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1 **A Systematic Review of the Association between Emotions and Eating Behaviour in**
2 **Normal and Overweight Adult Populations**

3 **Abstract**

4 A systematic review was completed according to Preferred Reporting Items for
5 Systematic Reviews and Meta-Analyses (PRISMA) guidelines. A comprehensive search of
6 four electronic databases (2004-2015) yielded 60017 articles, of which 29 met inclusion
7 criteria. Included studies performed poorly on data quality analysis in terms of randomization
8 and controlling for confounding factors. Participant's BMI scores range from 19.73 (SD = 1.54)
9 to 28.4 (SD = 1.4) kg/m². Where positive and negative affect were compared, food was more
10 likely to be consumed in response to positive affect. With regards to discrete emotions; stress,
11 depression, and sadness consistently elicited eating behaviours that fall outside of nutritional
12 recommendations (e.g., increased food intake, poor nutritional food choices). The role of
13 moderators including individual differences in dietary restraint and emotional eating, as well
14 as methodological considerations, such as means of eliciting and measuring emotions, may
15 account for equivocality with regards to some emotion and eating associations. The paper
16 concludes with recommendations for future research and implications for practice.

17
18 *Keywords:* emotional eating, self-regulation, restrained eating, eating behaviour, emotions

1 It is widely accepted that emotions can bring about changes in eating behaviour (Greeno and
2 Wing, 1994). Negative emotions and indeed stress are said to produce physiological
3 sensations resembling satiety; where we would naturally expect to see decreases in appetite
4 and food intake (Wing et al., 1990). Emotional eating is a term used to describe *increased*
5 eating in response to negative emotions, whereby emotions are said to be regulated by food
6 intake (Christensen, 1993; Macht, 2008). Emotionally elicited eating is of interest to
7 researchers and practitioners as it has been associated with a failure to maintain weight
8 management goals in overweight and obese individuals (Elfhag and Rössner, 2005). In a
9 systematic review of emotions and eating behaviour (Nicholls, Devonport, and Blake, 2016),
10 negative mood, sadness, tension and instability of emotions were found to be antecedents of
11 binge eating in an adult BED-Obese sample. In order to build on this synthesis of existing
12 literature, there is utility in understanding emotion and eating associations in non-clinical
13 normal and overweigh adult populations. A systematic review of emotions and eating
14 behaviour undertaken with these populations may provide knowledge on variables implicated
15 in increasing vulnerability towards becoming obese. This may inform early community-based
16 interventions intended as obesity prevention or awareness raising measures (Carter and
17 Jansen, 2012).

18 Negative emotions have arguably received the most attention in eating related
19 research, yet less is known about the roles of discrete emotions (with the exception of
20 depression and stress), and so it is unclear whether they elicit varying effects on eating
21 behaviour (Nicholls, Devonport, and Blake, 2016). For example, emotions such as anxiety
22 and depression may interfere with one's motives or desires for eating (Macht and Simons,
23 2000; Rousset et al., 2008). Although there is little research on positive emotions and eating
24 behaviour (Tchanturia et al., 2015), it is plausible that eating in response to a positive
25 emotion state diverts attention to the cause of the positive emotion, disrupting the conscious

1 restriction of food intake (Jansen and van den Hout, 1991). Increased eating in response to
2 emotions may be of particular interest when we consider its potential to undermine weight
3 loss and weight maintenance efforts.

4 The purpose of this paper was to offer a comprehensive review of the reported
5 associations between emotions and eating behaviour in normal and overweight adults. The
6 aims were to review the associations between discrete emotions and eating behaviours,
7 identify variables that modify these associations, and offer a critique of the extant literature.

8 METHOD

9 To ensure methodological rigour we adhered to the standard methodology for
10 systematic reviewing (Higgins and Green, 2008). The aims, inclusion criteria, data extraction,
11 and data quality evaluation were specified at the outset to ensure objectivity and replicability.
12 The review was registered on PROSPERO (CRD42014013138).

13 Searches

14 A systematic search of electronic databases was undertaken, identifying literature
15 published over a period between July 2004 and September 2015. The rationale being that a
16 systematic review conducted in 2004 (National Institute of Clinical Excellence (NICE),
17 2004) concluded there was insufficient knowledge on the nature of atypical eating to inform
18 interventions. In addition, there has been a marked increase in severe obesity from 2004-2014
19 (Public Health England (PHE), 2015), therefore understanding atypical eating behaviours
20 which may contribute to obesity is critical.

