Do emotions predict eating?

The role of previous experiences in emotional eating in the lab and in daily life

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Abstract

Emotional eating (EE) is defined as an increase in eating following negative emotion. Self-reported emotional eating has been associated with physical health concerns. However, experimental and daily diary studies indicate that induced or naturally experienced negative emotions do not reliably lead to increased eating in healthy eaters, not even among self-professed emotional eaters. Recent literature demonstrates that emotional eating may be learned and may depend on associations people have made between specific emotions and eating. Accordingly, in this paper, we propose a set of studies with the overarching goal of determining whether accounting for the variation in people's associations between eating and different discrete emotions would lead to more consistent findings than has been found in the literature thus far. Specifically, in both Study 1 (N = 118) and 2 (N = 111), we asked people to report on their tendency to eat following two discrete emotions (sadness and anxiety) and determined whether and how much they ate when feeling sad or anxious in the lab (Study 1) or in their daily lives (Study 2). Hypotheses, methods, and analysis plans for both studies were preregistered on the Open Science Framework (OSF) platform. We found no support for our hypotheses in either study; self-professed sad- or anxious-eaters did not eat more when induced with these emotions in the lab, or when experiencing these emotions in their daily lives. We discuss why this may have been the case, specifically focusing on the importance of emotion frequency, intensity, timing, and social context.

Keywords: emotional eating, discrete emotions, sadness, anxiety

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Many of us have personally experienced how emotional states can affect our eating behavior and might recall times when we ate an entire box of cookies or a bag of chips after an upsetting day at work. We also see reflections of this repeatedly in various media, such as scenes in movies depicting a character eating large amounts of food when feeling sad, anxious, or angry. This increase in eating following negative emotion is called emotional eating (Macht, 2008)[1].

While emotional eating may result in short-term amelioration of negative mood (Finch & Tomiyana, 2014), it can also have long-term physical health implications. Higher self-reported emotional eating has been associated with higher current body mass index (Péneau, Ménard, Méjean, Bellisle, & Hercberg, 2013), long-term weight gain (Koenders & van Strien, 2011; Sung, Lee, & Song, 2009; Tatjana van Strien, Peter Herman, & Verheijden, 2012), long-term weight fluctuations (Keller & Siegrist, 2015), difficulties with weight loss (Blair, Lewis, & Booth, 1990), pre-diabetes and diabetes (Tsenkova, Boylan, & Ryff, 2013), and obesity (Konttinen, Haukkala, Sarlio-Lähteenkorva, Silventoinen, & Jousilahti, 2009).

These findings are important; however, they are correlational and rely on people's *perceptions* of their emotional eating, and therefore, may not reflect true increases in eating following negative emotion. There are two lines of research

[1] While recent research shows that emotional eating may occur following positive emotion as well (e.g. Bongers, Jansen, Havermans, et al., 2013), these studies are quite sparse when compared to studies focusing on negative emotion. For this reason, in this paper, we focus only on negative emotional eating.

that examine whether people in fact eat more when emotional: experimental, lab-based studies that induce emotion and measure subsequent food intake, and daily diary or experience sampling studies that measure daily variations in emotion and subsequent food intake. However, results have been inconsistent with both methodologies. Experimental studies indicate that negative mood inductions do not consistently lead to increased eating in healthy eaters (for meta-analyses, see Cardi, Leppanen, & Treasure, 2015; Evers, Dingemans, Junghans, & Boevé, 2018; for a systematic review, see Devonport, Nicholls, & Fullerton, 2017). Similarly, daily diary or experience sampling studies often fail to find a connection between negative emotions and eating in healthy adults (Bongers & Jansen, 2016). What might explain the counterintuitive observation that negative emotional eating happens by report but not by observation? One possibility is that there are moderators that obscure the effect.

One potential moderator of the effect of induced emotion on eating is the extent to which people report having the dispositional desire to eat when emotional. The studies that examine this potential moderator hypothesize that those who report having high desire to eat when emotional will also eat more when emotional, both in daily life and in the lab. However, findings from these studies are also mixed; while some studies find that desire to eat when emotional interacts with experienced emotion in predicting eating, many don’t (for reviews, Bongers & Jansen, 2016; Devonport et al., 2017; Evers, Dingemans, Junghans, & Boevé, 2018). In sum, emotions either induced in the lab, or experienced in daily life, do not consistently lead to increased eating, even in those who report high desire to eat when emotional.

At first glance, these results may seem surprising: why are even the people who say they typically have a high desire to eat when emotional not eating when emotional in the lab? So far, researchers have mostly attributed these inconsistent findings to limitations in methodology; mainly, that high scores on the self-report questionnaires may reflect factors other than desire to eat when emotional. For example, some have argued that high scores may reflect low perceived self-control, high concern about one's eating behavior, a tendency to attribute overeating to negative affect, or learned cue reactivity (for a review, see Bongers & Jansen, 2016). The conclusion, then, is that these questionnaires do not measure what they intend to measure, and therefore studies fail to find a significant interaction effect.

