction effect of external eating and stress on cognitive bias for snack words (e.g. chocolate), but not meal-related words. Low external eaters had a greater bias for snack words when unstressed (which was not predicted) and stressed high external eaters had a greater bias for snack words than stressed low external eaters. They 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 and they recommended that further research should use the visual probe task. Johansson, Ghaderi and Andersson (2004) used the visual probe task with words and obtained unexpected results as high external eaters appeared to have a greater tendency to direct their attention *away* from food words in comparison to low external eaters. Whereas Brignell et al. (2008), using a visual probe task with pictorial food cues in students, found a positive relationship between high external eaters and attentional bias *towards* food cues. The latter findings are consistent with the present results.

There is also mixed evidence concerning the relationship between restrained eating and attentional bias: Some studies suggest that restrained eaters show enhanced processing of food words (e.g. Green & Rogers, 1993; Francis, Stewart & Hounsell, 1997; Overduin, Jansen & Louwerse, 1995) whereas others have not found this (e.g. Jansen, Huygens & Tenny, 1998; Boon, Vogelzang & Jansen, 2000).

All three eating styles (emotional, external and restraint) have been associated with overeating and Van Strien, Schippers and Cox (1995) have argued that they reflect independent mechanisms for overeating. The present results however demonstrate inter-correlations between the three eating styles. This is further supported by previous research, for instance, Van Strien et al. (1986) and Van Strien et al. (1995) both found correlations between emotional eating and external eating. Van Strien et al. (1995) argued that, although

there was a strong relationship between emotional and external eating, a distinction between these constructs was warranted, e.g. because emotional eating was associated with emotional distress, whereas external eating was not. However, this does not seem unexpected given that nearly all the emotional eating items on the DEBQ refer to emotional distress, whereas the external eating items do not.

Braet and Van Strien (1997) found significant relationships in obese and non-obese children between emotional and external eating, stating "although the differentiation among the three eating styles may be important from a theoretical and a therapeutic viewpoint, the overlapping of emotional eating and eating in response to external food-related stimuli is considerable" (p. 871). They also suggest that failure of restrained eating can cause distress and so lead to both emotional and external eating (see also Wardle et al. 1992). Hence, the mechanisms underlying the three trait eating styles may be closely associated and the combination of these styles may be important in determining cognitive and behavioural responses to food cues, and overeating; therefore highlighting the importance of taking all three measures into account in future research.

Additional results

The present study also found that there was a near-significant trend for a difference between high and low emotional eaters in subjective appetite over the session, but not as predicted. Induced negative mood did not affect the subjective appetite of emotional eaters, which increased over the course of the session irrespective of the MIP. However subjective appetite did increase over the course of the session in non-emotional eaters after the negative MIP; but did not do so after the neutral MIP. One possible explanation may be that exposure to food cues (during the attentional task) increased subjective appetite in the high emotional eaters, and this obscured any effect of the MIP in that group. To examine this possibility, it might be interesting to assess the effect of a negative MIP on subjective appetite in a study,

which does not require participants to complete an attentional task (which inevitably involved exposure to food cues). However, the current study did not do this because a main aim was to examine the effect of mood on attentional bias.

The palatability results showed that, in general, participants had a greater attentional bias for foods, which were rated as being more palatable. However this effect did not interact with any other variable, e.g. MIP or emotional eating group. The foods in the present study were selected to all be palatable and therefore it might be interesting to examine attentional responses to a wider selection of foods which vary more in palatability. Future research should take into account other characteristics of food (e.g. calorific value) which may be important determinants of motivation to eat as research has suggested a relationship between attentional bias to high calorie words in hungry participants (Placanica, Faunce & Soames, 2002) and a relationship between craving and high fat foods in stressed emotional eaters (Oliver, Wardle & Gibson, 2000).

The present results also showed that higher BMI was significantly associated with higher levels of emotional eating, restrained eating and overall DEBQ. The latter finding is interesting considering that overall DEBQ, in turn, correlated with attentional bias. BMI was not associated with attentional bias in this study, but the sample had a relatively narrow range of BMI (mostly normal weight and overweight women), so it would be informative to examine the relationship between BMI and attention bias to food cues in a sample, which included larger numbers of obese individuals. Braet and Crombez (2003) found an enhanced attentional bias for food words in obese children. However they used a modified Stroop task, it would therefore be interesting to examine this relationship in adults using a visual probe task and pictorial food cues (as these may be more effective in revealing attentional biases than words).

