This is the author's version of a work that was submitted/accepted for publication in the following source:

Fay, Stephanie H. & Finlayson, Graham (2011)
Negative affect-induced food intake in non-dieting women is reward driven and associated with restrained-disinhibited eating subtype.

This file was downloaded from: https://eprints.qut.edu.au/46766/

© Copyright 2011 Elsevier

This is the author's version of a work that was accepted for publication in *Appetite*. Changes resulting from the publishing process, such as peer review, editing, corrections, structural formatting, and other quality control mechanisms may not be reflected in this document. Changes may have been made to this work since it was submitted for publication. A definitive version was subsequently published in Appetite, [VOL 56(3), (2011)] DOI: 10.1016/j.appet.2011.02.004

License: Creative Commons: Attribution-Noncommercial-No Derivative Works 4.0

Notice: Changes introduced as a result of publishing processes such as copy-editing and formatting may not be reflected in this document. For a definitive version of this work, please refer to the published source:

https://doi.org/10.1016/j.appet.2011.02.004
Negative affect-induced food intake in non-dieting women is reward driven and associated with restrained-disinhibited eating subtype.

Stephanie H. Fay¹, a

Graham Finlayson

Biopsychology Group, Institute of Psychological Sciences, University of Leeds, LS2 9JT, UK.

¹Corresponding author: stephanie.fay@bristol.ac.uk

¹Present address: School of Experimental Psychology
University of Bristol
12a Priory Road
Bristol BS8 1TU
UK.

Abstract
In humans the presence of negative affect is thought to promote food intake, but there is widespread variability. Susceptibility to negative affect-induced eating may depend on trait eating behaviours, notably ‘emotional eating’, ‘restrained eating’ and ‘disinhibited eating’, but the evidence is not consistent. In the present study, 30 non-obese, non-dieting women were given access to palatable food whilst in a state of negative or neutral affect, induced by a validated autobiographical recall technique. As predicted, food intake was higher in the presence of negative affect; however, this effect was moderated by the pattern of eating behaviour traits and enhanced wanting for the test food. Specifically, the High Restraint-High Disinhibition subtype in combination with higher scores on emotional eating and food wanting was able to predict negative-affect intake (adjusted $R^2 = .61$). In the absence of stress, individuals who are both restrained and vulnerable to disinhibited eating are particularly susceptible to negative affect food intake via stimulation of food wanting. Identification of traits that predispose individuals to overconsume and a more detailed understanding of the specific behaviours driving such overconsumption may help to optimise strategies to prevent weight gain.

**Keywords:** Negative Affect, Restraint-disinhibition subtype, Eating behaviour traits, Reward, Wanting, Food intake.

**Introduction**

Human eating behaviour is susceptible to influence from a range of factors independent of hunger or energy need that pose a risk for overconsumption and overweight. One such factor is
the acute presence of negative affect (Canetti, Bachar, & Berry, 2002; Greeno & Wing, 1994; Macht, 2008), a term which refers to the spectrum of negative emotions including anxiety, sadness, anger, guilt etc. In animals, aversive states result in decreased intake (Krebs, Macht, Weyers, Weijers, & Janke, 1996), suggesting that this may be a biologically adaptive response (Lima, 1987). However, in the context of human eating behaviour, while suppression of appetite in response to negative affect has been observed (Macht, Roth, & Ellgring, 2002), especially in free-living individuals (Tomiyama, Mann, & Comer, 2009), a more commonly reported reaction to negative affect is increased consumption, or ‘emotional eating’ (Epel, Lapidus, McEwen, & Brownell, 2001; Greeno & Wing, 1994). It has been observed in older adults (Cuijpers, Steunenberg, & Van Straten, 2007), adolescents (Downs, DiNallo, Savage, & Davison, 2007) and even children (van Strien & Bazelier, 2007).