21 Where databases allowed (Medline), the search was delimited to ‘human only’
22 studies, and all searches were restricted to studies presented in the English language. No
23 other restrictions were applied. PsychINFO, Medline, the Cumulative Index to Nursing and
24 Allied Health Literature (CINAHL), and SportDiscus were searched using terms related to
25 emotions, consumption of food, and regulation (see appendix A for example search). In

1 addition, the knowledge update from the National Obesity Observatory was hand-searched
2 for the last ten years for relevant papers.

3 Since it was of key importance that the present review captures the full range of
4 emotions represented in existing literature, the search terms for emotion were derived from
5 four measures of emotion (Crawford and Henry, 2004, Hanin, 2000, McNair et al.,1981;
6 Terry et al., 2003).

7 Inclusion Assessment

8 Citations were managed using Endnote. The search yielded 60017 references (see
9 Figure 1). After deduplication, 49646 titles were independently screened by two reviewers.
10 Where there was disagreement, the full text manuscript was consulted by both reviewers to
11 reach agreement. For a paper to be included, there had to be consensus that the following
12 criteria were met:

- 13 (a) Empirical research (e.g., not case studies, letters and commentaries);
- 14 (b) Published in a peer reviewed journal;
- 15 (c) Measured, assessed (quantitative), or discussed (qualitative) emotion or emotional eating;
- 16 (d) Measured, assessed (quantitative), or discussed (qualitative) eating or eating behaviour;
- 17 (e) Positioned emotions as a causal factor in contributing to eating behaviour (i.e., papers
18 describing emotions occurring as a *result* of eating were excluded);
- 19 (f) Participant's Reported mean BMI falls within 20-30kg/m², and as normal weight range is
20 reported to be within 18–25kg/m² (Royal and Kurtz, 2010), reported SD must indicate a
21 range of BMI from 18 kg/m² not exceeding 31kg/m²;
- 22 (g) Adult population.

23 243 papers were screened for full inclusion. Of these 214 papers were excluded. The
24 papers excluded at full screen were; 53 which did not report on an association of interest, 36
25 where data were collapsed across groups and no analyses of relevance could be extracted, 35

1 which did not report BMI and so inclusion assessment could not be completed, 40 papers
2 where participants did not meet BMI inclusion criteria, 9 papers with no measure of emotion,
3 19 where participants were classified as having binge eating disorder, anorexia or bulimia
4 nervosa, or demonstrated purging behaviour, 5 narrative reviews, 4 unpublished theses, 4
5 focussed on child populations, 3 which were not subject to peer review, 3 with no measure of
6 eating or eating behaviour, 1 animal study, 1 case study, and 1 addendum to an included
7 paper.

8 Data Extraction

9 Data extraction parameters were established in line with research questions and
10 managed using Excel. Data extraction headings facilitated the capture of pertinent
11 information including details concerning samples, measures, participant reported outcomes
12 concerning emotions and eating behaviour, research limitations and implications for practice.

13 Data Quality

14 Quality of included papers was assessed by all authors using the standard quality
15 assessment for evaluating primary research papers (Kmet et al., 2004). Inter-rater agreement
16 was assessed for a subset and was within an acceptable range ($n = 5$, range $\kappa = .774 - .900$).
17 Studies were evaluated based on 20 criteria spanning design, sampling, methodology,
18 analysis, results and conclusions. For each criterion, papers scored either 2 (good), 1 (partial
19 fulfilment), 0 (not fulfilled), or X (not relevant) (possible score range 0-2). A mean score was
20 calculated for each paper to give an overall rating of quality. In addition, a mean score for
21 each of the sub-criteria was used to indicate the relative strengths and limitations across all 29
22 included studies.

RESULTS

Characteristics of the Included Studies

Of the 29 included studies (Table 1), two studies were mixed methods, 26 utilized quantitative methods, and one used qualitative methods. The included studies were largely of Western origin including USA ($n = 11$), UK ($n = 2$), Netherlands ($n = 8$), Germany ($n = 5$), Greece ($n = 1$), Taiwan ($n = 1$) and China ($n = 1$). Participant's BMI scores range from 19.73 (SD = 1.54) to 28.4 (SD = 1.4) kg/m². The mean age ranged from 18.6 (SD = 0.1) to 33.6 (SD = 9.4) years, with percentage of females ranging from 50% to 100%.

