The role of self-compassion and self-criticism in binge eating behaviour

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Declarations of interest: None

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ABSTRACT

Self-criticism and low self-compassion are implicated in the development and maintenance of binge eating. However, the association between these self-attitudes and binge eating symptoms remains unclear. Women with symptoms of Bulimia Nervosa (BN) or Binge Eating Disorder (BED) were randomised to either a self-compassion (n=30) or self-critical rumination (n=30) strategy following a negative mood induction. Responses to food cues (cue reactivity and affect) and calorie consumption in a 'taste test' were assessed. The self-compassion strategy was associated with a greater improvement in positive and negative affect following the negative mood induction. Despite the differential effects on mood, self-compassion and self-critical rumination led to similar self-reported food cravings and physiological reactivity to cues. However, participants in the self-compassion condition consumed significantly fewer calories, rated the consumed food as less pleasurable, and reported less desire to continue eating. The findings suggest that therapeutic strategies for cultivating self-compassion are associated with improved food-related self-regulation in the context of negative mood.

INTRODUCTION

Binge eating involves the consumption of large quantities of food, in a discrete period of time, whilst experiencing a sense of loss of control over eating (American Psychiatric Association; APA, 2013). It is the hallmark symptom of Binge Eating Disorder (BED) and Bulimia Nervosa (BN), although the latter is also accompanied by the use of compensatory behaviours (e.g. vomiting, excessive exercise), after binge eating episodes (Association 1994)

People with eating disorders tend to be highly self-critical (Goss, 2007) and report high levels of shame (Grabhorn, Stenner et al. 2006); Swan & Andrews, 2003; (Troop, Allan et al. 2008). Self-criticism is a form of self-to-self relating that is characterised by negative judgments and evaluations, and is often activated by failures to meet personal standards (Gilbert, Clarke et al. 2004). Explorations of the function of self-criticism suggest that people relate to themselves in this way in an attempt to self-correct and improve personal features and behaviours (Gilbert, Clarke et al. 2004). Gilbert and colleagues conceptualise self-criticism and self-directed hostility as defensive coping strategies, driven by shame (Gilbert, Durrant et al. 2006). However, accumulating evidence suggests that the threat response elicited by self-directed attacks resembles that activated by criticism from others (Gilbert, 2000; Gilbert & Irons, 2005; (Longe, Maratos et al. 2009). Self-criticism also appears to maintain and exacerbate perceptions of inferiority, defectiveness, and feelings of shame (Gilbert, McEwan et al. 2010).

An alternative, adaptive response to perceived shortcomings is to reassure, soothe and have compassion for oneself. Self-compassion has been proposed to involve self-directed kindness, seeing one's pain, suffering and imperfections as common to humanity and being mindful of one's painful thoughts and feelings (Neff, 2003). Gilbert (2000) proposes that when individuals show themselves warmth and compassion, this activates the soothing-affiliative (interpersonal) system in the brain. It is proposed that the soothing system operates via the vagus nerve and is associated with increased parasympathetic activity and concomitant sympathetic

inhibition (Depue and Morrone-Strupinsky 2005, Porges 2007), effectively restoring homeostasis after activation of the flight-fight response (Porges 2007). Support for a role of self-compassion in activating this system and downregulating threat responses comes from studies of self-compassionate imagery and its effects on physiological and psychological indices of the threat response (Rockliff, Gilbert et al. 2008, Duarte, Matos et al. 2015).

Stress is associated with a decrease in heart rate variability (HRV), which is defined as variability in inter-beat intervals across time. Low-frequency HRV (HRV-LF) appears to relate to influence of the sympathetic nervous system on heart rate, while high-frequency HRV (HRV-HF) relates to parasympathetic activity. (1996). Whilst other metrics are available (Godfrey, Juarascio et al. 2019), since the ratio of LF to HF HRV combines measures of sympathetic and parasympathetic influence on cardiac activity, it is a potentially efficient integrated metric of general autonomic functioning. In particular, it is suggested to index the balance between sympathetic and parasympathetic activity (Shaffer, McCraty et al. 2014) decreasing during 'tend and befriend' behaviours, and increasing during periods of mental and physical challenge. Furthermore, it has been used in recent research examining the effects of stress (recovery) in binge eaters (Messerli-Bürgy, Engesser et al. 2010, Naish 2019).

In a series of studies, compassionate imagery was associated with increased heart rate variability, a proxy for parasympathetic responding (Porges, 2007), as well as significant decreases in the stress hormone cortisol and alpha amylase (Rockliff, Gilbert et al. 2008, Duarte, McEwan et al. 2015).

Individuals with eating disorders report difficulties in generating (Goss and Allan 2010), and fear of experiencing, self-compassion (Kelly, Carter et al. 2014, Oliveira, Ferreira et al. 2017). Thus binge eating may serve a functional role, to comfort and soothe the self, and escape awareness of distressing thoughts and feelings (Heatherton & Baumeister, 1991), in the absence of well-developed alternative adaptive strategies for managing distress (Goss and Gilbert, 2002).

While evidence suggests that binge eating alleviates negative affect, relief is usually short-lived and followed by intense feelings of shame, guilt and self-disgust (Berg, Crosby et al. 2015, Berg, Cao et al. 2017), which can trigger further binge episodes, thus, a self-defeating and self-perpetuating cycle is maintained (Goss & Gilbert, 2002).

Binge eating in response to negative affect and the temporary reduction in distress reinforces binge eating behaviour, which might therefore be maintained through instrumental conditioning. In addition, it is proposed that Pavlovian conditioning underlies intense food cravings, a form of food cue reactivity, experienced in response to food stimuli (Sobik, Hutchison et al. 2005). Food cravings can be conceptualised as the degree of "wanting" food. This describes the motivational drive to ascertain food (Berridge, 1996). Food cravings are also influenced by the hedonic properties of food, such as how much the person "likes" the taste of food. (Berridge, 1996). Although related, research shows that these two concepts operate independently to effect behaviour (Finlayson, King & Blundell, 2007).

Research into HRV in those with eating disorders has suggested that those with BED show lower HRV compared to obese non-binge eaters. Whilst all groups showed an increased LF:HF ratio during stress, in the BED group, the ratio did not return to baseline after recovery. This suggests an impaired ability of the cardiovascular system to adapt to stress exposure in binge eaters (Messerli-Bürgy, Engesser et al. 2010, Naish 2019).