Clinical Relevance

The current study found that negative affect increased hunger and attentional bias for food cues. It also found that increased subjective appetite was associated with increased attentional bias for food cues. If (as suggested by the present results) exposure to negative events increases hunger and attentional bias to food cues, these variables may contribute to overeating behaviour. However further research would need to be carried out to examine whether negative affect does in fact have a causal role in contributing to overeating behaviour, but if it did, it would be important to take this into account in psychological treatment programmes, so that individuals are taught helpful ways to cope with negative affect. For example, Dialectical Behaviour Therapy (DBT) has been found to be successful with people who eat in response to negative affect in helping regulate emotions through mindfulness, cognitive and behavioural self-monitoring and distraction techniques (Van Strien, 2002).

It would also be important to acknowledge the importance of attentional biases to food-related stimuli within treatment programmes, as attentional biases are implicit measures of motivational state and have been implicated in causing and maintaining dysfunctional eating (Lee & Shafran, 2004). Cognitive behaviour therapy may be useful in targeting such cognitive biases for food cues, and there is evidence suggesting that it may be helpful in the treatment of obesity (NICE, 2006). Research has also found attentional biases towards relevant stimuli in patients with eating disorders (Shafran, Lee, Cooper, Palmer & Fairburn, 2007; Lee & Shafran, 2004) and that treatment can reduce attentional biases and symptomatology (Shafran, Lee, Cooper, Palmer & Fairburn, 2008). However, further research is needed to clarify the causal nature between attentional biases and dysfunctional eating.

Negative affect has been found to increase hunger and attentional bias for food cues and, if later research supports the prediction that this in turn leads to overeating behaviour, this could have important clinical implications for health promotion. Health promotion

enables people to take control over and improve their health by taking a proactive preventative approach to combating possible causes of ill health e.g. overeating behaviour in response to sadness. Therefore advertising campaigns could educate people that sadness can lead people to overeat and therefore promote healthier coping styles e.g. exercising, to help alleviate sadness.

Limitations and future research

A potential limitation of the study is its use of a between-subjects design. A within-subjects design may be more sensitive to effects of mood manipulation as each person would serve as their own control. However the findings of significant effects of mood and emotional eating on attentional bias scores suggest that the study was sensitive to the effects under investigation. Another limitation is that the present study did not measure the effect of mood on food intake and this would be an interesting area for future research. Overduin et al. (1995) looked at the relationship between attentional bias and food intake and found cognitive bias for food words (assessed on the modified Stroop task) was correlated with food intake in non-restrained eaters, but not in restrained eaters. Thus future research examining this relationship between attentional biases to food cues and food intake should also take into account the potential influence of individual differences in eating style.

Another potential limitation of the study is using a median split to divide the sample into high and low emotional eaters. While there was no overlap in scores between the two groups (high vs. low) (see Appendix B for box-plot graph), using a median split to allocate people into groups means that both groups will contain some mid-range scores (i.e. some people will have scored close to the median) which can reduce the likelihood of finding group differences. However participants were screened in advance and those scoring at the extreme ends of both high and low emotional eating were recruited to take part in the study in order to minimise this.

The current study only examined the effect of a depressive mood induction on subjective appetite and attentional biases. However, previous research suggests that different sources of negative affect may have different effects on cognitive and behavioural responses to food, including food craving and intake. For example, O'Connor et al. (2008) reported, in a diary study, that ego-threatening, interpersonal and work-related stressors were associated with increased eating (in particular of high-fat, high-sugar palatable snacks), whereas physical threats tended to be associated with reduced eating. Similarly, Lattimore (2001) found, in a laboratory study, that an ego-threat stressor increased food intake, whereas a frightening film did not. Thus, it would be informative to examine the effects of different stressors on cognitive responses to food, including attentional biases.