Negative affect-induced eating may be a risk factor for overweight due to its potential to override satiety, or the energy-dense characteristics of the foods that tend to be chosen (Canetti, et al., 2002; Macht, 1999), which are often high in sugar and fat (Anton & Miller, 2005; Cuijpers, et al., 2007; Elfhag, Tynelius, & Rasmussen, 2007; Nguyen-Michel, Unger, & Spruijt-Metz, 2007). Such foods often produce a caloric surplus or ‘passive overconsumption’ (Viskaal-van Dongen, de Graaf, Siebelink, & Kok, 2009) that may lead to weight gain (Blundell, Burley, Cotton, & Lawton, 1993). In accordance with this, a relationship between negative affect-induced overconsumption and elevated BMI has frequently been reported (Blair, Lewis, & Booth, 1990; Chua, Touyz, & Hill, 2004; Geliebter & Aversa, 2003; Lowe & Fisher, 1983).

Consequently, the traits that lead individuals to eat during a negative affective state are of concern. However, the evidence behind particular trait eating behaviours and negative affect eating is unclear. The trait of emotional eating, identified on a subscale of the Dutch Eating
Behavior Questionnaire (DEBQ) (van Strien, Frijters, Bergers, & Defares, 1986), is defined as the tendency to eat in response to feelings rather than hunger (van Strien, Frijters, Bergers, et al., 1986). Emotional eating has previously been associated with eating after experimentally induced negative affect (Goossens, Braet, Van Vlierberghe, & Mels, 2009; Wallis & Hetherington, 2009). Perhaps the most commonly investigated trait for risk of eating in response to negative affect, however, is dietary restraint (Greeno & Wing, 1994). Restraint theorists postulate that the food intake of restrained eaters is kept under strict cognitive control which is liable to break down when overwhelmed by strong emotion (Herman & Mack, 1975; Herman & Polivy, 1975). In this situation restrained eaters abandon control and proceed to overconsume. In line with this theory, restrained eating has been associated with negative affect-induced eating in a number of contexts (Cools, Schotte, & McNally, 1992; Peñas-Lledó, Loeb, Puerto, Hildebrandt, & Llerena, 2008; Polivy, Herman, & McFarlane, 1994; Schotte, Cools, & McNally, 1990; Shepherd & Ricciardelli, 1998; Stice, 1994) although its role has more recently been disputed (Sheppard-Sawyer, McNally, & Fischer, 2000; Wallis & Hetherington, 2009; Wolff, Crosby, Roberts, & Wittrock, 2000). Trait disinhibition, defined as a tendency to overeat in the presence of palatable food, or other disinhibiting stimuli that trigger eating (Savage, Hoffman, & Birch, 2009), has more recently been linked with eating in response to negative affect. Disinhibition has been repositioned as a psychobiological tendency toward ‘opportunistic eating’ (Bryant, King, & Blundell, 2008). It is commonly assessed by the Three Factor Eating Questionnaire (TFEQ-D) (Stunkard & Messick, 1985). However, opportunistic eating may be better measured by a combination of the emotional and external eating scales of the DEBQ, which appear to have higher validity than the original TFEQ (Ouwens, van Strien, & van der Staak, 2003; Soetens, Braet, Van Vlierberghe, & Roets, 2008; Strien, Cleven, & Schippers, 2000; Tapper, Pothos,
Fadardi, & Ziori, 2008), although revised versions of the TFEQ have been developed (Karlsson, Perrson, Sjostrom, & Sullivan, 2000). More recently, a high restrained/high disinhibited subtype has been identified as a more reliable risk factor for food consumption after negative affect than restrained eating alone (Bryant, Kiezebrink, King, & Blundell, 2008; Haynes, Lee, & Yeomans, 2003; Savage, et al., 2009; Strien, et al., 2000; Yeomans & Coughlan, 2009). The subtypes of these combined traits are likely to be more sensitive than each trait alone, as they distinguish interactions between eating styles which otherwise would be left undetermined.

The differential expression that certain trait eating behaviours show in the presence of negative affect encourages an exploration of the mechanism by which these traits may act. One such mechanism could be an enhanced response to the rewarding properties of food in the form of specific ‘wanting’ for the food available and thus greater motivation to eat. A neuropsychological separation of the ‘wanting’ and ‘liking’ components of reward was first introduced by Berridge (Berridge, 1996; Berridge & Robinson, 2003); Finlayson has since confirmed this experimentally in humans (Finlayson, King, & Blundell, 2006; Finlayson, King, & Blundell, 2007a). Wanting for test food, rather than liking of it, has been associated with greater intake (Finlayson, King, & Blundell, 2008; Finlayson, King, & Blundell, 2007b). It is possible that, in some individuals, negative affect may lead to enhanced wanting of food, regardless of how much it is liked. Evidence for an interaction of food wanting and trait eating behaviours comes from Lemmens et al. (Lemmens, et al., 2010), who found that restrained and unrestrained individuals showed differential wanting following consumption of ‘unhealthy’ foods.