Compassion-focused therapy (CFT) was specifically developed to address experiences of shame and self-attack by helping people to cultivate affiliative emotions and compassion (Gilbert, 2000, 2009). Preliminary non-randomised studies have demonstrated improvements in eating disorder symptoms with the addition of CFT to standard eating disorder outpatient treatments including cognitive behaviour therapy (Gale et al., 2014) and inpatient treatment (Kelly et al., 2017). Similarly, Kelly and Carter (2015) found that a three-week CFT guided self-help intervention and structured eating plan led to a significant reduction in binge eating

frequency in patients with BED. These studies suggests that adjunctive compassion-focused strategies can improve therapeutic outcomes for people with eating disorders. However, treatment components in complex interventions are likely to interact in complex ways, so the specific contribution of the self-compassion enhancing strategies used in the above intervention studies remains unclear. One way of identifying the specific and individual contribution of a therapeutic strategy is to examine this strategy in isolation under controlled laboratory conditions (Kazdin, 2007).

An example of this approach is Adams and Leary's (2007) seminal study, which explored the effects of directly manipulating self-compassion in response to diet breaking. In their study, undergraduate women with highly rigid and restrained eating patterns were asked to eat a 'preload' consisting of unhealthy foods, in an attempt to mimic diet breaking. Half of the participants were then primed to think self-compassionately about what they had eaten, while the control group received no strategy instructions. Afterwards participants were presented with a fake 'taste-test' and the amount of food they consumed was measured. Adams and Leary (2007) found that those in the self-compassion condition initially reported less guilt, and subsequently ate less during the taste test than those in the control condition. Their findings suggest that self-compassion can help reduce binge eating that often occurs after diet breaking.

In the current study we investigated the causal role of self-compassion and self-critical rumination as a response style to a negative event (false feedback relating to academic failure) on food cue reactivity and binge eating behaviour. We hypothesised that participants instructed to respond with self-compassion to a negative mood induction entailing experiences of failure, would feel more soothed and comforted, reflected in simultaneously higher parasympathetic and/or lower sympathetic response during the 'recovery' period (lower LF:HF HRV ratio) and increased positive affect. It was additionally predicted that self-compassion instructions would be associated with lower ratings for wanting, and perceived pleasantness (liking) of the food on

exposure to food as well as fewer calories consumed during a taste test. In contrast, those instructed to respond with a self-critical rumination were predicted to remain threat focused, and would consequently experience an increased desire to eat (wanting), increased sympathetic and/or lower parasympathetic responding during recovery (higher LF:HF ratio), and would therefore be more likely to overeat following the negative mood induction stressor.

METHOD

Participants

Participants were recruited through online research recruitment sites, the eating disorder charity 'Beat', a university eating disorder support group and posters placed on university noticeboards.

A power calculation (G*Power3; (Faul, Erdfelder et al. 2007) was used to determine sample size. Based on a large effect sizes reported in previous similar studies (Adams & Leary, 2007; Svaldi, Tuschen-Caffier, Trentowska, Caffier, & Naumann, 2014), a minimum sample size of n=60 (30 per group) would be sufficient to detect a significant (α=0.05) between-group effect with power set at 0.80.

Eligibility was assessed via an initial telephone screen. Women aged between 18 and 50 years, with a body mass index (BMI) between 18.5 and 30kg/m^2, who met DSM-5 criteria for BED and BN (APA, 2013) and were fluent in English were included in the study. Probable diagnostic status was determined by administering the bulimic episodes, binge eating disorder and use of compensatory behaviours modules of the Eating Disorder Examination Interview (EDE; Fairburn, Cooper, O'Connor, 2008). EDE modules were administered by RA, supervised and supported by LS, who has extensive training and experience in the use of the EDE. Exclusion criteria were: 1) current pregnancy or breast-feeding, 2) current alcohol/drug abuse or dependency, 3) current or history of cardiovascular complications (in case this had any impact

on heart rate reactivity) 4) self-reported current severe mental health problems including psychosis, bipolar disorder and post-traumatic stress disorder and 5) obesity (as this is known to impact heart rate variability, (Karason, Mølgaard et al. 1999)Messerli-Burgi et al, 2010).

Of the 172 people responding to advertisements, 123 completed a telephone screen and 71 fulfilled the eligibility criteria. Sixty-three attended the experimental session and were randomised to either the compassion or self-critical rumination condition according to a randomisation code generated from the website www.random.org. Three were unable to complete the experiment due to equipment malfunction (n=1), a fire alarm during testing (n=1) and request to terminate due to distress experienced during the rumination induction. As such, the statistical analysis was based on a total sample of n=60.

All participants received a payment of £10 for their time. Ethical approval for the study was obtained from the University College London Graduate School Research Ethics Committee.

Measures

Subjective state measures

Positive and negative affect: Current positive and negative affect was measured using the 10-item short-form version of the Positive and Negative Affect Schedule (PANAS-SF; (Thompson 2007). Additionally, the Types of Positive Affect Scale (TPAS; (Rockliff, Gilbert et al. 2008) was used to assess different types of positive affect. This scale requires participants to rate 18 positive affective attributes, which form three subscales of positive affect: Active Affect, Relaxed Affect and Safe Affect. Participants were instructed to respond to the items on both the PANAS and TPAS according to how they felt at that given moment, using 5-point Likert scales (1=not at all, 5=very much so). The scores for each affect subscale were added together to give a total score. Thus higher scores indicate stronger affective states.

State self-compassion and self-criticism: The State Self-Compassion and Self-Criticism Scale (SCCS, (Falconer, King et al. 2015) is a scenario based measure assessing self-criticism and self-compassion in response to imagined negative scenarios (e.g. "You arrive home to find that you left your keys at work"). Participants are instructed to imagine these scenarios and to rate, using a 7-point Likert Scale (1=not at all to 7=highly), the extent to which they would react to themselves in a soothing, reassuring, compassionate, or harsh, contemptuous and critical manner. The items are summed to provide a state self-compassion and a self-criticism score. Scores can range between 15-105 for each subscale, with higher scores indicating higher levels of self-compassion and self-criticism. The scale has been shown to be sensitive to change in repeated measures designs that examine the effects of short periods of experimentally induced self-compassion (Falconer, Slater et al. 2014, Kamboj, Kilford et al. 2015) (Kamboj, Walldén et al. 2018).

Self-reported desire to eat: Desire to eat was assessed using the following question, "At this moment in time how much do you want to eat something?" which was rated using a 100mm visual analogue scale (VAS), with 0 indicating "not at all" and 100 indicating "very much".

Baseline hunger: A 100mm VAS was used to measure baseline self-reported hunger from 0 indicating "not at all" to 100 indicating "extremely".

Trait measures

Eating disorder symptoms: The Eating Disorder Examination Questionnaire (EDE-Q; Fairburn & Beglin, 2008) is a self-report questionnaire that assesses the frequency and severity of eating disorder-related symptomology over the past 28 days. It yields four subscales: Restraint, Eating Concern, Weight Concern and Shape Concern, and a Global score, which is an average of the four subscales. The global and subscale scores range from 0 to 6, with higher scores indicating greater symptom frequency and/or severity. The EDE-Q has good test-retest reliability, internal consistency and validity (Berg, Peterson et al. 2012). The community norm

for the Global EDE-Q for women is 1.55 (SD=1.21) (Fairburn & Beglin, 2008). The Global EDE-Q norm for outpatients with BN is 4.45 (SD=1.11) and 4.07 (SD=0.82) for patients with BED (Brewin, Baggott et al. 2014).