While this may be the case, it is also possible that these inconsistent findings are a result of unfounded assumptions about the nature of emotional eating. An implicit assumption in the methodologies used in the experimental literature so far is that it is the emotion itself that leads to increased eating. Based on this assumption, the expectation is that any induced emotion should always lead to eating, especially in those who say they have a desire to eat when emotional. However, theories of how emotion may shape behavior posit that it may not be the *emotion itself* that directly shapes behavior, but rather, one's previous experiences with that emotion (Barrett, 2006; Baumeister, Vohs, DeWall, & Zhang, 2007). As such, people may not eat following *any* emotion, but *only* emotions that they have learned to associate with eating in the past. Moreover, people may not *always* eat more when emotional, even when they're feeling emotions they've learned to associate with eating. For example, someone who has learned to associate sadness with eating may not necessarily eat more when feeling anxious, and further, this person may not eat more *every* time they're sad, but rather, only in certain contexts. In conclusion, the effect of different emotions on eating may vary across people and contexts; having failed to account for this variation may be one of the reasons behind the mixed findings in previous studies.

In the next section, I will present evidence that emotional eating is learned based on previous experiences, and therefore, that the effect of each emotion may vary across people and contexts and may constantly be modified due to learning. First, I will explore the role that previous experiences might play in learning to associate emotions with eating, and how discrete, full-fledged emotions (e.g. sadness, anxiety), rather than general affect (e.g. feeling positive or negative), may form these associations. Then, I will consider the broader social context and comment on the role that social norms and social modeling might play in learning to eat when emotional. We discussed many of these ideas in a recent brief review (Altheimer & Urry, 2019).

Emotional eating may require having learned to associate emotion with eating

Early theories suggest that emotional eating may be learned (rather than innate), as the natural response for most people in response to stress and negative affect is a *decrease* in food intake (Wardle, 1990). More specifically, psychosomatic theories (Bruch, 1973; Kaplan & Kaplan, 1957), propose that classical conditioning early in life might explain why some people cannot distinguish between arousal caused by hunger versus that caused by negative emotion. These theories posit that children who learn to associate negative emotion with eating early in life may go on to become emotional eaters later in life.

Recent empirical work with adults supports the role of learning through classical conditioning in emotional eating. In this classical conditioning framework, food intake is the unconditioned stimulus (US), which is paired with unconditioned responses (URs) such as salivation and a desire to eat. Over time, if negative emotion is systematically paired with food intake, it may become a conditioned stimulus (CS) and become capable of producing conditioned responses (CRs) such as an increased desire to eat (Bongers, van den Akker, Havermans, & Jansen, 2015). In support of this, Bongers and Jansen (2017) successfully conditioned their participants to expect and desire chocolate following a negative mood. This study provided preliminary support for the potential role of classical conditioning in emotional eating, however the specific way in which it occurs in everyday life is not yet known.

Further support for the role of classical conditioning in emotional eating comes from the developmental psychology literature, where studies investigate the role of parental behavior, as well as the home environment more broadly, in the development of emotional eating in children. These studies are based on the idea that parents may inadvertently teach their children to associate eating with negative emotion by attempting to soothe a distressed child with palatable food. For instance, a cross-sectional study found that emotional feeding practices in mothers may be closely related to emotional eating behaviors in children, even after accounting for other factors such as general parenting style, maternal psychopathology, and child age and gender (Braden et al., 2014). Moreover, a small experimental study demonstrated that parental use of food as a means to regulate their child’s emotions was associated with higher consumption of sweet, fatty foods in the laboratory, especially in the context of induced negative emotion (Blissett, Haycraft, & Farrow, 2010).

While parental behaviors may cause emotional eating in children, the converse is also possible: parents might engage in such behaviors because they know that their child is highly motivated to obtain food for pleasure, or that food has a calming effect for their child. In fact, in a longitudinal study, higher levels of emotional feeding at ages 6 and 8 predicted higher levels of emotional eating at ages 8 and 10 respectively, but evidence for the opposite direction of the influence was also found (Steinsbekk, Barker, Llewellyn, Fildes, & Wichstrøm, 2017). Finally, a large-scale longitudinal study of twins concluded that shared environmental influences explained most of the variance in emotional eating in children, compared to genetic influences (Herle, Fildes, Rijsdijk, Steinsbekk, & Llewellyn, 2017; Herle, Fildes, Steinsbekk, Rijsdijk, & Llewellyn, 2017). Altogether, findings from developmental psychology indicate that emotional eating may be based on previous experiences and associations made between emotion and eating, rather than as a direct consequence of the emotion. While these studies demonstrate that previous experiences shape eating behavior, they do not consider the potential differential effects of affect and emotion.

Emotional eating may follow only specific discrete emotions

Theories of how emotion shapes behavior differentiate the effect of affect and full-fledged emotion on learning (Barrett, 2006; Baumeister et al., 2007). Affect refers to conscious or non-conscious automatic responses that typically consist of no more than a feeling that something is good or bad, whereas emotion refers to conscious and discrete responses that are typically saturated by cognitions (Baumeister et al., 2007). These theories suggest that while affect may be quick enough to immediately guide behavior, emotion may be too slow to guide behavior directly. From this perspective, while affect may simply activate approach or avoid tendencies, conscious emotions stimulate reflection and learning. In fact, it is suggested that the main purpose of full-fledged, conscious emotion may be to provide feedback after behavior occurs, so that lessons can be learned for the future (Baumeister, DeWall, Vohs, & Alquist, 2009).