A further confounding issue encountered in previous research on eating in response to negative affect is that the form of negative affect under examination is either not specified or
misattributed. For example, a common method of inducing negative affect in the laboratory is by using ego-threatening tasks or fear inducing stimuli, but such techniques tend to increase arousal in conjunction with negative affect. States of affect and arousal are quite separate and have been associated with opposing effects on food intake (Macht, 2008). Furthermore, individual differences in arousal and emotional reactivity to stimuli make it difficult to know which state (arousal, affect or both) is influencing subsequent behaviour. Indeed it has been argued that the stress inherent in negative mood induction procedures, rather than negative affect itself, may account for reported increases in food intake (Lowe & Kral, 2006). In our literature search we found surprisingly few experimental studies on negative affect and food intake that manipulated negative affect without simultaneously increasing arousal. The present study aimed to clarify this issue by investigating the effect of inducing negative affect alone on food intake when given access to palatable snack food. We hypothesised that eating in the presence of negative affect would be moderated by trait eating behaviour; in particular, higher levels of disinhibition and restraint, and by explicit wanting for the test food. —Wanting

Methods

Participants

Participants were 30 non-obese females who were not following a weight-loss diet at the time of testing. The mean age of the sample was 21.7 years ($SD$ 1.02). They were recruited from the undergraduate population of the University of Leeds in response to an advert for a study investigating ‘food and memory’. All participants were screened for history of eating or mood disorders, current dieting, medication known to affect appetite and willingness to eat the test
food via a ‘General Health Questionnaire’ administered prior to the first test session. Menstrual cycle phase was recorded by self reported date of last menstruation. The research was approved by the ethics committee of the Institute of Psychological Sciences, University of Leeds. Participants were not paid for their time.

**Measures**

**Assessment of trait eating behaviours**

The Dutch Eating Behavior Questionnaire (DEBQ; (van Strien, Frijters, Bergers, et al., 1986) was used to measure trait eating behaviours. It is a 33-item questionnaire consisting of three subscales measuring the constructs of emotional eating (13 items), external eating (10 items) and restrained eating (10 items). Responses are made via a 5-point Likert scale ranging from ‘Never’ (1) to ‘Very often’ (5). It has good reliability and internal and discriminative validity (van Strien, Frijters, Vanstaveren, Defares, & Deurenberg, 1986). A measure of disinhibited eating was obtained by calculating the mean of emotional and external eating scores, following Ouwens et al. (2003), Soetens et al. (2008) and Tapper et al. (2008).

**Mood induction procedure**

A validated technique was adapted from a study by Schaefer and Philippot (2005) in which emotional responses were evoked with the recall and oral description of emotional autobiographical memories. In the present study, participants were asked to write about one or more autobiographical memories for three minutes. They were asked to describe in detail the event and their reactions to it. If they could not write for three minutes about one particular memory, they were asked to think of another in order to continue, as long as the second memory...
had the same emotional significance. However, all participants wrote about one memory only.

The task instructions varied according to experimental condition. In the negative affect condition, participants were asked to write about a negative memory, concentrating on their feelings at the time associated with the events. The control condition required a neutral memory; an example given was describing a daily routine. This technique approximates a naturalistic diary-writing style often associated with the recording of personal emotions, and so may encourage more naturalistic affect by minimising embarrassment and self-consciousness. Autobiographical scripts have been shown to produce more intense emotions than film clips (Lane, Reiman, Ahern, Schwartz, & Davidson, 1997) and, importantly, the possibility of individual differences in response to film content was avoided.