Trait self-criticism: The Forms of Self-Criticising/Attacking and Self-Reassuring Scale (FSCRS;(Gilbert, Clarke et al. 2004) was used to measure participants' dispositional tendency towards self-criticism and self-reassurance. This scale consists of 22 statements, which are rated using a 5-point Likert scale according to how true they are of the person (1=not at all like me; 5=extremely like me). The questionnaire comprises of three scales: Inadequate Self, which is measured by statements such as "I am easily disappointed with myself" and "there is a part of me that feels I am not good enough"; Hated Self, which includes statements measuring sense of dislike towards oneself (e.g. "I have a sense of disgust with myself"), and Reassuring Self, which measures tendencies to be kind, supportive and forgiving to oneself (e.g. "I am gentle and supportive with myself"). The three subscales of the FSCRS have been shown to have good reliability (Baiao, Gilbert et al. 2014).

Depression: The Beck Depression Inventory-II (BDI-II; Beck, Steer & Brown, 1996) consists of 22 questions that assess the degree of depressive symptoms, including affective, cognitive, behavioural and physical symptoms of depression. Higher scores on this scale reflect more severe symptoms of depression. The reliability and validity of the BDI-II is well established (Wang & Gorenstein, 2013).

Strategy response compliance.

Compliance with the self-compassion and self-critical rumination response strategy instructions was measured by asking participants to answer the following question, "During the last exercise, please indicate the extent you were able to think about each statement by marking a cross on the following scale", using a 100m VAS that was anchored with "Did not spend any time thinking about what was said" and "Spent 100% of the time thinking about what was being said".

Physiological measures

Heart rate variability: The ratio of low frequency (LF) to high frequency (HF) components of heart rate variability (HRV) was used as an index of cardiovascular autonomic regulation. HRV was obtained using a heart rate monitoring device with a sampling rate of 1 kHz (Bodyguard 2, FirstBeat Technologies, Jyväskylä, Finland). The device was attached to participants using two ECG electrodes, with one attached below the right collarbone and the other at the bottom of the left ribcage. The ratio of LF/HF components of HRV were derived using the Kubios software package (Tarvainen, Niskanen, Lipponen, Ranta-Aho, & Karjalainen, 2014). The HF (0.15-0.4 Hz) component of HRV is thought to reflect cardiac parasympathetic nervous system activity, while the low frequency component (0.04 to 0.15 Hz) is generally understood to represent sympathetic responding (Task Force of the European Society of Cardiology, 1996). Thus the ratio of LF to HF is used to quantify the relationship between sympathetic and parasympathetic activity, with increases in the LF to HF ratio reflecting a shift to sympathetic dominance. A decrease in this index corresponds to parasympathetic dominance (Pagani et al., 1984, 1986). Although a variety of HRV indices of parasympathetic activity are used in psychophysiological research, given that our procedure involved the use of both an experimental stressor and a strategy intended to oppose the 1accompanying sympathetic activation (by

putatively increasing parasympathetic activity: the self-compassion strategy), LF:HF seemed the more appropriate index.

Stimulus Materials

Negative mood induction procedure. The negative mood induction procedure was the failure version of the Remote Associates Test (RAT; McFarlin & Blascovich, 1984). The RAT requires participants to solve 10 problems, each of which involves finding a word that relates to three presented words (e.g. "box" to the set of words "soap–shoe-tissue") in five minutes. Items in the failure version are solvable but designed to be so difficult that people are unlikely to be able to identify the link word, and on average only one problem is answered correctly. This failure to complete the task reliably induces negative mood (Brown and Dutton 1995). To enhance the induction, after completion of the test the researcher marked three of the answers as correct and gave standardized feedback, "on average people get five right, ok, so you managed to get three right". Participants were also informed prior to taking the test that the test assesses verbal reasoning ability, a component of IQ that is highly correlated with academic achievement.

Self-compassion and self-critical rumination response strategy instructions. Instructions designed to induce self-compassion and self-critical ruminative response styles were audio recorded by the first author in a sound attenuated environment. The instructions for cultivating self-compassion were based on Kristin Neff's mindful self-compassion guided meditation. This is available at http://self-compassion.org. This guided meditation is a core practice in the 8-week mindful self-compassion group intervention developed by Neff and Germer (2013). The meditation focuses on cultivating self-compassion by encouraging one to 1) show oneself kindness and understanding instead of criticism and self–judgment; 2) see one's

pain, suffering and imperfections as common to humanity rather than isolating; and 3) be mindful about one's feelings and thoughts instead of over-identifying with them.

To induce a self-critical ruminative response style, an adaption of the internationally adopted paradigm for inducing rumination, developed by Nolen-Hoeksema and Morrow (1993), was used.

As with the original paradigm, participants were asked to focus their attention on thoughts that were symptom-focused, emotion-focused, and self-focused. However the script was adapted to include more explicit self-criticism and to foster a self-critical response to these thoughts. For example, they were asked to think about "what your feelings might mean", "the physical sensations you feel in your body" and "how quick/slow your thinking is right now" (Nolen-Hoeksema & Morrow). The paradigm was adapted to include more explicit self-criticism and to foster self-critical responses to the symptom-focused, emotion-focused and self-focused states.

For example, "Everybody has something about themselves that they don't like, something that that causes them to feel insecure or not good enough. Think about what causes you to feel this way, and the consequences of feeling this way".

The two response strategies were matched in terms of duration of the recordings (10 minutes), number of words (self-compassion n=678; self-critical rumination n=686) and complexity of language (Flesch-Kincaid grade level 6.9 for both recordings; Kincaid, Fisburne, Rogers, & Chissom, 1975). Ten doctoral candidates in clinical psychology reviewed the content of each strategy and completed the PANAS-SF and SCCS prior to and after each recording. This was undertaken to validate whether the response strategy instructions affected mood states and state levels of self-criticism and self-compassion. The piloting showed that the two response strategies had differential effects on state self-compassion, self-criticism and mood, with the self-compassion instructions effectively increasing state self-compassion and positive mood. In

contrast, the self-critical rumination instructions had no effect on levels of self-compassion but increased levels of state self-criticism and negative mood.