Applying this framework to the field of emotional eating, it may be that *discrete emotions that people have learned to associate with increased eating* lead people to eat, rather than general affect. Therefore, which discrete emotions lead to eating may vary across people based on each person’s previous experience with that emotion. Self-report questionnaires of emotional eating, however, largely do not take this into account, which may in part explain why some studies fail to observe an increase in eating following emotion inductions in the lab, even in those who report having a desire to eat when emotional.

The most commonly used self-report questionnaire in these studies is the Dutch Eating Behavior Questionnaire's Emotional Eating Subscale (DEBQ-E; Van Strien, Frijters, Bergers, & Defares, 1986), which asks participants to report on their desire to eat following 13 discrete emotions and situations. While the DEBQ-E is often used as a measure of overall emotional eating, many of its items focus on sadness and stress/anxiety. More specifically, 5 of the 13 items seem to measure the desire to eat when feeling sad (e.g. "depressed or discouraged" "lonely," "somebody lets you down," "disappointed," "have nothing to do"). Similarly, 8 of the 13 items seem to measure the desire to eat when feeling stressed or anxious (e.g. "irritated," "cross," "approaching something unpleasant to happen," "anxious, worried, and tense," "things are going against you or when things have gone wrong," "frightened," "emotionally upset," "bored or restless"). Therefore, high scores on the DEBQ-E may really reflect being sad and/or anxious eaters in particular, rather than emotional eaters in general.

If the DEBQ-E in fact identifies sad and/or anxious eaters, then we would expect it to moderate the effect of emotion on eating only when the emotion induced is sadness or anxiety. A close examination of the literature on this moderation effect indicates that this may, in fact, be the case. Among experimental studies that examine this moderation effect by what emotion was induced, we found that the studies inducing sadness and stress/anxiety were more likely to find a significant effect, compared to those inducing general affect (i.e. negative, neutral, positive; see Table 1). In that case, it is possible that these studies found a significant moderation effect because they specifically identified sad- and/or anxious-eaters using the DEBQ-E. Similarly, another study on emotional eating following social exclusion also found a significant moderation effect, perhaps because they specifically identified those who report eating following social exclusion using a single item measure.

On the other hand, among experience sampling or daily diary studies of emotional eating, we found only one study that examined the moderation of experienced emotion and self-reported emotional eating in predicting eating (Reichenberger et al., 2018). This study measured general positive and negative affect and indeed found that emotional eating style moderated the relationship between experienced negative emotion and food intake. However, it is worth noting that they also used the DEBQ as their self-reported measure of emotional eating, and their measure of negative emotion also centered around sadness and anxiety (items were: irritated, bored, nervous/stressed, distressed, depressed).

There is also preliminary experimental evidence supporting the idea that people only engage in emotional eating following specific discrete emotions that have led them to eat in the past. Schneider and colleagues (2012) tested this idea in an exploratory experiment, where they induced anxious, angry, and neutral moods, and measured subsequent food intake in a sham palatability test. Their findings indicated that those who self-reported high desire to eat when anxious in fact ate more following the anxiety mood induction, while those who reported low desire to eat when anxious ate less. They also found a similar, but non-significant pattern for anger[2]. Overall, a significant moderation effect seems to only emerge in those studies that matched their emotion induction to their self-reported measure of emotional eating.

In sum, experimental studies show preliminary support for the role of classical conditioning in emotional eating, and findings from developmental psychology show that emotional eating may be based on previous experiences with and associations made between emotion and eating. Furthermore, our literature review and an exploratory experimental study by others suggest that people may only engage in emotional eating following discrete emotions that have led them to have an increased desire to eat in the past, rather than general affect. These findings are consistent with prior theoretical work positing that it may not be the emotion itself that shapes behavior, but rather, one's previous experiences with that emotion (Barrett, 2006; Baumeister et al., 2007). In the next section, we will consider the potential effect of the broader social context, specifically, the role of social norms and expectations, as well as social modeling in shaping emotional eating.

Emotional eating may depend on social context

Studies indicate that perceived social norms (what we believe most other people do or approve of) have a considerable influence on general eating behavior. In a meta-analysis of fifteen experimental studies that manipulated information about eating norms, Robinson, Thomas, Aveyard, and Higgs (2014)

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[2] However, please note that this exploratory study was likely underpowered due to a small sample size (N = 60, and cell sizes as low as n = 2 for some analyses) and was not specifically designed to test this hypothesis.

found that norms moderately influenced eating behavior. More specifically, if participants were told that others make low-energy or high-energy food choices, their likelihood to make similar food choices increased significantly. This effect is also found in correlational studies of daily eating behavior, however the causal direction of the effect is unclear, as most of these studies are not longitudinal (Robinson, 2015). In sum, perceptions of social norms seem to shape eating behavior, even when participants aren't explicitly aware of this influence (Vartanian, Spanos, Herman, & Polivy, 2017).

Considering the robust effect of perceived social norms on eating behavior, it is possible that perceptions of social norms related to emotional eating may also shape people's emotional eating behavior, though no studies to date have examined this effect in the context of emotional eating. In the laboratory context, for example, the salient perceived social norms related to emotional eating may be different than those in daily life, which might explain the inconsistency of results described previously. In daily life, the presence of social norms about eating in certain settings (e.g. school, work, outings with friends) might affect the presence and timing of emotional eating behaviors.