Assessment of mood state, appetite and hedonic response

Subjective mood was measured at baseline and after the negative or neutral mood induction technique using pen and paper visual analogue scales (VAS) 100mm long representing intensity of emotion, anchored at each end (‘Not at all’ and ‘Extremely’). Participants were required to place a vertical mark on the line to indicate their current feeling. VAS measured Calmness (‘How calm do you feel now?’), Sadness (‘How sad do you feel now?’), Anger (‘How angry do you feel now?’), Happiness (‘How happy do you feel now?’), Tension (‘How tense do you feel now?’) and Contentment (‘How content do you feel now?’). Emotions measured were adapted from work by Chua et al. (2004), Sechrist et al. (2003) and Davidson’s approach/withdrawal model (1984a). They were balanced across valence and arousal, as emotions are known to vary on both dimensions (Alfano & Cimino, 2008).
Appetite was measured using similar VAS. Adapted from Blundell (1990), scales measured Hunger (‘How hungry do you feel now?’), Fullness (‘How full do you feel now?’) and Prospective Consumption (‘How much food could you eat now?’, anchors: ‘None at all’, ‘A very large amount’).

VAS of explicit liking and wanting for the test food were also measured, adapted from Finlayson et al. (2007) to measure expected liking (‘How pleasant would it be to taste some of this food now?’), explicit wanting (‘To what degree do you want more of this food?’) and general palatability (‘How pleasant/palatable was this food?’).

Test food
The test food was sweet popcorn presented ad libitum, following Schotte et al. (1990). It was chosen as it is palatable and presented in small, regular-sized pieces to discourage monitoring of intake.

On each trial 100g warm popcorn was presented in a large white ceramic bowl. Popcorn was made by the experimenter before each testing session using the oil-popping method. One 100g serving of popcorn was made from 50g corn kernels, 20g “Crisp ’n’ Dry” solid vegetable oil and 30g “Lyle’s” golden syrup. It contained approximately 4.6 kcal/gram.

Procedure
The experiment used a repeated measures cross-over design with the order of trials counterbalanced across participants. All participants had been asked to refrain from consuming anything other than water for two hours prior to each testing session and compliance was assessed on arrival by self report combined with an appetite VAS. Testing took place between
10 a.m. and 12 p.m. in individual experimental cubicles within the laboratory. Each participant was presented with a booklet containing VAS and space for writing down their chosen autobiographical memory. Baseline mood and appetite were measured and then participants completed either the negative or the neutral mood induction procedure as outlined above, before completing a second set of VAS ratings. They were then presented with the popcorn and were required to taste it in order to complete hedonic ratings, before being granted free access to consume it. Participants were told that they could consume as much or as little as they liked, and that there was more if required. During this time, they were given a simple visual search task consisting of highlighting the letter ‘t’ within a long factual text. After ten minutes participants were interrupted and asked to complete a final set of appetite and mood VAS. The popcorn remained with the participants until the end of the trial, which was terminated by the participant. The second testing session occurred at least one week after the first. Finally, the DEBQ was administered via email one week following the final session.

Data analysis

Data from one participant were removed from analyses as one autobiographical memory was strongly indicative of high arousal and stress due to a history of bulimia nervosa. Ratings of negative emotions (sadness, anger, tension) and positive emotions (happiness, calmness, contentment) were combined to produce mean negative affect and mean positive affect factors. The efficacy of the emotion induction procedure was analysed using a two-way within-subjects ANOVA with emotion condition (neutral, negative) and time (pre-induction, post-induction, post-consumption) as within-subjects factors. Difference in caloric intake between the conditions was analysed using paired-samples t-tests. Differences in appetite and hedonic
response between the conditions were examined by within-subjects ANOVA and t-tests, respectively. Where the assumption of sphericity was violated, the Greenhouse-Geiser correction was applied. For post-hoc analyses the Bonferroni adjustment was applied. Negative affect-induced food intake (NA-intake) was calculated using residualised change scores by regressing caloric intake from the negative condition on intake from the neutral condition. Residualised change scores are preferable to the use of subtraction scores, which can induce overcorrection of the post score by the baseline score (Cohen & Cohen, 1983); they also reduce autocorrelated error and regression to the mean effects (Schutz, 1989). Bivariate Pearson’s correlations were conducted to examine associations between appetite sensations, hedonic response, eating behaviour traits and NA-intake. The effect of restraint/disinhibition subtype on NA-intake was examined by one-way ANOVA after dividing participants into four groups according to disinhibition and restraint scores on the DEBQ. The subtypes compared were low restraint-low disinhibition (LRLD; N = 7), high restraint-low disinhibition (HRLD; N = 7), low restraint-high disinhibition (LRHD; N = 7), and high restraint-high disinhibition (HRHD; N = 8). Finally, a hierarchical regression was conducted to test the linear association between state (mood, appetite sensations, hedonic response) and trait (DEBQ factors and restrained/disinhibited subtype) variables and NA-intake. Variables were introduced to the model in stepwise fashion (probability of $F$ to enter, $< .05$). Assessment of order of condition and phase of menstrual cycle revealed no significant differences in food intake, mood, hedonic response or appetite (all $p > .05$). Therefore, trial order and menstrual phase were excluded from analyses. All data were analysed using SPSS version 15 (SPSS Inc., Chicago, IL, USA).