In vivo cue-reactivity procedure. Reactivity to food was assessed by positioning three bowls of food - one with Cadbury's milk chocolate buttons, another with mini blueberry muffins and the third with Maryland chocolate chip cookies, each weighing 50 grams - in front of the participants. Participants were then given standardised verbal instructions on how to interact with the food. Participants were asked to "focus their attention on the smell of the food and how it appears, without touching or tasting it". After 5 minutes participants were asked to indicate on a 0-100mm VAS 'At this moment in time how much do you want the chocolate/cake/biscuits?' in addition to 'At this moment in time how pleasant do you think the chocolate/cake/biscuits tastes?' The scales were anchored with "not at all" and "very much so". Participants were then asked to sample each of the foods and to rate how pleasant each of the foods tasted using the 100mm VAS (tapping the concept of liking) . Participants were instructed to eat as much or as little as they wanted to make their ratings. Once participants had finished eating and completed their ratings they were asked again to indicate, "At this moment in time how much do you want the cookies/chocolate/cake?"

Ad libitum food intake. Following the cue reactivity paradigm participants were told that they could eat as much of the leftover food as they wanted because the food would have to be disposed of for health and safety reasons. They were also told that they would not be able to take any food away with them again for health and safety reasons. After one minute the researcher told the participant that they needed to go and check on the next participant, and the current participant was left alone in the room with the food for five minutes. Once the participant had left, the remaining food was weighed to calculate the amount consumed.

Design and Procedure

A between-subjects experimental design was used, with participants randomly allocated to the compassion or self-critical rumination condition at the point of attending the experimental session. All participants provided written, informed consent prior to any experimental procedure. Prior to the session, participants were instructed to refrain from eating, drinking alcoholic or caffeinated drinks, or engaging in strenuous exercise for three hours and from smoking for an hour before the experiment. This was in order to reduce the influence of these factors on heart rate variability and to ensure similar hunger levels amongst participants (Notarius, Morris et al. 2006, Karakaya, Barutcu et al. 2007, Andrade-Lima, Forjaz et al. 2011).

Testing sessions were conducted individually in a quiet laboratory. To minimise expectancy effects, participants were told that the researcher was interested in exploring the relationship between verbal reasoning abilities, thinking styles, mood, heart rate activity and food preferences. They then completed baseline questionnaires measures (EDE-Q, BDI-II, FSCRS, and baseline hunger), state measures of affect (PANAS-SF, TPAS) and self-compassion/self-criticism (SCCS), and rated their current desire to eat (T1-baseline).

Participants were then fitted with the Firstbeat device and their HRV was measured during an initial 5-minute baseline period and throughout the rest of the experiment (Kamboj, Irez et al. 2017). After the baseline measure of HRV, participants completed the negative mood induction task (the 'failure version' of the Remote Associates Test), followed by the compassion or self-critical ruminative strategy. Affect, state self-compassion and self-criticism, and desire to eat were assessed again after the negative mood induction (T2) and after the compassion/self-critical ruminative strategy (T3). Participants then rated the extent to which they had complied with the instructions, followed by the cue-reactivity procedure. They completed measures of their degree of wanting and then were then offered ad libitum foods in a taste test, and completed ratings of pleasantness for each food. The procedure is depicted in

Figure 1. After the experiment participants were fully debriefed about the purpose of the experiment and were rewarded for their participation. Once they had left the room the amount of food eaten was measured.
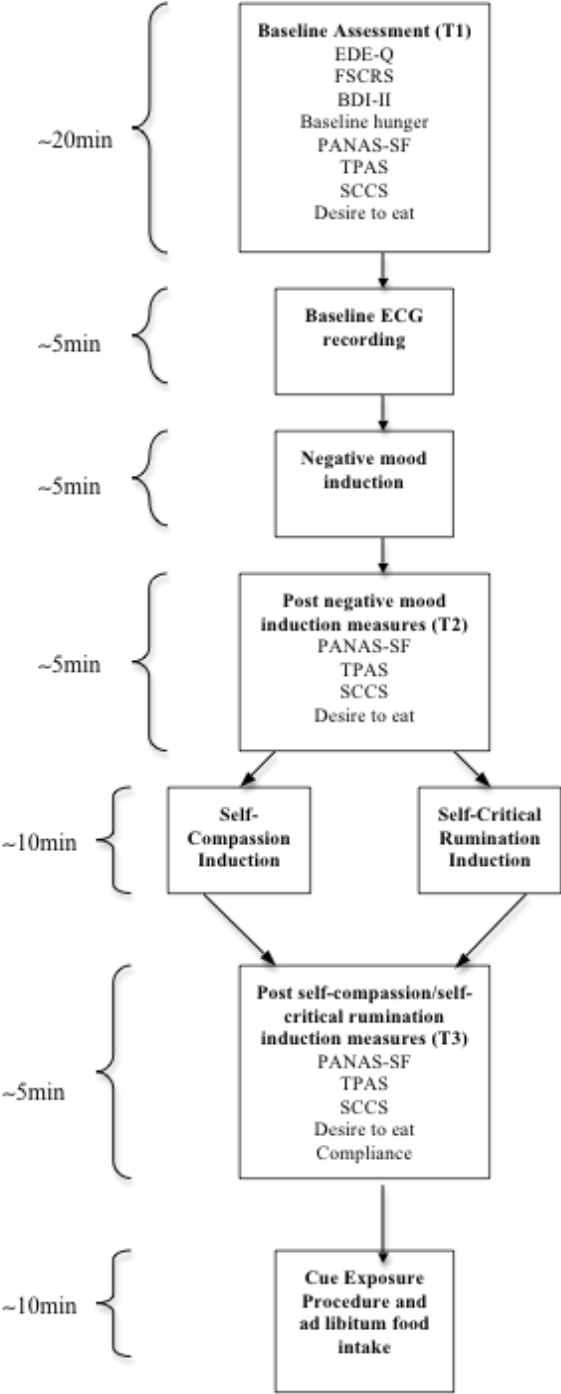

Figure 1: Timeline of experimental procedure

Statistical Analyses

Data was analysed using IBM SPSS Statistics 24.0. The significance level was set at 0.05 and all reported tests are two-tailed. Independent samples t-tests and ANOVA assumptions were verified by checking for skewness and kurtosis visually and statistically. Data that was significantly skewed was square root transformed. Where the assumption of equality of variances was violated, adjusted t values and degrees of freedom are reported. Outliers, defined as z-scores >3, were replaced with values of Mean + 3 SD (Field, 2013).

The two groups were compared according to baseline characteristics (demographic variables, trait measures, eating disorder symptoms, baseline hunger), cue-reactivity measures and amount of food eaten, using independent sample t-tests or chi-square/Fisher's exact tests for categorical data. The main outcomes were analysed using mixed 2 x 3 ANOVAs with Strategy (self-compassion vs self-critical rumination) as the between-subjects variable and Time (T1: baseline/pre strategy; T2: post negative mood induction, T3: post strategy) as the within-subject variable. Because the effects of Strategy were similar for the three foods types (chocolate, biscuits, muffin), an average response across the food types was used in the appropriate analyses. Pairwise post hoc analyses were Bonferroni corrected. Dependent, within-group effect sizes were calculated using Dunlap and colleagues' formula, based on t and r values of within subjects tests (Dunlap, Cortina, Vaslo, & Burke, 1996).