Conclusion

In conclusion, the present study found several novel and theoretically relevant results. Firstly, this study found that negative mood increased both subjective appetite and attentional bias for food cues, demonstrating that mood can influence motivation to eat. These findings are consistent with psychological models, which predict that negative affect increases the reward value of food cues, which in turn may explain the link between negative mood and overeating. Secondly, subjective appetite and attentional bias were significantly associated with each other, suggesting a common underlying mechanism, i.e. activation of a food reward system. Thirdly, the combination of the three trait eating styles (emotional, external and restrained eating) may be important in determining cognitive and behavioural responses to food cues and overeating. Therefore, the present results have importance for models that describe the cognitive mechanisms that underlie normal and dysfunctional eating.

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APPENDIX A

POWER CALCULATION

Power calculation

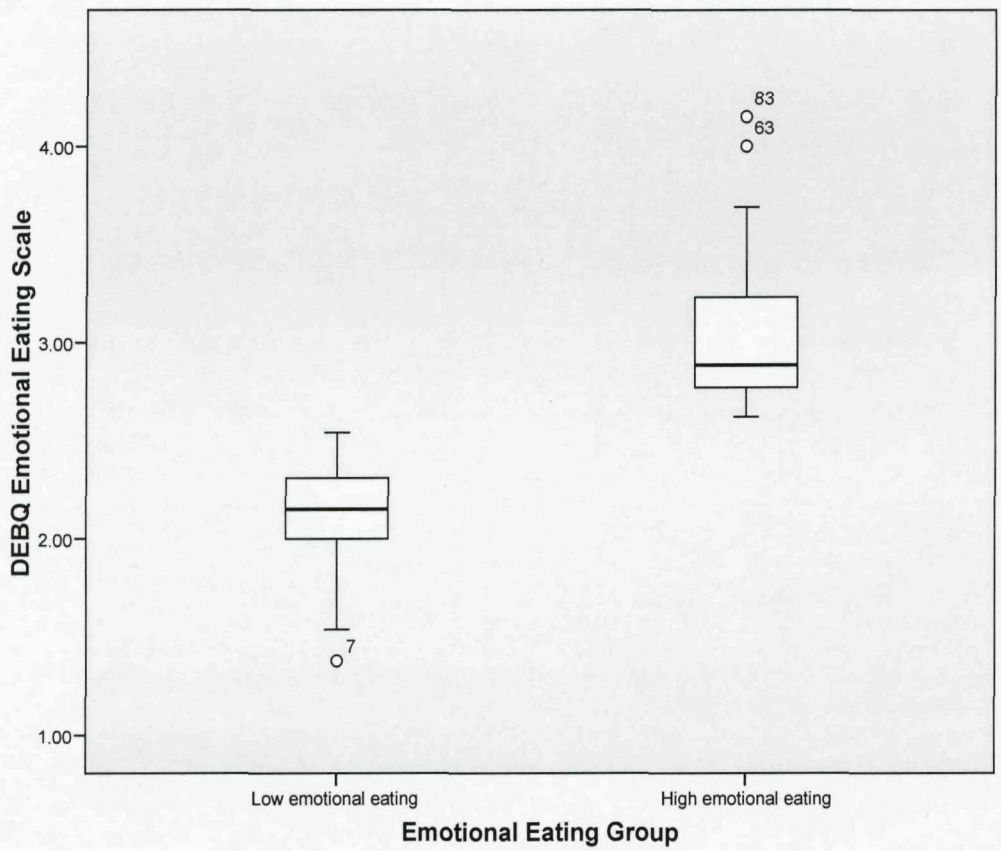
Newman et al. (2008) looked at the relationship between stress, attentional bias and eating style. They had 4 groups (N=66, average n=16.5) and had sufficient power to detect an interaction between eating style and mood manipulation. Comparisons of high and low external eaters in a high stress condition on attention bias gave a medium-large effect size of d = 0.6. Also Brignell et al. (2008) looked at the relationship between eating style and attentional bias and found high external eaters had a greater attentional bias for food cues than low external eaters (obtaining a large effect size of d = 1.0). In order to take into account differences between the Newman et al. (2008) and Brignell et al. (2008) studies and the current study, so as to avoid a type II error, a medium-large effect size was assumed.