Social modeling may also play a role in shaping emotional eating (Herman, Roth, & Polivy, 2003). Social modeling refers to when people adjust their food intake to that of their eating companion, and therefore could either inhibit or facilitate one's food intake depending on their companion's behavior. This robust effect is consistently observed across a wide range of ages, weight and restraint statuses, and hunger levels, and occurs even when the eating companion isn't physically present (for a meta-analysis, see Vartanian, Spanos, Herman, & Polivy, 2015; for a systematic review, see Cruwys, Bevelander, & Hermans, 2015).

While the effect of social modeling on eating in general is well-established, its effect on emotional eating in particular has not yet been examined. In the laboratory context, it is possible that people's behavior is influenced by the behavior of the non-eating experimenters. In daily life, it's possible that some social contexts facilitate emotional eating (e.g. presence of companions who are also eating), while others prohibit or delay it (e.g. presence of non-eating companions).

Finally, social context may play a role not only in how emotional eating is learned, but also in how it may manifest in different social settings, such as the lab setting. Impression management in this context refers to when people adjust their food intake as a means of creating a particular impression of themselves (Vartanian, 2015), and is especially relevant when people are being observed by a non-eating observer while eating (Herman et al., 2003). A recent meta-analysis found that participants significantly reduce food intake when they are made aware of the fact that their food intake is observed (Robinson, Hardman, Halford, & Jones, 2015). This is especially a concern for experimental studies where participants might naturally feel observed.

In sum, research on the effect of perceived social norms and social modeling indicates that people consistently and robustly change their eating behavior to match the expectations and behavior of others. Overall, the research summarized here lends further support to the idea that it may not be emotion itself that causes eating, but instead, that its effect on eating may depend on previous experiences *and* social context.

In this paper, we present a set of studies with the overarching goal of determining whether accounting for the variation in people's emotional eating in response to different discrete emotions while paying special attention to social context leads to more consistent findings than has been found in the literature thus far. Specifically, in both Study 1 and 2, we asked people to report on their general tendency to eat following two discrete emotions (sadness and anxiety) and determined whether this predicted how much they ate when feeling sad or anxious in the lab (Study 1) or in their daily lives (Study 2). The goal was to determine whether we can observe emotional eating if the specific emotions people experience when faced with the opportunity to eat are matched to the emotions they report having led them to eat more in the past (e.g. sad eaters will eat more when sad, and not when anxious). In Study 1, we took special care to design the social context of the study to allow emotional eating. Because Study 2 took place in a much more flexible environment (i.e. daily life, vs. the lab), we explored whether the social context of their eating episodes predicted whether people consumed more food on days when they're emotional. Hypotheses, methods, and analysis plans for both studies were preregistered on the Open Science Framework (OSF) platform; these preregistrations, as well as materials and data can be found on OSF (Study 1: https://osf.io/kcqej/, Study 2: https://osf.io/3euvg/).

Study 1

The main goal of this study was to determine whether acknowledging the variation in which discrete emotions generally lead people to eat more can help us reliably observe emotional eating in the lab. To this end, participants completed a self-report measure of emotional eating that differentiates between subtypes of emotional eating (i.e. sad eating and anxious eating). Subsequently, they came into the lab for three sessions, each of which involved the induction of sadness, anxiety, or a neutral emotional state. Participants were offered popcorn during these emotion inductions. In addition, while we did not systematically vary the social context of these lab sessions, we attempted to make it as conducive to emotional eating as possible based on prior knowledge about eating behaviors.

Our pre-registered hypotheses (https://osf.io/kgzcv) were as follows:

H1a) Those who self-report that they tend to eat more when feeling sad would be more likely to engage in sad-eating (compared to anxious-eating) in the lab.

H2a) Those who self-report that they tend to eat more when feeling anxious would be more likely to engage in anxious-eating (compared to sad-eating) in the lab.

Importantly, prior literature has commonly used measures of emotional eating that only assess the frequency of *over*eating when emotional. Scores on the measure we used (Salzburg Emotional Eating Questionnaire; described later), however, indicate both overeating and undereating when emotional. While there is a lack of empirical research on emotional undereating, our theory led us to predict a crossover interaction where:

> H1b) Those who self-report that they tend to eat less when feeling sad would be less likely to engage in sad-eating (compared to anxious-eating) in the lab.
>
> H2b) Those who self-report that they tend to eat less when feeling anxious would be less likely to engage in anxious-eating (compared to sad-eating) in the lab.

While a crossover interaction was required to infer full support for our hypothesis, we decided to consider a spreading interaction (e.g. sad-eating higher than anxious-eating at higher levels of self-reported sad-eating, but perhaps no difference at lower levels of self-reported sad-eating) as partial support for our hypothesis.

Method

Participants

We recruited participants of all genders using an online eligibility survey. People with eating disorders, any conditions that might affect their appetite (e.g. pregnancy, lactation, smoking), or a dislike of popcorn or allergies to any of its ingredients were excluded.

In order to determine our sample size, we conducted power analyses through a Monte Carlo simulation-based power analysis package for generalized linear mixed models (simr; Green & Macleod, 2016). Specifically, first, we simulated data for 10,000 studies, each with N = 100 participants. While doing this, we took into account a pattern of estimated correlations between our predictors, as well as between these predictors and food intake. We computed difference scores to obtain a sad- and anxious-food intake score by subtracting food intake during the neutral condition from food intake during the sad and anxious conditions.