Sample Characteristics and Baseline Analyses

Participants were given probable diagnoses of DSM-5 BED (57%) or BN (43%) using the relevant modules of the EDE. Baseline characteristics of participants in the two groups are presented in Table 1. There were no significant differences between groups on any of the sociodemographic variables, binge eating frequency, use of compensatory behaviours, BMI, severity of depression, trait self-criticism or baseline hunger.

Compliance with Response Strategy Instructions

The compliance with strategy instructions did not differ between groups and was relatively high in both conditions (self-compassion: M=72.87%, SD=14.13; self-critical rumination: M=72.03%, SD=17.04; $t(58)$=0.206, p=0.84).

Mood deterioration and recovery: effects of negative mood induction and response strategy

Positive affect: There was a main effect of Time on the 'active', 'relaxed' and 'safe' subscales of the TPAS (F values $\geq$ 23.71, p values <0.001, η_p^2 values $\geq$ 0.29); and for the positive affect subscale of the PANAS ($F(2,116)$=12.93, p=0.01, η_p^2=0.18). There was also a main effect of Strategy on active ($F(1,58)$=5.65, p=0.021, η_p^2=0.09) and positive affect ($F(1,58)$=5.66, p=0.02, η_p^2=0.09). These effects were qualified by significant Time x Response Strategy interactions for relaxed ($F(2,116)$=7.81, p=0.001, η_p^2=0.12) and safe affect ($F(2,116)$=4.08, p=0.019, η_p^2=0.07).

Table 1

Demographic *Mean ± SD or n (%)*	Self-Compassion (*n*=30)	Self-Critical Rumination (*n*=30)	Total sample (*n*=60)	Test statistic
Age	26.8 (6.78)	24. (5.60)	25.8 (6.42)	$t(58)=1.21$ $p=0.231$
BMI (kg/m^2)	24.0 (3.87)	23.8 (3.15)	23.9 (3.50)	$t(58)=0.21$ $p=0.838$
Ethnicity, *n* (%)				
Caucasian	16 (53.3%)	14 (46.7%)	30 (50.0%)	$p=0.954$*
East Asian	5 (16.7%)	6 (20.0%)	11 (18.3%)	
Southern Asian	3 (10.0%)	5 (16.7%)	8 (13.3%)	
African/Caribbean	3 (10.0%)	2 (6.7%)	5 (8.3%)	
Multiracial	3 (10.0%)	3 (10.0%)	6 (10.0%)	
Employment status, *n* (%)				
Employed part or full-time	11 (36.7%)	11 (36.7%)	22 (36.7%)	$p=0.805$*
Student	17 (57.7%)	15 (50.0%)	32 (53.3%)	
Unemployed	2 (6.7%)	4 (13.3%)	6 (10.0%)	
Years of education	15.93 (2.16)	15.53 (1.74)	15.73 (1.96)	$t(58)=0.79$ $p=0.433$

Diagnosis, *n* (%)

BED	16 (53.3%)	18 (60.0%)	34 (56.7%)	$x^2 (1)=0.27$ $p=0.795$
BN	14 (46.7%)	12 (40.0%)	26 (43.3%)	
OBE in last 28 days, mean	11.8 (10.44)	10.7 (6.42)	11.3 (8.61)	$t(58)=0.48$ $p=0.630$

Compensatory behaviours (last 28 days; *n* (%))

Vomiting	7 (23.3%)	3 (15.0%)	10 (16.7%)	$p=0.299$*
Laxative misuse	5 (16.7%)	1 (3.3%)	6 (10.0%)	
Excessive Exercise	18 (60.0%)	17 (56.7%)	35 (58.3%)	
Extreme Dietary Restriction	16 (53.0%)	13 (43.3%)	29 (48.3%)	

Questionnaire scores

BDI-II, mean (SD)	21.50 (14.75)	16.40 (7.46)	18.95 (11.87)	$t(58)=1.69$ $p=0.096$
FSCRS Inadequate	24.33 (8.92)	22.50 (7.25)	23.42 (8.11)	$t(58)=0.87$ p=0.386
FSCRS Hated	7.20 (5.50)	5.20 (3.81)	6.20 (4.80)	$t(58)=1.64$, p=0.107

Table 1 cont/

FSCRS Reassuring	15.57 (7.05)	16.23 (6.85)	15.90 (6.90)	$t(58)=-0.37$, p=0.712
EDEQ Global	3.30 (1.25)	2.98 (1.16)	3.14 (6.42)	$t(58)=1.03$ p=0.309
EDEQ Restraint	2.56 (1.65)	2.23 (1.47)	2.40 (1.21)	$t(58)=0.81$ p=0.422
EDEQ Concerns	3.05 (1.13)	2.53 (1.21)	2.79 (1.29)	$t(58)=1.58$ p=0.120
EDEQ Shape	3.92 (1.39)	3.75 (1.37)	3.84 (1.37)	$t(58)=0.47$ p=0.643
EDEQ-Weight	3.65 (1.58)	3.39 (1.31)	3.52 (1.44)	$t(58)=0.71$ p=0.479
Baseline Hunger	49.10 (26.89)	58.40 (29.50)	53.75 (28.34)	$t(58)=-1.28$ p=0.207

Note. BDI-II=Beck Depression Inventory II, BED=Binge Eating Disorder; BMI= Body Mass Index; BN=Bulimia Nervosa, EDE-Q=Eating Disorder Examination Questionnaire; FSCRS=Forms of Self-Criticising/Attacking and Self-Reassuring Scale; OBE=Objective Binge Episodes; SD=standard deviation *=Fisher's exact statistic

Table 1: *Characteristics of sample and baseline comparisons between self-compassion and self-critical rumination groups*

As can be seen from Figure 2, participants in the compassion condition reported greater active and positive mood states across all three time points. Post hoc tests revealed a significant deterioration in active (panel a) and positive affect (panel d) from T1 to T2 (p values <0.001, d values ≥0.69) to a similar degree in both conditions, suggesting that the negative mood induction procedure was effective in reducing positive and active affect. There was no significant change in active (panel a) or positive affect (panel d) between T2 and T3 for either group (p values ≥ 0.7), suggesting that neither the rumination nor compassion condition were associated with a change in active or positive affect.