[Insert Table 1 about here]

Data Quality

The possible range of scores on the quality assessment was 0-2, with a higher score indicating better quality (Kmet et al., 2004). The mean scores (SD) for individual studies are presented in Table 1. The mean score for data quality was 1.68 (SD = 0.16). The range was 1.14 (SD = 0.66) (Macht et al., 2005) – 1.93 (SD = 0.26) (Wallis and Hetherington, 2004). Six studies scored more than one standard deviation below the sample mean (Crockett et al., 2015; Evers et al., 2009; Hilbert et al., 2011; Macht et al., 2005; Royal and Kurtz, 2010; Sproesser et al., 2011). Consequently, whilst these studies are included and contribute toward a useful critique of existing literature, their findings should be interpreted with caution.

The mean scores (SD) for individual indicators of quality across all quantitative studies are presented in Table 2 ($n = 28$). Studies overall performed well on having a follow up (applies to 6 studies), describing the trial and describing those lost to follow up, specifying a clear hypothesis and design, and use of suitable and validated predictor and outcome measures. Studies using a manipulation did not perform well on randomization. Studies also

1 performed poorly on controlling for confounding factors and describing samples, with many
2 papers lacking detail on the ethnicity of participants.

3 [Insert Table 2 about here]

4 Narrative Synthesis of Findings

5 To facilitate interpretation of data, findings will be organised and presented by study
6 design. A number of eating behaviours are evaluated in included studies, including binge
7 eating, emotional eating, amount of food consumed (measured), and amount of food
8 consumed (reported). This is important to note, as discrepancy in the *type* of eating behaviour
9 investigated may influence findings.

10 *Qualitative*

11 One qualitative paper (Bennett et al., 2013) examined triggers for emotionally elicited
12 eating behaviour over a three-day period using a food journal and in-depth interviews ($n =$
13 16). Young individuals were purposively selected who scored highly on emotional eating.
14 Females spoke of university stress increasing food consumption, whilst males stated that
15 stress was more likely to decrease consumption. The primary trigger for eating in females
16 was stress, frequently followed by guilt, whilst males identified boredom or anxiety. Coping
17 with stress through eating was identified as a significant barrier to healthy eating across
18 genders.

19 *Non-experimental Associations between Emotions and Eating*

20 Two studies found emotional eating to be significantly correlated with self-reported
21 overeating (Macht and Mueller, 2007; Van Strien et al., 2009). That is, individuals reporting
22 eating in response to negative emotions, also reported overeating. When exploring
23 associations between *specific* emotions and eating among female Greek students, 36.7%
24 reported that stress had no effect on their eating behaviour, 35% reported eating more in
25 response to stress, and 28.3% reported that they normally eat less than usual during stress

1 (Costerelli and Patsai, 2012). Among Chinese students, Zhu, Cai, and Chen (2013) reported a
2 higher score for eating in response to positive emotions when compared to depression,
3 anxiety and anger. Furthermore, sex differences emerged in that females were more likely to
4 eat in response to depression and anxiety than were males. In a further study, difficulties with
5 emotion regulation were associated with more emotional eating behaviour in response to
6 boredom and 'other' emotions (summed subscales for depression, anxiety, and anger)
7 (Crockett et al., 2015). Binge-eating behaviour was associated with aggression and
8 depression in a healthy sample (Slane et al., 2010), and with depression among a sample of
9 female undergraduate students (Kelly et al., 2014).

10 Regarding food choice, highly palatable foods such as chocolate, followed by crisps
11 and ice cream were preferred during stressful times (Costerelli and Patsai, 2012). Emotional
12 eaters reported more intense chocolate cravings, higher chocolate consumption, and less
13 chocolate related guilt than restrained eaters (Macht and Mueller, 2007). When individuals
14 were motivated to choose foods to regulate negative affect, this was associated with a less
15 healthy dietary pattern, compared with being motivated to choose food for weight loss
16 (Sproesser et al., 2011).