We then estimated power for a model predicting food intake from our predictors, namely, emotion condition (sad-neutral or anxious-neutral), self-reported sad-eating scores, self-reported anxious-eating scores, the two-way and three-way interactions between these variables, as well as BMI, gender, and daily hunger (sad-neutral and anxious-neutral) as covariates. To do this, we used simr to extrapolate from the observed simulated sample size of N = 100 to unobserved sample sizes up to N = 200. The simr package then determined whether the predicted effects were significant and moderate in size (β = .30) for each sample size for every study, which we then aggregated across the 10,000 studies within each sample size to determine power. Results of this analysis indicated that a sample of 143 participants would give us 80% power to detect both two-way interactions that are part of our confirmatory analyses. We initially decided to collect data from 144 people so that our sample could be fully counterbalanced.

Considering the overall burden of collecting data from 144 participants, each of whom would attend three lab sessions, we then decided to use a sequential analysis approach (Lakens, 2014) with two "looks" – i.e., analyses – using the power family linear spending function with a phi of 1. We computed alpha boundaries using the WinDL software by Reboussin et al. (2000) using the step-by-step guide by Daniel Lakens, https://osf.io/uygrs/files. Based on our initial interim analysis plan (https://osf.io/sr3dj), we conducted our initial analysis after we obtained complete data from 72 participants (time = 0.5, with an alpha boundary of 0.0250). We would have terminated data collection if both of the expected interaction effects were significant in the predicted direction, however our first look revealed no significant interaction effects. Moreover, the effect sizes for our expected interaction effects were smaller than our smallest effect size of interest (SESOI), predetermined to be 0.18 by computing 60% of our original expected effect size of 0.30 (Perugini, Gallucci, & Costantini, 2014). However, with only half of our ultimate sample size, we had low power (.403) to detect both two-way interactions and were concerned that the estimates were insufficiently stable to make a definitive conclusion. We had access to the psychology participant pool, where we could recruit participants for credit, so we decided to continue data collection until the pool closed on 05/02/2019.

On 05/02/2019, we reached N = 119. We conducted a second interim analysis (https://osf.io/m64vj) with complete data from these 119 participants (time = 0.83, with an alpha boundary of 0.02548). We decided to terminate data collection if both of the expected interaction effects were significant in the predicted direction or if the observed effect sizes were smaller than our SESOI, 0.18. The observed effect sizes were smaller than our SESOI, therefore we terminated data collection.

In total, we collected data from 127 Tufts University undergraduates in exchange for course credit. Participants who completed all parts of the study (N = 119) were given bonus credit as an incentive. Because our main confirmatory analysis concerned the interaction of manipulated emotion and self-reported anxious- and sad-eating, we only included participants who completed all three lab sessions and had complete scores on both anxious- and sad-eating. Any participants who missed a session (n = 7) were removed from the sample. Two participants accidentally saw the same film clip twice and were also removed. We therefore had usable data from 118 participants.

Out of the final sample, 67.8% of our participants identified as female, 31.4% identified as male, and 1 participant identified as a non-binary woman. The age range was 18-27 years (M = 19.09, SD = 1.13). Our sample was 5.9% Hispanic or Latino, 63.6% White, 31.4% Asian, 9.3% Black, and 1.7% Hawaiian or other Pacific Islander; 2.5% declined to provide racial/ethnic information. Mean BMI was 23.12, which is in the normal weight range and considerably lower than the mean BMI for a representative US sample (29.1 in men and 29.6 in women; Fryar, Kruszon-Moran, Gu, & Ogden, 2018) According to the Centers for Disease Control and Prevention BMI guidelines (Centers for Disease Control and Prevention, 2017), 5.1% of our sample were within the underweight range, 73.7% were within the normal range, 17.8% were within the overweight range, and 3.4% were within the obese range.

Materials

Confirmatory measures.

Emotional eating. Participants completed the sadness and anxiety subscales of the Salzburg Emotional Eating Scale (SEES; Meule, Reichenberger, & Blechert, 2018)**,** which is a 20-item measure with four subscales measuring emotional eating in response to sadness, happiness, anger, and anxiety. The sadness and anxiety subscales consist of 5 items each. Order of item presentation was randomized. Participants were asked to report on the extent to which each emotion typically affects their eating behavior on a scale from 1 (*I eat much less than usual*) to 5 (*I eat much more than usual*). Subscale scores were computed by averaging the five item scores. Unlike the DEBQ, this scale has subscales for several discrete emotions, which made it suitable for our study. Scores on these subscales seem to correlate in the expected direction with previous scales of emotional eating like the DEBQ, indicating convergent validity. In addition, internal consistencies for the sadness and anxiety subscales have been good (Cronbach's αs > .7; Meule et al., 2018). In the present study, the internal consistency was acceptable for the sadness subscale (α = .67) and good for the anxiety subscale (α = .84). Please see Appendix A for the complete scale.