**Results**
Mood induction procedure

Mean affect intensity ratings assessed at three time points in both the neutral and negative affect conditions are shown in Table 1. A mixed ANOVA confirmed a significant effect of the mood induction procedure. There was a significant effect of emotion condition on reported negative affect intensity \( (F(1, 28) = 45.81, p < .001) \) and reported positive affect intensity \( (F(1, 27) = 32.73, p < .001) \). There was also a significant effect of time on negative affect intensity \( (F(2, 56) = 28.18, p < .001) \) and on positive affect intensity \( (F(2, 56) = 21.48, p < .001) \), and a significant interaction (negative affect: \( F(2, 56) = 56.29, p < .001 \); positive affect: \( F(2, 56) = 24.98, p < .001 \)). Figure 1 shows reported mean negative affect (panel a) and mean positive affect (panel b) over time in both conditions.

[Figure 1 about here]

Impact of mood induction on food intake

A paired-samples t-test showed a significant difference in consumption between the two conditions. Participants consumed significantly more of the test food following the negative emotion induction procedure \( (M = 191.03, SD = 115.92) \) than in the neutral condition \( (M = 133.42, SD = 78.42) \) \( (t(28) = -2.34, p < .05, r = .72) \). Mean consumption in each condition is shown in Figure 2.

[Figure 2 about here]

Examination of individual consumption patterns revealed a large individual variability in food intake during negative affect. In total, 19 participants increased their consumption and 10 decreased their consumption during the negative affect condition compared with the neutral condition.
Impact of negative affect on appetite sensations and hedonic response

Ratings of hunger, fullness and prospective consumption did not differ according to affect condition (largest $t = -1.61, p = .12$). Similarly, actual and expected liking of the test food did not differ (largest $t = -1.65, p = .11$). However, there was a significant effect of condition on explicit wanting ($t(28) = -2.31, p < .05$); participants reported significantly greater wanting of the test food during a negative affective state ($M = 72.14, SD = 18.03$) compared to neutral state ($M = 63.14, SD = 21.58$).

Association between state variables and negative affect-induced food intake

Bivariate correlation analyses were conducted to explore the association between mood, appetite sensations and hedonic response with NA-intake. Interestingly, only hedonic responses during negative affect were significantly associated (expected liking: $r = .52, p < .01$; explicit wanting: $r = .56, p < .01$). The correlation between general palatability of the test food and NA-intake was close to significance ($r = .36, p = .06$). Individual subjective mood scores and appetite sensations were not associated with NA-intake (largest $r = .26, p = .18$). Figure 3 shows food intake as a function of explicit wanting (low or high) and condition (negative or neutral mood). Explicit wanting was correlated with food intake during negative affect but not during neutral affect.

[Figure 3 about here]

Association between trait variables and negative affect-induced food intake
Scores on the DEBQ sub-factors are shown in Table 2. Participants reported relatively low scores on restraint, and moderate on emotional and external eating (compared with the assessment of Wardle (1986)). The relationship between trait eating behaviours as measured by the DEBQ and NA-intake was examined by correlation. Significant positive correlations were observed between NA-intake and restraint ($r = .53, p < .01$), emotional eating ($r = .61, p < .0001$), and disinhibition ($r = .56, p < .01$), but not external eating ($r = .09, p = .65$).