Similarly, post hoc tests revealed a significant deterioration in relaxed (panel b) and safe affect (panel c) from T1 and T2 for both groups (p values <0.001, *d* values >0.60) again consistent with an effective negative mood induction (Figure 2). However, a twofold larger increase in relaxed and safe affect from T2 to T3 occurred in the compassion group (relaxed affect: p<0.001, *d*=1.31; safe affect p<0.001, *d*=0.88) relative to the self-critical rumination group (relaxed affect:

p=0.05, *d*=0.67; safe affect p=0.06, *d*=0.41). This suggests that the compassion induction was associated with a greater increase in relaxed and safe affect than the rumination induction.
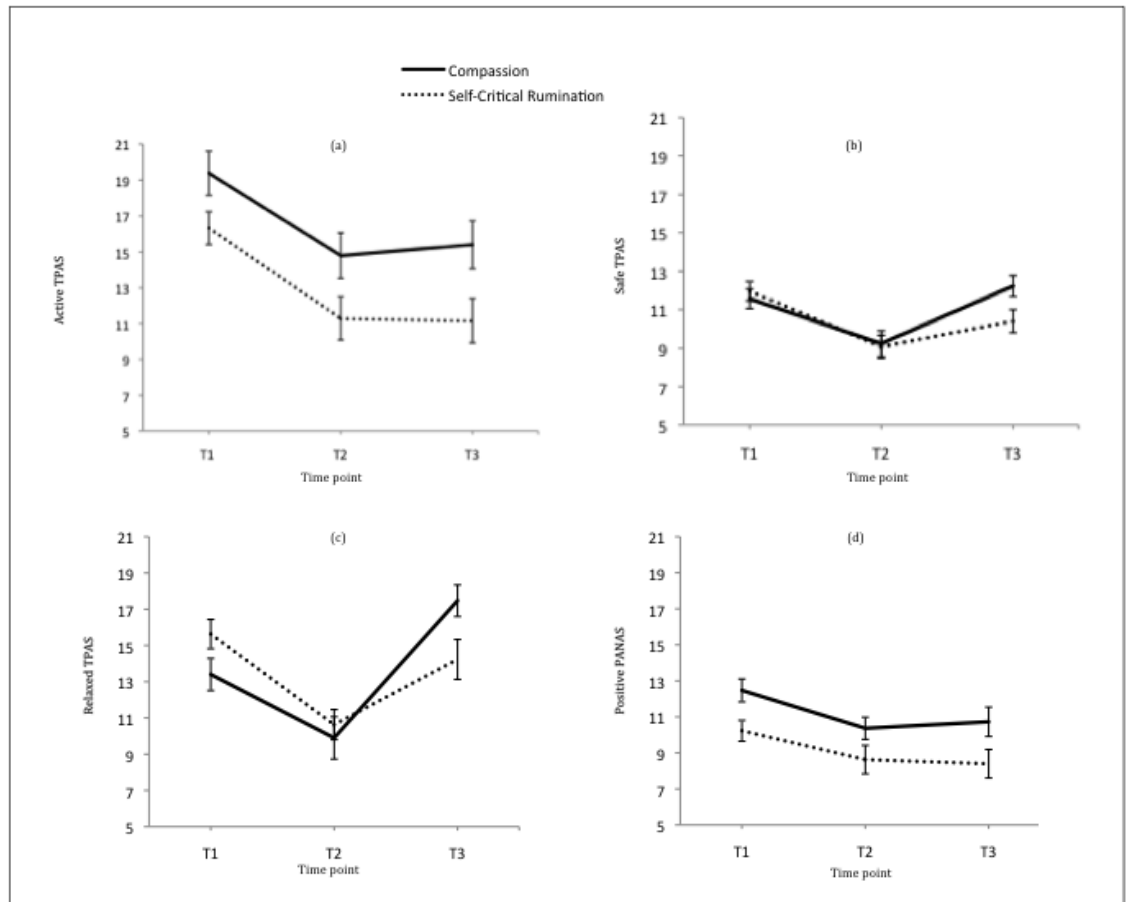

Figure 2: Mean ± SEM positive affect scores at three within-session time points (baseline (T1), post negative mood induction (T2) & post response strategy (T3)). (a) Active affect, (b) Safe affect, (c) Relaxed affect and (d) Positive affect.

Negative affect: There was a main effect of Time (F(2,116)=19.57, p<0.001, η_p^2=0.18) and a Time x Strategy interaction F(2,116)=3.53, p=0.032, η_p^2=0.057) on the negative affect subscale of the PANAS (Figure 3). This interaction reflected a similar significant increase in negative affect from T1 to T2 for both groups (p values ≤ 0.009, *d* values ≥ 0.634) and a larger reduction in negative affect from T2 to T3 for the compassion group (p<0.001, *d*=0.88) relative to the self-critical rumination group (p=0.59, *d*=0.24).
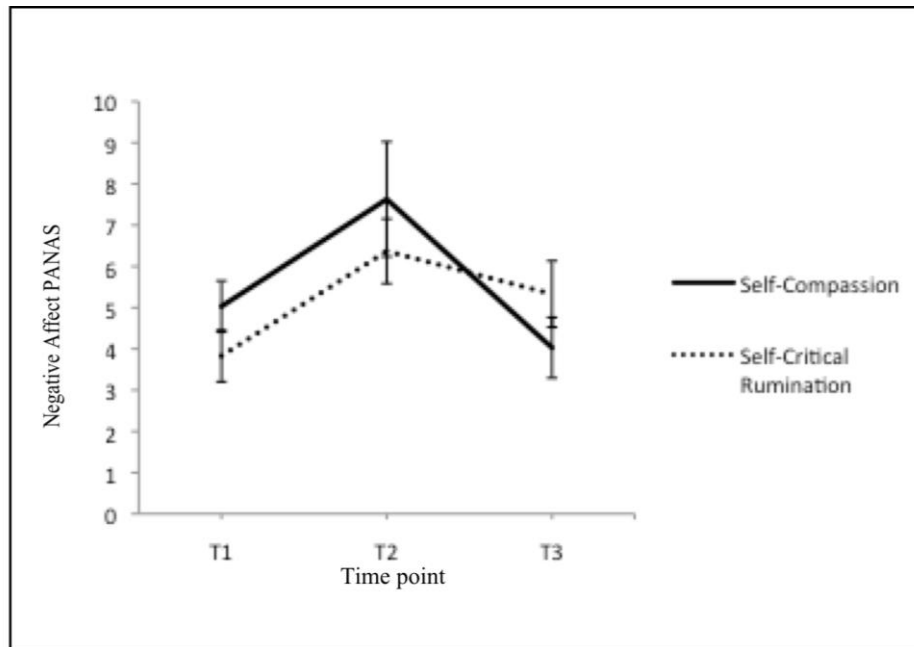
Figure 3: Mean ± SEM negative affect scores (PANAS) at three within-session time points. Baseline (T1), post negative mood induction (T2), post response strategy (T3).