17 When exploring associations between emotions and eating, some authors performed
18 subgroup comparisons. For example, Tomiyama, Dallman, and Epel (2011) used perceived
19 stress scores to classify healthy premenopausal women into extreme quartiles of low versus
20 high stress groups. Greater emotional eating was reported in women high in chronic stress
21 when compared to women low in chronic stress. In a secondary analysis undertaken by Zhu
22 et al. (2013), Chinese students were categorised into three groups according to whether they
23 ate in response to positive emotion, negative emotion, or were normal eaters. Those who ate
24 in response to negative emotions reported experiencing more anxiety, depression, and
25 hostility than those who ate in response to positive emotions and normal eaters. In addition,

1 those classified as ‘positive emotional eaters’ reported experiencing more anxiety and
2 hostility than did normal eaters.

3 *Experimentally induced emotions and eating behaviour*

4 Studies commonly induced emotion experimentally utilising idiosyncratically relevant
5 emotion situations generated from participant’s memory. Where a recall technique was used
6 to compare the effect of positive and negative emotion induction on food consumption, both
7 ate more than the control condition, but there was no difference between groups (Evers et al.,
8 2013). Schneider et al. (2010) asked lean participants to complete three counterbalanced
9 experimental sessions involving different mood inductions (neutral, anxiety, anger). Similar
10 to the previous findings, no significant difference in subsequent food intake was observed
11 between experimental groups. However, other studies have found an influence.

12 Hilbert et al. (2011) induced stress with findings indicating a corresponding rise in
13 desire to binge from baseline to post emotion-induction. Chao, Yang, and Chiou (2012)
14 assigned participants to one of three induction study conditions (shame, guilt, or neutral).
15 Shamed participants ate more nougat than participants in the neutral and guilt conditions,
16 with no difference between guilt and neutral conditions. Notably, Chao et al. (2012) excluded
17 restrained eaters, a factor that has shown to influence the emotion and eating relationship
18 (Greeno and Wing, 1994).

19 Other methods were used to induce emotions. Using films, Evers et al. (2013) found
20 those in the positive emotion condition consumed more than participants in negative or
21 neutral conditions. Where stress was induced using the Trier Social Stress Test (TSST; Van
22 Strien et al., 2013a), mean food intake did not significantly differ from that in the control
23 condition. In response to stress induced following a maths test, participants with high visceral
24 adiposity showed a higher mean food ‘wanting’, ‘wanting’ for dessert and snacks, and their
25 energy intake, carbohydrate and fat intake were higher in the absence of hunger in the stress

1 versus rest condition, whereas this effect was not found for normal weight participants
2 (Lemmens et al., 2011).

3 *Psychometrically Determined Subgroups*

4 An alternative methodological approach was to compare the effect of an experimental
5 condition between psychometrically determined subgroups. Evers et al. (2009) induced
6 negative and positive affect in a group of female students. Those in the positive emotion
7 conditions consumed more food following emotion induction than participants in negative or
8 neutral conditions. However, on further analysis, self-reported emotional eaters did not eat
9 more than non-emotional eaters in any of the experiments. In addition, the amount of food
10 consumed when feeling negative did not predict self-reported emotional eating. Similarly,
11 Royal and Kurtz (2010) found no effect of emotional eating on the food consumption of
12 female undergraduate students after low-stress (solving easy anagrams) or high-stress
13 (working on unsolvable anagrams) conditions.

14 In a series of studies, Van Strien and colleagues examined whether it was possible to
15 predict distress-induced eating when categorizing individuals as a high or low emotional
16 eaters. Van Strien et al. (2012) found that low emotional eaters ate less during a sad movie
17 than during a neutral movie, whereas high emotional eaters ate more. In a follow up study
18 (Van Strien et al., 2013b), low emotional eaters ate similar amounts after sad and joy mood
19 conditions (elicited with movie clips); whilst high emotional eaters ate significantly more
20 after the sad mood condition than after the joy mood condition. Van Strien et al. (2013a)
21 measured difference in actual food intake after a control condition or the TSST. High
22 emotional eaters with a blunted cortisol stress response ate more food after distress than those
23 with an elevated cortisol stress response, whilst low emotional eaters showed no such
24 relationship. These findings were later replicated (Van Strien et al., 2014) as low emotional
25 eaters ate less after distress than after control conditions, and high emotional eaters ate more.