**Multivariate analysis of negative affect-induced food intake**

To test whether combinations of state and trait variables could account for individual differences in NA-intake, a hierarchical regression was performed based on the significant associations revealed in the bivariate analyses. Hedonic responses were introduced to the model followed by trait eating factors from the DEBQ. The results of these multivariate analyses are summarised in Table 4. Explicit wanting, disinhibition and restraint each contributed significantly to the variance in NA-intake. $R^2$ was significantly different from zero following each step. The final model, with all variables in the equation, was $R^2 = .66$ (.62 adjusted), indicating that ~60% of the variability in NA-intake was predicted by explicit wanting for the test food and scores on disinhibition and restraint. The size and direction of the coefficients suggested that NA intake was greater in HRHD subtypes with a stronger explicit wanting for the test food.

**Relationship between restraint/disinhibition subtype and negative affect-induced food intake**

The four restraint/disinhibition (R/D) subtypes were identified by median split on disinhibition and restraint scores. Subtype mean scores are detailed in Table 3. A one-way ANOVA revealed significant differences in NA-intake according to R/D subtype. The HRHD subgroup consumed
significantly more calories in response to negative affect than the LRLD subgroup \( (p < .05) \), shown in Figure 4.

[Figure 4 about here]

Discussion

This study sought to examine the effect of induced negative affective state on food intake and the role of eating behaviour states and traits on the modulation of this effect. Results showed that the negative affect induction procedure successfully increased negative affect intensity, validating its use in the food intake laboratory. In the group as a whole, food intake was significantly increased during a negative affective state, suggesting that stress is not a necessary condition for negative affect-induced eating (NA-intake). However, large variability in NA-intake was observed, specifically associated with enhanced hedonic wanting for the test food (relative to control). NA-intake was also associated with trait emotional eating, restraint and disinhibition, but not external eating. Moreover wanting, restraint and disinhibition were found to independently predict NA-intake.

A positive relationship with emotional eating is perhaps to be expected, since the construct of emotional eating is defined as the tendency to eat in response to feelings rather than hunger (van Strien, Frijters, Bergers, et al., 1986). Furthermore, research has shown that both emotional and restrained eating styles may moderate the relationship between affect-induced overconsumption and overweight (van Strien, Herman, & Verheijden, 2009); as observed in the present study, this would appear to encompass affect induced overconsumption. Our finding that food intake in the presence of negative affect is correlated with restrained eating lends some
support to restraint theory (Herman & Mack, 1975); however, research investigating restraint in conjunction with NA-intake has tended to produce inconsistent results. Consideration of subtypes of restrained eating may shed light on this discrepancy. In particular, research suggests that restrained non-dieters may be more susceptible to disinhibited eating when compared to restrained non-dieters. A study by Guerrieri et al. (2009) found that priming restrained participants with impulsivity (a related construct to disinhibition) increased consumption in non-dieters only, whereas dieters consumed less compared to control. The fact that participants in the present study were not dieting may explain the observed positive correlations between restraint and food intake, and lends support to the interpretation of restraint as a multidimensional construct (Lowe, Whitlow, & Bellwoar, 1991). As described in the literature, individuals scoring highly on both restraint and disinhibition scales are often the most vulnerable to overconsumption in response to a variety of ‘triggers’ (Bryant, Kiezebrink, et al., 2008; Haynes, et al., 2003; Savage, et al., 2009; Westenhoefer, Broeckmann, Munch, & Pudel, 1994; Yeomans & Coughlan, 2009). In this study, participants with higher scores on restraint and disinhibition (HRHD type) consumed on average 186 more calories in the presence of negative affect compared to the LRLD type. Within this subtype, restraint appeared to play a stronger role, as HRLD type tended towards greater consumption in response to negative affect compared with the LRHD type. Overall however, these findings lend further support to those advocating a distinction between successful and unsuccessful restrained eating according to susceptibility to disinhibited eating.