To provide sufficient power (.80) to detect a medium-large effect size between four independent groups, where $\alpha = .05$, it was estimated that a sample size in the range of 18- 45 participants per group was needed, giving a total N in the range of 72 - 180 (Cohen, 1992). However the upper estimate was not feasible within the time constraints and so as many people as possible were tested within the time frame resulting in a sample of N = 80 participants, with an average n = 20 per group. This study was also in line with other research studies in terms of its sample size. For example, Newman et al. (2008) had a sample of 66 participants and Bradley et al. (2008) who examined the effect of a MIP on attentional bias in smokers had an N = 24 participants (average n = 12 per group).

APPENDIX B

A BOX-PLOT GRAPH OF SCORES ON THE DEBQ EMOTIONAL EATING SCALE FOR HIGH AND LOW EMOTIONAL EATING GROUPS

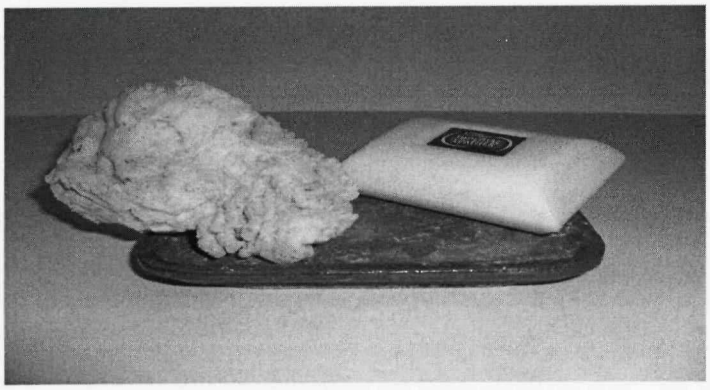
A box-plot graph of scores on the DEBQ Emotional Eating Scale for high and low emotional eating groups