State self-criticism and self-compassion: There was also a main effect of Time ($F(2,116)=21.43$ p<0.001, $\eta_p^2=0.27$) and a Time x Response Strategy interaction $F(2,116)=6.36$, p=0.032, $\eta_p^2=0.10$) for the self-compassion scale of the SCCS. As can be seen in Figure 4, this interaction reflects a similar decrease in self-compassion from T1 to T2 for both groups (p values ≤ 0.015, *d* values > 0.21) and a significant increase in self-compassion from T2 to T3 for the compassion group (p<0.001, d=0.34) relative to the self-critical rumination group (p=0.052, *d*=0.22). This shows that the manipulations were effective in increasing self compassion for the self compassion group but not the self critical rumination group.

There was also a main effect of Time ($F(2,116)=42.95$, p<0.001, $\eta_p^2=0.43$) and a Time x Response Strategy interaction $F(2,116)=13.16$, p<0.001, $\eta_p^2=0.19$) on the self-criticism scale of the SCCS. As can be seen in Figure 6, this interaction reflects no difference in self-criticism from T1 to T2 for both groups (p values = 1, *d* values ≤0.007) but a three times larger reduction in

self-criticism from T2 to T3 for the compassion group (*d*=0.89, p<0.001) relative to the self-critical rumination group (*d*=0.29, p=0.018).
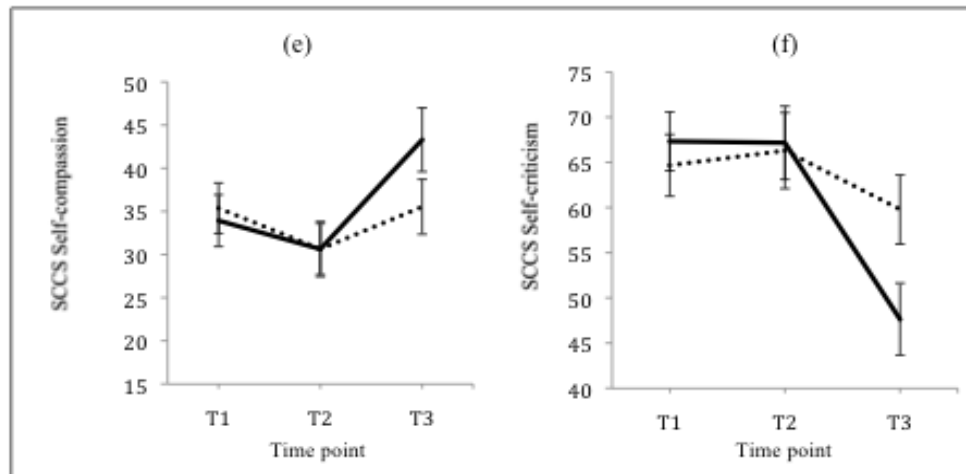

Figure 4: Mean ± SEM self-compassion (e) and self-criticism scores (f) at three within-session time points. Baseline (T1), post negative mood induction (T2) & post response strategy (T3).

Heart Rate Variability. Sympathetic and parasympathetic balance was indirectly indexed using the ratio of LF to HF HRV. The LF:HF ratio showed a main effect of Time (F(2,112)=10.54, p<0.001, η_p^2=0.16). Post hoc tests showed that this was due to a significant increase in sympathetic relative to parasympathetic responding from T1 to T2 (p<0.01) and no significant change from T2 to T3 (p=0.38) for both groups There was no main effect of Response Strategy.

Effects of Mood and Response Strategy on Desire to Eat

No main effects of Time or Response Strategy or significant interactions were found for desire to eat.
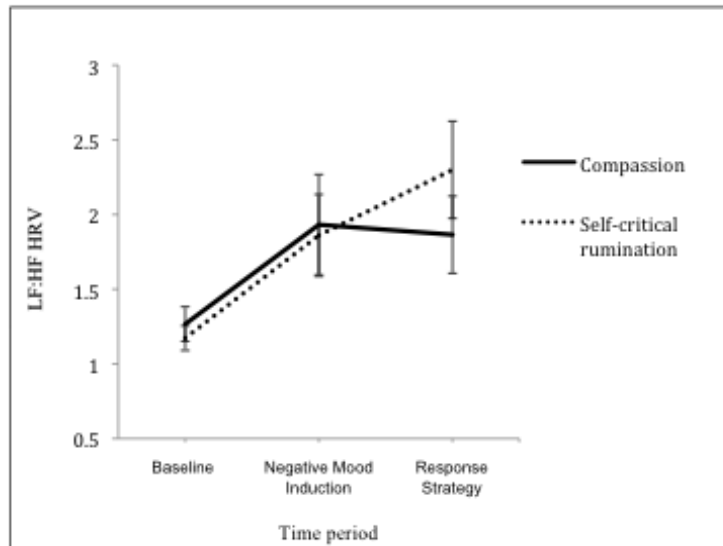
Figure 5: Mean ± SEM low frequency to high frequency HRV ratio
during three within-session time periods.

Effects of Response Strategy on Cue-Reactivity and Food Intake

Cue-triggered "Wanting" and "Liking" of food and HRV: There were no significant differences between strategy groups on measures of food wanting, anticipated pleasantness or HRV after food exposure to food cues and prior to food tasting. Seven participants refused to perform the taste test (four from the compassion group and three from the rumination group)[1]. Analysis was therefore based only on participants who completed this task. This showed that participants in the self-critical rumination condition rated the food they ate as significantly more pleasant in taste (M=70.25, SD=17.13) than participants in the compassion condition (M=56.15, SD=18.49), (*t*(51)=2.880, p=0.006, *d*=0.81).

After the taste test, participants in the self-critical rumination condition rated their wanting of the food significantly higher (M=58.14, SD 24.41) than those in the compassion condition (M=40.18, SD=18.63), (*t*(51)=2.15, p=0.036, *d*=0.56).

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[1] Reasons cited for food refusal were similar in both conditions and included fear of triggering a binge eating episode and allergies.