1 Collectively, this research highlights the importance of subgroup analysis in exploring
2 emotional eating in experimental settings.

3 Tryon, DeCant, and Laugero (2013) categorized women as high chronic stress or low
4 chronic stress based on Wheaton Chronic Stress Inventory scores (Wheaton, 1994), and
5 saliva samples were used to determine stress-induced cortisol reactivity. Low and high acute
6 stress groups were established by taking a median-split. Participants completed both a control
7 task and the TSST, with each visit occurring one month apart. At 60-minutes post stress and
8 control session, women reporting higher chronic stress and exhibiting low cortisol reactivity
9 to the acute stress task consumed significantly more calories from chocolate cake on both
10 stress and control visits. High stress cortisol reactors did not show differences in chocolate
11 cake consumption. In other words, trait as opposed to state stress appeared to influence food
12 intake.

13 Research exploring the effects of dietary restraint on the association between emotion
14 and eating produced inconsistent findings. Macht and Mueller (2007) found that healthy
15 participants who scored highly on both emotional eating and restrained eating showed highest
16 levels of negative affect. Evers et al. (2013) found the association between positive emotions
17 and food consumption was not moderated by dietary restraint. Similarly, Royal and Kurtz
18 (2010) found participants in a high stress condition ate significantly more than participants in
19 the low stress condition regardless of their dietary restraint.

20 The interaction between restrained eating and stress on food choice was explored in
21 four studies. Shapiro and Anderson (2005) classified participants as restrained or non-
22 restrained using a median split, and then randomly assigned them to either a stress
23 (unsolvable anagrams) or no-stress (finding letters in a passage of text) condition. Both
24 groups participated in a taste test using several classes of foods (high fat/high sugar; low
25 fat/high sugar; high fat/low sugar; low fat/low sugar). Restrained eaters did not consume

1 more total calories under stress, when compared to those not under stress. However, there
2 was a trend in food choice; restrained eaters under stress consumed more high fat-low sugar
3 snacks than restrained eaters who were not under stress. Similar findings emerged in a later
4 study by Habhab, Sheldon, and Loeb (2009), who explored the food types that female
5 students consumed in response to stress induction using Sudoku puzzles; comparing foods
6 that varied in fat, sugar, and salt. In support of Shapiro and Anderson (2005), more high-fat
7 food was eaten by those in the high restraint group when compared to low restraint,
8 regardless of stress condition. Wallis and Hetherington (2004) found that under stress
9 conditions more chocolate was consumed. High restraint, low emotional eating participants
10 consumed more chocolate under stress conditions than low restraint, low emotional eating
11 participants. Conversely, Wallis and Hetherington (2009, study 2) found that restrained eaters
12 consumed significantly less after stress conditions than after the neutral conditions, but this
13 was associated only with intake of the low fat snack.

14 Sleep has also been explored as a potential mediator of the association between
15 emotions and eating. Dweck, Jenkins, and Nolan (2014 - experiment 2) examined whether
16 sleep duration interacted with stress and emotional eating to affect food consumption among
17 females. Participants were grouped into high and low emotional eaters, divided into short (<7
18 h/night) and normal (≥ 7 h/night) sleepers, and then provided with snacks under stressed
19 (required to solve Sudoku puzzles) and control conditions. Whilst there was no effect of
20 stress or sleep duration on the amount of cookies consumed in the group of low to moderate
21 emotional eaters, high emotional eaters ate more cookies in the stress condition, and short
22 sleep predicted higher cookie consumption among high emotional eaters in the control
23 condition.

24 *Naturally Occurring Emotions and Eating Behaviour*

25 Evers et al. (2013) used a 7-day diary to record snacking and emotions as they

1 occurred in the natural environment. Consistent with their lab-based findings (Evers et al.,
2 2009; Evers et al., 2013 studies 1 and 2), they found that participants reported eating in
3 response to positive emotions more frequently than negative emotions. Wallis and
4 Hetherington (2009, study 1) compared retrospective self-reported changes in snack intake
5 for emotional and non-emotional eaters during times of stress. Groups were based on a
6 median split of scores on the DEBQ (Van Strien et al., 1986). Female students self-reporting
7 as emotional eaters were more likely to report overeating in response to a specific stressor
8 than non-emotional eaters, and non-emotional eaters were more likely to report under-eating.
9 Three snack foods (crisps, chocolate, biscuits) were all more likely to be eaten in times of
10 stress with emotional-eaters reporting overeating biscuits and crisps to a larger extent than the
11 non-emotional eaters. All participants reported over-consumption of chocolate in times of
12 stress.