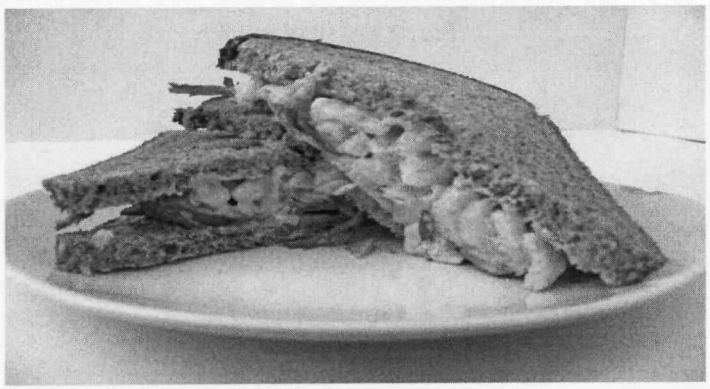


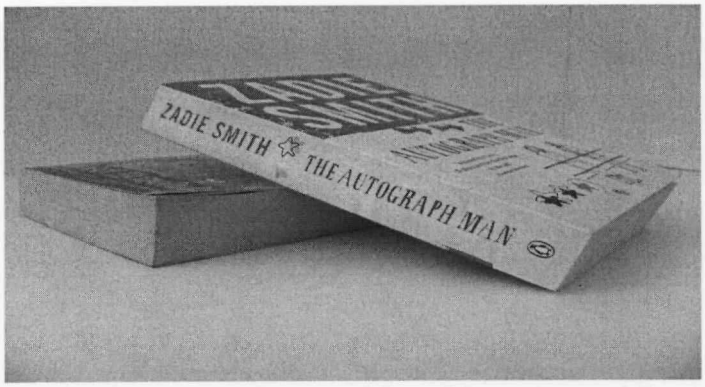
APPENDIX C

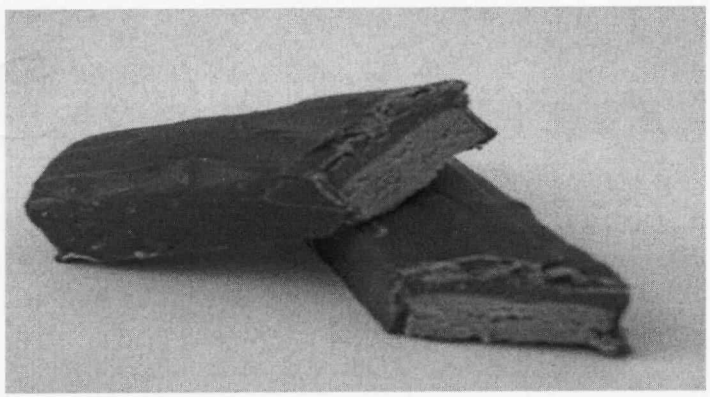
PICTORIAL STIMULI

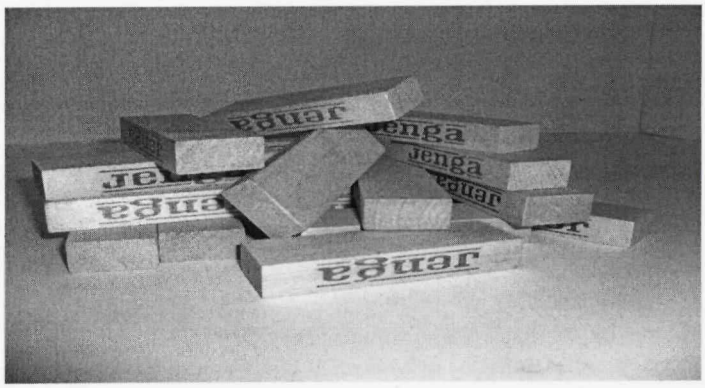
Food and matched food un-related picture pairs











APPENDIX D

ETHICS FORMS

Date: Tue, 17 Jul 2007 10:52:16 +0100
From: "Speiser B." <B.Speiser@soton.ac.uk>
To: rh605@soton.ac.uk
Subject: Ethics Application
Part(s): 2 Indemnity Insurance Form.doc application/msword 77.32 KB

Dear Rebecca,

Re: Emotional eating and the role of negative affect

The above titled application was approved by the School of Psychology Ethics Committee on 16 July 2007.

You will now need to complete the attached form for insurance purposes, and return to the address provided.

Should you require any further information, please do not hesitate in contacting me. Please quote reference PG/04/60.

Best wishes,

Barbara

Barbara Speiser
Academic Administrator

School of Psychology / Institute for Disorder of Impulse and Attention
University of Southampton
Shackleton Building (room 4041)
Highfield, Southampton
SO17 1BJ

Telephone number: 023 8059 5578
Fax number: 023 8059 2606
Email adress: B.Speiser@soton.ac.uk <mailto:B.Speiser@soton.ac.uk>

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Legal Services - Research Governance Office

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Tel +44 (0)23 8059 8848/9
Fax +44 (0)23 8059 5781
Email mad4@soton.ac.uk
ld7@soton.ac.uk

RGO REF: 5291

Miss Rebecca Hepworth
44 Britannia Drive
Beggarwood
Kempshott Park
Basingstoke
RG22 4FN

20 August 2007

Dear Miss Hepworth

Project Title: Emotional Eating and the Role of Negative Effect

I am writing to confirm that the University of Southampton is prepared to act as sponsor for this study under the terms of the Department of Health Research Governance Framework for Health and Social Care (2nd edition 2005).

The University of Southampton fulfils the role of Research Sponsor in ensuring management, monitoring and reporting arrangements for research. I understand that you will be acting as the Principal Investigator responsible for the daily management for this study, and that you will be providing regular reports on the progress of the study to the Research Governance Office on this basis.

I would like to take this opportunity to remind you of your responsibilities under the terms of the Research Governance Framework, and the EU Clinical Trials Directive (Medicines for Human Use Act) if conducting a clinical trial. We encourage you to become fully conversant with the terms of the Research Governance Framework by referring to the Department of Health document which can be accessed at:

http://www.dh.gov.uk/assetRoot/04/12/24/27/04122427.pdf

In this regard if your project involves NHS patients or resources please send us a copy of your NHS REC and Trust approval letters when available.

Please do not hesitate to contact me should you require any additional information or support. May I also take this opportunity to wish you every success with your research.

Yours sincerely

Dr Martina Prude
Research Governance Manager
cc: File

University of Southampton

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Miss Rebecca Hepworth
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Beggarwood
Kempshott Park
Basingstoke
RG22 4FN

RGO REF - 5291
School Ethics Ref - PG/04/60

20 August 2007

Dear Miss Hepworth

Professional Indemnity and Clinical Trials Insurance

Project Title: Emotional Eating and the Role of Negative Effect

Participant Type:	No Of Participants:	Participant Age Group:	Notes:
Healthy volunteers	128	Adults	

Thank you for forwarding the completed questionnaire and attached papers.