Ad Libitum Food intake

Participants in the self-compassion condition consumed significantly fewer calories (M=161.74, SD=114.38) than the self-critical rumination group (M=305.92, SD=155.00), *t*(46.49)=-3.86, p<0.001, *d*=1.27 (See Figure 6).
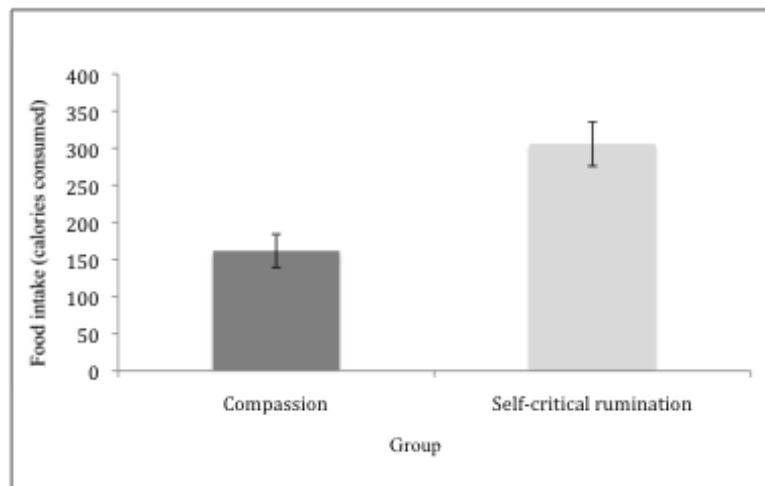

Figure 6: Mean ± SEM of calories consumed in each condition

DISCUSSION

The aim of the current study was to examine the effects of self-compassion and self-critical rumination, following a negative mood induction, on food cue reactivity, affect and food consumption, in women with BED and BN. Our findings add to the body of literature showing that self-affiliative attitudes can in fact improve self-regulation of behaviours. Specifically, we found that participants in the self-compassion condition rated the food they consumed as part of the experimental 'taste test' as less pleasurable (reduced 'liking'), consumed significantly fewer calories and reported less desire to continue eating (less 'wanting' of food), compared to the self-critical rumination group. Although the self-compassion response strategy resulted in greater recovery in positive and negative affect and levels of state self-compassion and self-criticism,

this did not appear to lead to differences in self-reported cravings or in HRV response to food prior to the taste test.

The finding that increased negative mood did not lead to increased cravings to eat prior to tasting the food is inconsistent with previous research. Previous studies have reliably found that the induction of negative mood, among individuals with BED and BN, leads to increased self-reported cravings to eat (Svaldi, Caffier, & Tuschen-Caffier, 2010; Waters, Hill, & Waller, 2001), increased heart rate in response to food cues (Laberg, Wilson et al. 1991, Waters, Hill et al. 2001) and greater activity in the brain regions subserving the rewarding value of appetitive stimuli (Wagner, Boswell et al. 2012).

Differences in self-reported cravings were found, however, *after* participants had tasted the food. The finding that the self-compassion strategy reduced food cravings after eating and total food consumption, replicates Adam and Leary's (2007) findings, which showed that promoting self-compassionate attitudes toward eating among restrictive and guilty eaters reduced disinhibited eating. In addition, the current study adds to the findings as it suggests that relating to oneself with compassion in the face of failure and distress in general, can improve self-regulation in individuals who are prone to lose control of their eating.

Self-regulation, particularly with regards to eating, is often derailed by negative affect (Heatherton & Baumeister, 1991). Therefore adaptive management of negative affect is likely to result in improved self-regulation of behaviours. The findings from the current study support this. Specifically, we showed that the self-compassion strategy resulted in greater recovery in negative and positive affect, as well as state self-compassion and self-criticism. Thus self-compassion may help people who binge eat maintain control over eating behaviour through the regulation of negative affect. Our study was not adequately powered to investigate this possibility using mediation analysis, although this would be an interesting next step.

The finding that self-compassion reduced the ratings of pleasantness of food in comparison to the self-criticism strategy is novel, and has implications for understanding the mechanisms through which self-compassion can help people regulate their eating behaviour. It suggests that the experience of self-compassion and improved affect may reduce the relative rewarding hedonic value of food and therefore cravings to continue eating. Further research is clearly needed to determine whether these findings are robust and whether they translate into reduced bingeing following this kind of self-compassion intervention.

Despite our promising findings, we must acknowledge some limitations that limit the generalisability of the current findings. Firstly, to control for gender differences in self-reported cravings, the sample consisted of females only (Cepeda-Benito, Fernández-Santaella et al. 2003). Whether these findings apply to men who binge eat remains to be determined. Binge eaters are more likely to be female (ratio 2.4:1 for BED, 3.6:1 for BN (Kessler, Berglund et al. 2013)), however, so our findings do have widespread applicability. In addition, the majority were students and were relatively young (Mean=26 years old). Binge eating difficulties are particularly prevalent in this population, with studies finding up to 44% of female students report binge eating symptoms, while between 6-8% meet criteria for BED or BN (Saules, S Collings et al. 2009, Napolitano and Himes 2011). However, many people develop BED in midlife, and a significant proportion are male. In addition, the participants in the current study were normal weight or overweight rather than obese. Although most women with BN are normal weight, the majority of individuals meeting criteria for BED are obese (Bruce and Agras 1992). Overall, therefore, the sample used in this study may not be representative of the range of people who suffer with BED and BN.

It is also likely that the experimental context influenced the amount eaten. Binge eating typically occurs in isolation because of the shame associated with the behaviour (American Psychiatric Association, 2013). Therefore it is likely that participants regulated their food intake

to some extent in accordance with social desirability. Indeed, during the debrief, a number of participants in the critical rumination condition stated that they would have eaten everything available (and more) if they had completed the experiment in the privacy of their own home. Furthermore, although the experimental procedure was designed so that participants were unaware that the researcher was interested in how much food they consumed, it is possible that they guessed this and regulated their behaviour in accordance with expectations. This could have been checked by asking participants to guess the true intention of the experiment. In addition, future studies should aim to reduce social desirability effects by using ecologically valid approaches such as ambulatory assessment.

The entire experiment was conducted in a single session, with no follow up. It is possible that more pronounced effects on binge eating might have emerged with out-of-session practice of the allocated strategy. For example, we have recently shown that pronounced behavioural effects of a related strategy (mindfulness) only emerged after a one week period, when participants (heavy drinkers) had been given the opportunity to further develop their self-regulation skills (Kamboj et al, 2017). Future studies should also consider the additional control groups. For example, using a sample of non-binge eaters would allow the specificity (to BED and BN) of the effects to be determined. In addition, use of a no-task comparison condition would allow enable conclusions about the harmfulness of self-criticism to be assessed.

In summary, self-compassion after a negative mood induction was associated with improved mood, a reduction in the rewarding hedonic value of food, reduced wanting to continue to eat and reduced food consumption. This suggests that facilitating emotion regulation through the cultivation of self-compassion could help individuals with BED and BN self-regulate their eating behaviour. Further studies should explore whether this effect also occurs in men, and in people whose weight is within the obese range, with and without BED. The results of these studies could help inform weight management treatments, as well as treatments for eating

disorders for a wider population. Compassion focused therapy appears to have efficacy for individuals with eating disorders (Goss et al, 2010). The current research is consistent with this approach, in that increasing self-compassion appears to lead to a reduction in cognitions and behaviours associated with binge eating. In contrast, Integrative Cognitive Affective Therapy ICAT; Wonderlich, Peterson, Smith, Klein, Mitchell, & Crow, 2015) directly implicates self-criticism as a maintenance mechanism for binge eating. Our study is not entirely consistent with the theory of ICAT, given that we found that increasing self-criticism did not increase cravings prior to the taste test.

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