Film clips. Most standardized film clips for emotion elicitation (Gross & Levenson, 1995; Samson, Kreibig, Soderstrom, Wade, & Gross, 2016) are quite short in duration (<5 mins for negative emotions), and may not allow enough time for participants to experience the intended emotions and consume food. Therefore, we selected 3 film clips that are ~10 minutes in duration for each emotion elicitation. The selection of the final film clips was based on the results of a pilot study conducted on Amazon MTurk, where participants viewed and rated ~10-minute film clips using the DEQ, as well as additional items assessing boredom, pleasantness, and arousal. The sadness clip comprised of a series of scenes where a young woman and her family come to terms with her terminal leukemia, from the movie *My Sister's Keeper* (Furst et al., 2009). The anxiety clip comprised of a series of scenes depicting a plane crash, from the movie *Cast Away* (Hanks, Rapke, Starkey, & Zemeckis, 2000). Finally, the neutral clip comprised of a series of scenes from the life of a department store worker, from the movie *Carol* (Karlsen, Woolley, Vachon, & Haynes, 2015).

Emotion ratings. Because our goal was to elicit two discrete emotional states (anxiety and sadness), to determine whether this goal was met, we asked our participants to complete the anxiety and sadness subscales of the Discrete Emotions Questionnaire (DEQ; Harmon-Jones, Bastian, & Harmon-Jones, 2016), which is a 32-item measure of anger, disgust, fear, anxiety, sadness, desire, relaxation, and happiness. The sadness and anxiety subscales consist of 4 items each. Order of item presentation was randomized. Participants were asked to report on the extent to which they felt an emotion (e.g. sadness, dread, anxiety, worry, etc.) before and after watching the film clips, on a scale from 1 (*not at all*) to 7 (*an extreme amount*). Subscale scores were computed by averaging the four item scores. This instrument has been shown to be sensitive to various emotion elicitation paradigms in the predicted manner (scores on the target subscales were elevated significantly more than scores on the other subscales), namely autobiographical recall, guided imagery, and viewing photographs. In addition, internal consistencies for all subscales have been high (Cronbach's αs > .8; Harmon-Jones et al., 2016). In the present study, we only computed internal consistency for the post-film clip ratings as the pre-ratings were at floor. The internal consistency was acceptable for the sadness subscale (α = .78, .76, and .66 for the sadness, anxiety, and neutral conditions, respectively) and good for the anxiety subscale (α = .87, .91, and .77 for the sadness, anxiety, and neutral conditions, respectively). Please see Appendix A for the complete scale.

Food intake. A pre-weighed bowl of popcorn was made available to participants and was weighed again after the film viewing to determine the amount of food consumed. As noted in our preregistration plan, we initially intended to measure the popcorn weight in grams, then convert to kcals based on package instructions for analysis. However, we noticed partway through the study that the weight of popcorn increased over time (see Figure 1), which may have been due to it reabsorbing some of the humidity in the room. Due to this instability, we decided to not convert to kcals and report in grams instead. We also rounded our measurements to the nearest integer rather than retaining accuracy to 2 decimal points.

For our confirmatory hypothesis testing, we computed difference scores to indicate sad-eating and anxious-eating by subtracting the grams consumed in the neutral condition from the grams consumed in the sadness and anxiety conditions.

Hunger ratings. Participants were provided with a series of items about how they were feeling at the moment and rated each item on a scale from 1 (*not at all*) to 7 (*an extreme amount*). The items of interest were the ones measuring hunger (“hungry” and “full”); however, to ensure we were not signaling our primary interest in hunger/food, we embedded these items in a list of questions about how participants were feeling at the moment, including items such as thirsty, sleepy, tired, achy, warm, and cold. To further this goal, we added these items to the end of the DEQ, so that it all felt like a single measure. Hunger scores were computed by averaging the scores for the two hunger items after having reverse-coded one of them, such that higher scores indicated higher levels of hunger.

Exploratory measures.

Perceived stress. Participants completed the 4-item version of the Perceived Stress Scale (PSS-4; Cohen, Kamarck, & Mermelstein, 1983), which measures the degree to which participants find events in their lives overwhelming. While the original version of this scale measures global levels of stress over the course of a month, it has also successfully been used to measure daily stress (Carney, Armeli, Tennen, Affleck, & O'Neil, 2000). Each statement began with "In the past 24 hours, how often did you feel…" and was rated on a 5-point scale ranging from 0 (*never*) to 4 (*very often*). Sample items include: "unable to control the important things in your life?" and "felt that things were going your way?" Scale scores were computed by averaging the four item scores after reverse scoring positively worded items, such that higher scores indicated higher stress. The daily version of this scale has been reported to have good internal consistency (Cronbach's $\alpha > .7$; Carney et al., 2000). In the present study, the internal consistency was acceptable ($\alpha = .78$, .74, and .79 for the sadness, anxiety, and neutral conditions, respectively). Please see Appendix A for the complete scale.

Daily stressors. Participants completed the Daily Stress Inventory (DSI; Brantley, Waggoner, Jones, & Rappaport, 1987), which is a 58-item inventory that allows participants to report minor stressors they experienced for the past 24 hours. After indicating which events have occurred, participants rated the stressfulness of these events on a scale from 1 (*occurred but was not stressful*) to 7 (*caused me to panic*). Sample items include: “unable to complete a task,” “spoke or performed in public,” and “exposed to feared situation or object.” Participants were also given an open-ended opportunity to enter other events they may have encountered that are not included in the inventory. Three scales were derived from the DSI: FREQ represented the number of events that occurred that day, SUM represented the summation of the item ratings, and AIR represented the impact ratings of all events that were endorsed (i.e. SUM divided by FREQ). Norms for a single day of monitoring and psychometric data are available (Brantley et al., 1987). The FREQ and SUM scores have been reported to have high internal consistency (Cronbach’s α = .83 and .87 respectively; internal consistency scores cannot be computed for AIR; Brantley et al., 1987), and has convergent validity with endocrine indices of stress (Brantley, Dietz, McKnight, Jones, & Tulley, 1988). In the present study, the internal consistency was good for both the FREQ subscale (α = .79, .82, and .84 for the sadness, anxiety, and neutral conditions, respectively) and the SUM subscale (α = .77, .85, and .86 for the sadness, anxiety, and neutral conditions, respectively). Please see Appendix A for the complete scale.