Having taken note of the information provided, I can confirm that this project will be covered under the terms and conditions of the above policy, subject to written consent being obtained from the participating volunteers.

If there are any changes to the above details, please advise us as failure to do so may invalidate the insurance.

Yours sincerely

Ruth McFadyen
Insurance Services Manager

cc: File

APPENDIX E

INFORMATION SHEET

UNIVERSITY OF
Southampton
School of Psychology

Mood and Cognitive Processes in Eating

Consent Form For Research Participants

Information sheet

My name is Becky Hepworth, I am a trainee clinical psychologist from Southampton University. I am requesting your participation in a study regarding the role of mood and attention in eating.

During this study you will be asked to recall some memories whilst listening to a piece of music. This is to help you get into a particular mood state (either negative or neutral). After this you will be shown some pictures. You will be asked to respond as quickly as possible to small dots appearing on the screen, by pressing a response button. Your response times will be recorded while you do this task. You will also be asked to make some simple ratings of some pictures. I will also ask you to complete some questionnaires. The study will take approximately 60 minutes to complete.

Personal information will not be released to or viewed by anyone other than researchers involved in this project. Results of this study will not include your name or any other identifying characteristics.

Your participation is voluntary and you may withdraw your participation at any time. If you choose not to participate there will be no consequences to your grade or to your treatment as a student in the psychology department. If you have any questions please ask them now or contact me Becky Hepworth at rh605@soton.ac.uk.

Signature Date

Name: Becky Hepworth

School of Psychology, University of Southampton, Highfield Campus, Southampton SO17 1BJ United Kingdom
Tel: +44 (0)23 8059 3995 Fax: +44 (0)23 8059 2606 http://www.psychology.soton.ac.uk/

APPENDIX F

CONSENT FORM

UNIVERSITY OF
Southampton
School of Psychology

Statement of Consent

I _____ have read the above informed consent from.

I understand that I may withdraw my consent and discontinue participation at any time without penalty or loss of benefit to myself. I understand that data collected as part of this research project will be treated confidentially and that published results of this research project will maintain my confidentiality. In signing this consent letter, I am now waiving my legal claims, rights or remedies. A copy of this consent letter will be offered to me.

Circle Yes or No to the following statements:

I give consent to participate in the above study Yes No

Participants signature Date

Name

I understand that if I have questions about my rights as a participant in this research, or if I feel that I have been placed at risk, I can contact the Chair of the Ethics Committee, Department of Psychology, University of Southampton, Southampton, SO17 1BJ. Phone: (023) 8059 3995.

School of Psychology, University of Southampton, Highfield Campus, Southampton SO17 1BJ United Kingdom
Tel: +44 (0)23 8059 3995 Fax: +44 (0)23 8059 2606 http://www.psychology.soton.ac.uk/

APPENDIX G

DEBRIEFING STATEMENT

UNIVERSITY OF
Southampton
School of Psychology

Mood and Cognitive Processes in Eating

Debriefing Statement

Thank you for taking part in this study. The aim of this research was to investigate the relationship between mood, attention and emotional eating. Participants were randomly located into two groups, one which asked the participant to induce a negative mood, the second asked participants to induce a neutral mood. It is expected that people who report they sometimes eat in response to emotion would attend to food cues more when they were in an emotional state (i.e. negative mood). Therefore we expected them to respond quicker to food related pictures (i.e. respond quicker to the dot if it was in front of a food related picture). Your data will help further our understanding of people's motivation to eat and the link between mood, concentration and eating behaviour.

Once again results of this study will not include your name or any other identifying characteristics. You may have a copy of this summary if you wish. If you wish to receive more information about the findings of this study leave me your e-mail address and I will send you some information when it is completed.

As you probably know, people vary considerably in how much they tend to feel worried or low in mood, and some people tend to be relatively free of negative thoughts and worries. Of course, our moods can change from day to day. However, for some people their mood may remain low for some time. If this should apply to you, we would like to point out that there are several sources of advice or help which are readily available and which may prove helpful. These include your General Practitioner, your Tutor (where appropriate) and the University Counselling Service.