13 Two studies explored associations between emotions and eating during naturally
14 occurring stressful (exam/test) and control conditions. Costerelli and Patsai (2012) found that
15 among Greek female University students, emotional eating was significantly correlated with
16 stress in the exam period but not in the control period. Macht et al. (2005) found that stress
17 (exam) and control (no exam) group participants did not differ significantly in self-rated
18 emotions during baseline, but 3-4 days before the exam the stress group showed higher
19 ratings of tension, fear and emotional stress as well as lower ratings of happiness, relaxation
20 and positive mood; with a corresponding higher tendency to eat in order to distract from
21 stress.

22 *Emotions and Eating with Intervention*

23 One study trained participants to either suppress emotion, accept emotion, or re-
24 appraise emotion in response to a video clip to induce sadness (Svaldi et al., 2012). For
25 participants with high dietary restraint both the acceptance and suppression conditions

1 resulted in a higher desire to eat following the video clip, with no change for reappraisal.
2 There were no significant effects for participants with low restraint.

3 DISCUSSION

4 Consistently, participants ate more in response to general positive affect, when
5 compared with general negative affect (Evers et al., 2009; Evers et al., 2013; Zhu et al.,
6 2013). Van Strien et al. (2013b) explored associations between discrete emotions (Joy, Sad)
7 and eating, with high emotional eaters eating significantly more after the sad mood condition
8 than after the joy mood condition. Macht et al. (2005) found that before an exam, stress group
9 participants reported higher ratings of negative emotion (tension, fear, emotional stress) and
10 lower positive emotion (happiness, relaxation, positive mood); with a corresponding higher
11 tendency to eat in order to distract from stress. These findings highlight the importance of
12 capturing positive and negative emotions when examining associations with eating
13 behaviours (Tchanturia et al., 2015). Not only might positive emotion associate with eating as
14 indicated in the present review (Evers et al., 2009; Evers et al., 2013; Zhu et al., 2013), but as
15 also indicated, an absence of pleasant emotion when experiencing unpleasant emotion may be
16 influential (Macht et al., 2005). The finding that positive emotions can influence eating
17 (Bongers et al., 2013) makes intuitive sense when one considers the use of food as part of
18 social rituals (e.g., birthdays, weddings, religious events; Desmet and Schifferstein, 2008). It
19 follows that, whilst individuals may not necessarily be using food to regulate positive
20 emotion; positive emotions may trigger increased intake through associative learning.
21 Alternatively, a positive emotional state may divert attention to the origin of the positive
22 emotion, disrupting the conscious restriction of food intake (Jansen and van den Hout, 1991).

23 When exploring negative emotions and eating behaviour, stress was the most
24 commonly explored discrete emotion. Chronic stress (Tryon et al., 2013) and trait stress
25 (Tomiya et al., 2011) were both associated with higher food consumption, with people

1 eating more during stressful periods (Costerelli and Patsai, 2012; Macht et al., 2005; Royal
2 and Kurtz, 2010). However, depression and sadness were also reported to be antecedents of
3 eating behaviour (Van Strien et al., 2013b) and binge eating (Kelly et al., 2014; Slane et al.,
4 2010). Boredom proneness and emotional eating demonstrated strong positive correlations
5 (Crockett et al., 2015), and shamed individuals ate more in a taste test experiment with no
6 effect for guilt (Chao, et al., 2012). Aggression/anger was positively correlated with
7 emotional eating (Zhu et al., 2013) and with binge-eating behaviour in a healthy sample
8 (Slane et al., 2010).

9 Emotion was also found to affect the type of food consumed. Feeling stressed
10 influenced food choice towards more palatable and less healthy meals (Costerelli and Patsai,
11 2012; Wallis and Hetherington, 2004, 2009), whilst motivation to eat in order to regulate
12 negative affect was associated with an unhealthy dietary pattern (Sproesser et al., 2011). The
13 results suggest that negative emotions can elicit unhealthy eating behaviour, poor food
14 choices, with food being used to regulate stressful or negative emotions in normal and
15 overweight individuals. When one considers the demands of daily life, using unhealthy food
16 to regulate negative emotional states may well contribute to a steady increase in weight gain
17 over time.