Dietary restraint. Participants completed the restraint subscale of the revised, abbreviated Three Factor Eating Questionnaire (TFEQ-R18v2; Cappelleri et al., 2009), which is a 3-item subscale that measures participants’ perceptions on how much they typically restrain their food intake for the purposes of losing weight. Participants responded to each item on a scale from 1 (*definitely true*) to 4 (*definitely false*). Items are: “I deliberately take small helpings to control my weight,” “I don’t eat some foods because they make me fat,” and “I consciously hold back on how much I eat at meals to keep from gaining weight.” This version of the scale was revised from the 6-item version due to better factor loadings and internal consistency (Cronbach’s α = 0.78 in a web-based, non-clinical sample). In the present study, the internal consistency was good (α = .82). While studies have shown that self-report measures of dietary restraint do not measure actual restraint (Stice, Cooper, Schoeller, Tappe, & Lowe, 2007; Stice, Fisher, & Lowe, 2004; Stice, Sysko, Roberto, & Allison, 2010), *perceptions* of restraint have nonetheless been predictive of emotional eating behaviors (Fay & Finlayson, 2011).

Depression and anxiety. Participants reported on their mood and anxiety using the Anxiety Depression Distress Inventory-27 (ADDI-27; Osman et al., 2011), which measures general levels of anxiety and depression. The ADDI-27 is a 27-item scale which contains three subscales, each with nine items: positive affect, somatic anxiety, and general distress. Participants reported on how much they experienced or felt certain items during the past two weeks on a 5-point Likert scale, ranging from 1 (*not at all*) to 5 (*extremely*). Sample items include “felt sad,” “felt like a failure,” “worried a lot about things,” and “felt confident about myself.” A scale score for each subscale was obtained by summing the item scores on that subscale. Each of the three subscales have been reported to have high internal consistency (Cronbach’s α for positive affect = .89, for somatic anxiety = .83, for general distress = .89; Garcia, Berzins, Acosta, Pirani, &

Osman, 2018). In the present study, the internal consistency was good for the positive affect subscale (α = .89) and the general distress subscale (α = .89), and was acceptable for the somatic anxiety subscale (α = .73). Please see Appendix A for the complete scale.

Awareness check. Participants were asked to briefly describe what they thought the study was about. Open-ended responses were later coded independently by two coders on 3 dimensions: 1) Was the participant aware that the intention of the film clips was to manipulate their emotions? 2) Was the participant aware that their food intake was being measured? and 3) Was the participant aware of the interaction hypothesis of the study? Each entry was rated on each of these dimensions using a 3-point scale indicating 0 (*no awareness*), 1 (*some awareness*), and 2 (*full awareness*). If coders disagreed on an entry, they discussed it together and mutually agreed on a final code.

Procedure.

After piloting our procedures, we proceeded with real data collection. Reducing participant awareness that we were interested in their emotions and food intake was paramount, so we pitched the study as a study of physiological responses to watching movies. Prior to the lab session, participants completed an online pre-study survey, where, following consent, they answered questions about the exclusion criteria, and, completed the SEES, demographics, and a few filler measures to detract from the main purpose of the study. Those who were eligible were then scheduled for 3 experimental sessions which occurred approximately at the same time on different days. Because caffeine can suppress food intake

(Schubert et al., 2017), we asked participants to refrain from consuming caffeine for 4 hours prior to their scheduled lab sessions. In addition, to increase the likelihood that participants would eat during the session, we asked them to refrain from consuming food for 2 hours. We attempted to schedule these sessions within a period of 7 days, however, allowed for scheduling flexibility to accommodate participant schedules to avoid attrition.

Sessions took place in a small RF-shielded booth that was set up to feel like a living room. Specifically, there was a comfortable chair, a side table, and a screen where film clips were displayed. The room was lit with lamps, rather than overhead lighting, and was decorated with posters and paintings. Following consent, participants were fitted with a physiological armband. They were then told that, for their comfort, the experimenter would not monitor their progress or advance slides for them. They were oriented to the experimental set-up such that they would advance through slides themselves using a mouse that was connected to the screen. Then, the experimenter left the room and closed the door.

After sitting quietly for 1 minute, participants completed the hunger and mood measures. Then, the film clip was shown. The order of film clips was counterbalanced between sessions. Following the film clip, participants completed another mood measure. They were then asked to sit quietly for 1 minute. Following this period, they were asked to inform the experimenter that they have completed this part of the study to further signal to them that their experience was not being monitored. The experimenter then reentered the room with a clipboard and removed the food bowl to be measured, while simultaneously presenting the participant with the clipboard which included a page where participants were asked to write a summary of the film clip they just watched. While participants were completing this measure, the experimenter measured and noted the amount of food that was left in the bowl. Participants were then shown a positive film clip to restore their mood. Finally, they completed the stress measures. At the end of their third and final session, participants also completed an awareness check measuring their suspicion about the real purpose of the study, as well as the measures about their dietary restraint, depression, and anxiety. Finally, their height and weight were measured for BMI calculations, and they were debriefed. See Figure 2 for a visual representation of study procedures.