The finding that enhanced wanting for the test food was associated with food intake following negative affect throws some light on the mechanism by which negative affect may lead to overconsumption. Van den Bos and de Ridder (2006) posited that negative affect could
compromise the balance between the reward system and self control and that this may especially
be the case for restrained eaters. Other research has reported that restrained eaters exhibit
stronger automatic approach tendencies and greater wanting for high-fat foods (Roefs, Herman,
MacLeod, Smulders, & Jansen, 2005; Veenstra & de Jong, 2010). In one study (Tapper, et al.,
2008), non-dieting restrained females demonstrated higher food-related processing bias
(indicative of motivational state) compared to non-restrained eaters and restrained dieters. The
authors also reported a trend for food processing bias and trait disinhibition. This indicates that
restrained and possibly disinhibited eaters appear to be susceptible to the consumption of foods
with strong hedonic appeal. In the present study, we found that negative affect was a necessary
intermediary in the reported association between hedonic wanting and amount of food consumed
(see Figure 3). This provides evidence that NA-intake is a reward driven behaviour.
Furthermore, it suggests that negative affect promotes hedonic eating episodes in susceptible
individuals. Experimentally induced negative affect was recently reported to increase subjective
motivation to eat and attentional bias for food, in association with restrained and external eating
behaviour (Hepworth, Mogg, Brignell, & Bradley, 2010); the present study demonstrates that
these conditions are also related to objective measures of food intake.

A strength of this study was that it was conducted in a controlled setting using a
homogenous sample with the experimental conditions separated by at least one week. However,
with this approach a number of limitations are also inherent. By design, the artificial setting
removed the participants from influences in the real environment, and therefore thoughts and
behaviours exhibited may have a reduced significance to the free-living situation. Concerns exist
over the induction of mood in an experimental context, and results from laboratory studies have
not always been replicated in more natural settings (Tomiyama, et al., 2009), possibly due to the acute level of affect that can be generated under controlled conditions.

There were also limitations concerning the sample recruited for this study. Young females may have a tendency towards higher levels of restraint than in the general population (Allison & Baskin, 2009). However, on average the sample scored only moderately on all three DEBQ subscales, which is in line with the wider population. It has been noted elsewhere that research involving undergraduate students can restrict the usefulness of the data collected (Levitt & List, 2007; Rosenthal, 1965). Therefore the findings of the present study may be limited in their relevance for understanding eating behaviour in the wider context. A further concern in the laboratory context is that experimental cues may unintentionally bias the research outcome (Faith, Wong, & Allison, 1998). However, in the present study participants were not aware that the purpose of the experiment was to study affect and eating behaviour. Care was also taken to administer the DEBQ one week after the final test session in order to reduce demand characteristics as much as possible. Notably, the mood induction procedure involved a more subtle, internalised and naturalistic induction of negative affect than previous laboratory studies have achieved.

To conclude, in the present study we used a validated mood induction technique to investigate the role of eating behaviour traits and states on food intake during negative affective state in non-dieting women. Results showed that eating in the presence of negative affect was associated with enhanced hedonic wanting and was moderated by restrained and disinhibited eating. These findings suggest firstly that intake during negative affect is reward driven, and secondly that individuals who are both highly restrained and vulnerable to disinhibited eating are particularly at risk of negative affect-induced overconsumption.
References


van Strien, T., & Bazelier, F. G. (2007). Perceived parental control of food intake is related to external, restrained and emotional eating in 7-12-year-old boys and girls. Appetite, 49(3), 618-625.


### Table 1: Mean (standard deviation) VAS ratings of affect intensity.

<table>
<thead>
<tr>
<th></th>
<th>Neutral condition</th>
<th>Negative condition</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Pre-induction</td>
<td>Post emotion induction</td>
</tr>
<tr>
<td>Anger</td>
<td>9.79 (12.39)</td>
<td>10.17 (12.04)</td>
</tr>
<tr>
<td>Tension</td>
<td>26.03 (17.25)</td>
<td>23.03 (16.07)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>----------------</td>
<td>-------</td>
<td>-----</td>
</tr>
<tr>
<td>Sadness</td>
<td>20.90</td>
<td>19.10</td>
</tr>
<tr>
<td>Happiness</td>
<td>63.66</td>
<td>61.76</td>
</tr>
<tr>
<td>Calmness</td>
<td>70.00</td>
<td>67.21</td>
</tr>
<tr>
<td></td>
<td>(14.34)</td>
<td>(17.78)</td>
</tr>
<tr>
<td>Contentment</td>
<td>60.59</td>
<td>64.29</td>
</tr>
<tr>
<td></td>
<td>(18.07)</td>
<td>(17.05)</td>
</tr>
</tbody>
</table>
Table 2: Mean (standard deviation) eating behaviour trait scores for DEBQ factors.