18 Given the complexity of associations between emotions and eating, researchers have
19 begun to explore moderators in an attempt to better explain emotionally elicited eating
20 behaviour. As an illustrative example, research indicates that those who score highly on
21 emotional eating tend to eat more under stress (Van Strien et al., 2012; Van Strien et al.,
22 2013a; Van Strien et al., 2014), and sadness (Van Strien et al., 2012 - study 1) than those with
23 low scores for emotional eating. Further, this relationship appears to be exacerbated by
24 personal factors, such as when individuals high in emotional eating experience short sleep
25 (Dweck et al., 2014). In contrast to these findings, Royal and Kurtz (2010) found no effect of

1 emotional eating on food consumption under high stress conditions. However, it is worth
2 noting whilst Van Strien and colleagues identified individuals as high or low emotional eaters
3 using an inter-quartile range, Royal and Kurtz (2010) used a ‘median split’. Studies using a
4 median split to compare two groups (see also Hahab, 2009; Tryon et al., 2013; Wallis and
5 Hetherington, 2009 - study 1) have been criticised as this method may misclassify individuals
6 leading to a null result. Indeed, Van Strien et al. (2012) highlighted that their findings would
7 have been non-significant if a median split had been used.

8 Emotional eating may moderate the association between emotions and eating
9 behaviour through a negative maintenance cycle. Specifically, the weight change that
10 emotional eating may incur (Drapeau et al., 2003) can lead to negative psychological
11 outcomes, which in turn leads to higher levels of emotional eating (Van Strien et al., 2005).
12 Macht and Mueller (2007) called for longitudinal research to explore the causal order to
13 establish whether increased negative affect leads to eating, or whether eating predisposes
14 individuals to increased negative affect.

15 Whilst moderators of effect present one evidenced explanation for equivocality with
16 regards to emotions and eating behaviour, the range of methodological approaches utilized
17 present further plausible explanations. Self-report was commonly used; however, such
18 measures did not always correspond to behaviour. Self-identified emotional eaters did not eat
19 more than non-emotional eaters following experimental mood induction (Evers et al., 2009).
20 Furthermore, the amount of food consumed when feeling negative affect did not predict self-
21 reported emotional eating. This presents a significant limitation and questions how competent
22 people are in assessing their own emotional eating behaviour (Evers et al., 2009). Research
23 indicates that people may be biased towards under-reporting eating (Evers et al., 2009), and
24 may also under-estimate or over-estimate recalled emotions (Ready et al., 2007). For
25 emotional eating scales this potentially presents a triple recall bias as individuals are required

1 to recall their negative emotions, their food intake, and the association between both.
2 However, researchers have identified considerations that may increase the reliability of
3 retrospective self-report. Tanoffsky Kraff et al. (2007) recommended measuring emotional
4 eating in a domain specific way to improve the predictive potential of emotional eating
5 scores. The provision of specific exemplars of the target experience has been found to
6 produce a more valid assessment and enhance accuracy of recall of health behaviours in self-
7 report measures (e.g., Brauner-Otto et al., 2012). This has been applied to the measurement
8 of food craving (e.g., Nicholls and Hulbert-Williams, 2013), and may offer one method of
9 improving the concordance between self-reported emotional eating and eating behaviour.

10 The means of inducing emotion presents a methodological consideration for
11 experimental studies. Included experimental studies utilized a range of methods for stress
12 induction including the TSST (e.g., Van Strien et al., 2014), unsolvable anagrams (e.g., Royal
13 and Kurtz, 2010), idiosyncratic recall of a stress event (e.g., Schneider et al., 2010), and data
14 collection over exam periods (e.g., Costerelli and Patsai, 2012). Whilst all studies undertook
15 manipulation checks to establish stress was induced, the ecological validity of methods
16 approaches such as the TSST and unsolvable anagrams are questionable, and may be subject
17 to experimenter effects (Faith et al., 1998). Further, idiosyncratic recall techniques produced
18 inconsistent findings (Evers et al., 2013; Hilbert et al., 2011; Schneider et al., 2010), leading
19 to questions regarding the reliability of this method. Such approaches are unlikely to replicate
20 the intensity of felt emotions associated with meaningful, real-life, real-time events (e.g.,
21 exams, illness, job loss) (Berrios et al., 2015).