If you have any further questions please contact me Becky Hepworth at rh605@soton.ac.uk.

Thank you for your participation in this research.

Signature: Date:

Name: Becky Hepworth

If you have questions about your rights as a participant in this research, or if you feel that you have been placed at risk, you may contact the Chair of the Ethics Committee, Department of Psychology, University of Southampton, Southampton, SO17 1BJ.
Phone (023) 8059 3995.

APPENDIX H

TABLE OF MEAN COMPOSITE VAS NEGATIVE MOOD MEASURE IN HIGH AND LOW EMOTIONAL EATERS, IN NEGATIVE AND NEUTRAL MIP CONDITIONS

Mean composite VAS negative mood measure in high and low emotional eaters, in negative and neutral MIP conditions.

	Low Emotional Eaters				High Emotional Eaters			
	Neutral MIP		Negative MIP		Neutral MIP		Negative MIP	
	M	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*
Negative mood, Time 1	23.64	8.91	20.73	7.46	25.62	12.07	21.00	8.60
Negative mood, Time 2	27.30	11.02	47.70	11.51	23.72	10.66	46.45	13.39
Negative mood, Time 3	24.01	7.53	30.42	11.11	24.69	10.03	30.87	11.84
Negative mood, Time 4	25.89	8.94	45.47	11.16	23.76	10.08	40.84	11.00
Negative mood, Time 5	24.01	8.31	32.30	14.00	24.60	10.21	31.13	12.43
Negative mood, Time 6	24.01	7.97	27.32	12.19	24.11	10.59	25.86	10.60

Note: Time 1=before MIP, Time 2=after MIP, Time 3= after first part of attentional task, Time 4= after mood booster, Time 5= after second part of attentional task, Time 6= after rating task, end of study.

APPENDIX I

TABLE OF MEAN COMPOSITE VAS HUNGER/URGE TO EAT SCORES IN HIGH AND LOW EMOTIONAL EATERS, IN NEGATIVE AND NEUTRAL MIP CONDITIONS

Mean composite VAS hunger/urge to eat scores in high and low emotional eaters, in negative and neutral MIP conditions.

	Low Emotional Eaters				High Emotional Eaters			
	Neutral MIP		Negative MIP		Neutral MIP		Negative MIP	
	M	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*
Hunger/Urge, Time 1	31.63	32.46	30.73	24.35	29.38	29.20	36.02	29.32
Hunger/Urge, Time 2	25.53	28.88	37.00	23.49	31.24	31.24	36.93	32.60
Hunger/Urge, Time 3	32.93	31.94	50.63	30.17	51.65	34.80	58.30	33.79
Hunger/Urge, Time 4	31.30	33.16	46.60	29.04	54.09	36.78	52.50	36.17
Hunger/Urge, Time 5	31.73	34.81	54.08	29.99	55.82	36.99	63.23	37.52
Hunger/Urge, Time 6	37.50	35.71	67.15	32.22	60.62	35.92	69.43	35.40

APPENDIX J

TABLE OF PARTIAL CORRELATIONS BETWEEN ATTENTIONAL BIAS AND EATING AND EMOTION RELATED VARIABLES

Partial correlations between attentional bias and eating and emotion related variables.

	r	*p*	Control Variable
DEBQ Overall Total Score	.31*	.01	PSS, hunger/urge
DEBQ emotional	-.02	.87	DEBQ external, DEBQ restrained, hunger/urge, PSS
DEBQ external	.21	.07	DEBQ emotional, DEBQ restrained, hunger/urge PSS
DEBQ restrained	.20	.09	DEBQ emotional, DEBQ external, hunger/urge PSS
Hunger/Urge	.26*	.02	DEBQ emotional, DEBQ external, DEBQ restrained, PSS
PSS	.16	.162	DEBQ emotional, DEBQ external, DEBQ restrained, hunger/urge

*p < .05

Partial correlations between attentional bias and overall DEBQ, stress and subjective appetite

	r	*p*	Control Variable
DEBQ Overall Total Score	.31*	.01	PSS, hunger/urge
Hunger/Urge	.28*	.02	DEBQ overall, PSS
PSS	.16	.16	DEBQ overall, hunger/urge

*p<.05