<table>
<thead>
<tr>
<th>Factor</th>
<th>Mean</th>
<th>SD</th>
</tr>
</thead>
<tbody>
<tr>
<td>Restraint</td>
<td>2.28</td>
<td>0.80</td>
</tr>
<tr>
<td>Emotional Eating</td>
<td>2.89</td>
<td>0.72</td>
</tr>
<tr>
<td>External Eating</td>
<td>3.36</td>
<td>0.37</td>
</tr>
<tr>
<td>Disinhibition</td>
<td>3.13</td>
<td>0.43</td>
</tr>
</tbody>
</table>
Table 3: Mean (standard deviation) restraint and disinhibition scores for the four R/D subtypes.

<table>
<thead>
<tr>
<th></th>
<th>Restraint</th>
<th></th>
<th></th>
<th>Disinhibition</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>N</td>
<td>Mean</td>
<td>SD</td>
<td>Mean</td>
<td>SD</td>
</tr>
<tr>
<td>LRLD</td>
<td>7</td>
<td>1.63</td>
<td>0.53</td>
<td>2.79</td>
<td>0.15</td>
</tr>
<tr>
<td>HRLD</td>
<td>7</td>
<td>2.84</td>
<td>0.43</td>
<td>2.76</td>
<td>0.18</td>
</tr>
<tr>
<td>LRHD</td>
<td>7</td>
<td>1.64</td>
<td>0.53</td>
<td>3.27</td>
<td>0.16</td>
</tr>
<tr>
<td>HRHD</td>
<td>8</td>
<td>2.90</td>
<td>0.59</td>
<td>3.60</td>
<td>0.37</td>
</tr>
</tbody>
</table>
Table 4: Results of hierarchical regression model of negative affect-induced eating.

<table>
<thead>
<tr>
<th>Step</th>
<th>Variable</th>
<th>$\beta$</th>
<th>Adjusted $R^2$</th>
<th>$F$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Step 1</td>
<td>Wanting</td>
<td>.52**</td>
<td>.24</td>
<td>9.84*</td>
</tr>
<tr>
<td>Step 2</td>
<td>Wanting</td>
<td>.52**</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Disinhibition</td>
<td>.39*</td>
<td>.48</td>
<td>13.65**</td>
</tr>
<tr>
<td>Step 3</td>
<td>Wanting</td>
<td>.35*</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Disinhibition</td>
<td>.44**</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Restraint</td>
<td>.38*</td>
<td>.62</td>
<td>9.99*</td>
</tr>
</tbody>
</table>

* $p < .01$; **$p < .0001$. 
Figure 1: Profile of negative affect (top) and positive affect (bottom) after mood induction and snack consumption.

Means shown for neutral (dashed line) and negative (solid line) induced mood conditions.

Std. dev. shown as vertical lines. *$p < .001$ 

Figure 2: Food intake in calories after mood induction.

Means shown for neutral (white) and negative (black) induced mood conditions.

Std. dev. shown as vertical lines. *$p < .05$ 

Figure 3: Food intake in calories as a function of explicit wanting for the snack food and mood.

Means shown for neutral (dashed line) and negative (solid line) induced mood conditions.

Figure 4: Negative affect-induced food intake in calories according to restraint/disinhibition subtype.

Means shown as difference in intake after mood induction (neutral subtracted from negative condition) for R/D subtypes: R = restrained eating; D = disinhibition; L = scores below median; H = scores above median.

Std. dev. shown as vertical lines. *$p < .05$
Figure 1
Figure 4

The figure illustrates the change in food intake (kcal) for different conditions: LRLD, HRLD, LRHD, and HRHD. The y-axis represents the change in food intake in kcal, while the x-axis indicates the conditions. Bars with asterisks indicate statistical significance.