22 The need to measure actual eating behaviour in addition to measures of ‘desire to eat’,
23 ‘food wanting’ or ‘food liking’ was highlighted by Dweck et al. (2014). They found that
24 whilst there were no significant differences between hunger, desire to eat, and estimated
25 quantity of food that could be eaten between stress and control conditions, actual food

1 consumption did vary, with those in the stress condition, who were prone to emotional eating,
2 consuming more. Where actual food intake cannot be measured, food ‘wanting’ appears to be
3 a strong determinant of actual intake during induced stress (Lemmens et al., 2011). Thus
4 suggesting that ‘wanting’ in the absence of hunger, might be an important process in the
5 development of obesity.

6 Together, the lack of concordance between self-report and actual behaviour, and the
7 limited means of inducing emotions, point to the need for real time self-monitoring of
8 thoughts, emotions and behaviour, as offered by ecological momentary assessment
9 (Shiffman, 2009). As technology develops, this methodology is becoming more practical, and
10 offers an ecologically valid way of assessing emotion and eating behaviour as it occurs in
11 daily life (Polak et al., 2015).

12 When considering the implications of included studies for intervention development
13 and delivery, emotional eating may be a crucial target for interventions among those who use
14 food as a coping strategy (Wallis and Hetherington, 2009). It is suggested that such
15 individuals consider interventions such as: stress prevention or cognitive reappraisal of
16 stressful situations (Hilbert et al., 2011), developing adaptive coping strategies (Kelly et al.,
17 2014), consciously accessing healthier snack foods (Wallis and Hetherington, 2009),
18 repeating positive self-affirmations to enhance self-worth (Chao et al., 2012), or addressing
19 cognitive restraint via ‘enhanced’ cognitive behaviour therapy (CBT-E) (Fairburn et al.,
20 2009).

21 Individual differences highlighted within this review point to further considerations
22 for intervention development. For example, those with a higher dietary restraint score
23 experience more desire to eat when asked to accept or suppress emotions (Svaldi et al.,
24 2012). As such, illustrative advice that could be offered to individuals high in dietary restraint
25 is to minimise access to ‘temptation foods’ when experiencing stress (Wansink, 2004). Sleep

1 quality also warrants attention. A combination of sleep deprivation and proneness to
2 emotional eating was associated with increased food consumption (Dweck et al., 2014). Short
3 sleep is recognised to increase hunger and appetite, through the effect it has on leptin and
4 ghrelin (Spiegel et al., 2004), and sleep deprivation itself may act as an additional stressor (St
5 Onge and Schechter, 2014). Thus poor sleep has potential to undermine or ameliorate the
6 effects of any intervention. Conversely, it is possible that adopting a good sleep pattern
7 presents an intervention component that may amplify the effect of other interventions (Marks
8 and Landaira, 2015).

9 The present review highlights a research focus on negative emotions and eating
10 behaviours with an identified need to capture and differentiate between effects of discrete
11 positive and negative emotions to better understand associations between emotions and eating
12 behaviours (Tchanturia et al., 2015). The role of moderators and methodological
13 considerations in accounting for equivocality of research findings is illustrated. Moderators,
14 including dietary restraint and emotional eating, point to a need to take self-regulatory
15 behaviours into account when exploring emotion and eating associations (Sproesser et al.,
16 2011). Indeed, Sproesser et al. (2011) recommended that interventions should focus on the
17 general capacity for self-control as well as a capacity for body weight control. In accordance
18 with the strength model of self-control (Baumeister et al., 2007), continuously engaging in
19 self-regulatory acts (such as refraining from eating or regulating one's emotion states) is
20 effortful and depletes a limited resource (Muraven and Baumeister, 2000). Thus, emotions or
21 eating behaviours that require self-regulation could lead to resource depletion and a decrease
22 in ability to self-regulate at a later point (Vohs and Heatherton, 2000). Theories of self-
23 control hold promise in framing future investigations of emotion and eating behaviour
24 associations.

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