We took measures to enhance deception, both prior to and during lab sessions. Prior to sessions, we told them that the reason we asked them to refrain from caffeine and food was because these might interfere with our baseline physiological measurements. During the sessions, we fitted them with a physiological armband despite not collecting any data from it. We asked them to sit quietly for 1 minute prior to the movie, pitching this as a time to collect baseline physiological measurements. Popcorn was presented to them as a way to enhance their movie-watching experience. We also gave them what we pitched as a “memory task” following the main film clip to detract from the fact that we took their popcorn away for measurements. They were also given this “memory task” following the positive film clip so to detract from our interest in the first film clip. All study procedures were approved by the Social, Behavioral, and Educational

Research Institutional Review Board at Tufts University and the United States Army Human Research Protections Office.

Results

Preliminary analyses

What were the descriptive statistics of our variables? We computed descriptive statistics for all variables, namely, daily ratings of food intake, sadness, anxiety, hunger, actual stress, and perceived stress, as well as overall self-reported sad- and anxious-eating, BMI, dietary restraint, general distress, positive affect, and somatic anxiety, split by emotion condition (see Table 2). Of note, levels of sadness and anxiety were quite low, even after watching the sadness- and anxiety-inducing film clips. Also, participants ate about 19 grams, or approximately 2.5-3 cups of popcorn on average, amounting to approximately one third of a bag of popcorn. Based on a list of common movie-watching snacks, 34.0% of participants ranked popcorn as their most favorite movie-snack, 19.8% ranked it as their second favorite movie-snack, and 17.9% ranked it as their third favorite movie-snack.

Were variables correlated with each other? We conducted bivariate correlations between all variables, namely, food intake, hunger, actual stress, and perceived stress, as well as overall self-reported sad- and anxious-eating, BMI, dietary restraint, general distress, positive affect, and somatic anxiety, split by emotion condition. Here, we highlight significant moderate or large correlations ($r \geq .30$; see Table 3 for a correlation matrix). Food intake was positively correlated with hunger on all three days. Daily actual stress was positively correlated with perceived stress and general distress on all three days. Similarly, daily perceived stress was positively correlated with general distress and somatic anxiety, and negatively correlated with positive affect. Looking at correlations between our between-subjects measures, self-reported sad-eating was positively correlated with self-reported anxious eating. Finally, general distress and somatic anxiety were positively correlated with each other, and negatively correlated with positive affect.

Awareness and manipulation checks

Were participants suspicious about study procedures and did this affect their food intake? We computed frequencies for people's suspicions about the study; 61% of participants reported partial or full knowledge that we were manipulating their emotions, 55.9% of participants reported partial or full knowledge that we were measuring their food intake; no participants guessed our study-specific hypotheses involving the moderating role of self-reported sad- and anxious-eating.

To determine whether this awareness affected their food intake, we used the lme4 package in R (Bates, Mächler, Bolker, & Walker, 2015) to conduct a linear mixed-effects regression (LMER) model with a random intercept and continuous outcome variable, specifically the sadness/anxiety minus neutral condition difference scores for food intake, measured in grams. We had two fixed effects predictors of interest: one for awareness that we manipulated emotion (categorical; 0 = not aware, and 1 = aware), and one for awareness that we measured food intake (categorical; 0 = not aware, and 1 = aware). We allowed the intercept for food intake to vary randomly across subjects. Gender (time-invariant categorical; -0.5 = men, 0.5 = women) and BMI (time-invariant continuous), hunger (time-varying continuous; anxiety-neutral and sad-neutral), and emotion condition (time-varying categorical; 0 = sad-eating [sad-neutral] and 1 = anxious-eating [anxiety-neutral]) were included as fixed effect covariates of no interest. All continuous variables were mean-centered. While people engaged in more emotional eating when they were hungrier, $p < .001$, and engaged in more anxious-eating (anxious minus neutral) than sad-eating (sad minus neutral), $p < .001$, neither type of awareness, nor their interaction, significantly predicted food intake (see Table 4).

Did the emotion inductions induce the intended emotion at each session? We used the lme4 package in R (Bates et al., 2015) to conduct a linear mixed-effects regression (LMER) model with a random intercept and a continuous outcome variable.

We predicted self-reported, continuous emotion rating scores from three fixed effects predictors: two dummy-coded variables for emotion condition (categorical; the first one coded as 1 = sadness and 0 = neutral or anxiety, and the second coded as 1 = anxiety and 0 = neutral or sadness), rating type (categorical; coded as -0.5 = sadness or 0.5 = anxiety) and time (-0.5 = before film clip or 0.5 = after film clip). We allowed the intercept for emotion scores to vary randomly across subjects. All continuous variables were mean-centered. We would consider our anxiety manipulation successful if we obtained significant emotion*rating type*time interactions for both of our dummy-coded emotion condition variables, such that the desired effects are present after, but not before the film clips, and are specific to the rating type (e.g. sadness scores increase in the sadness condition and anxiety scores increase in the anxiety condition).

We found support that our manipulation worked largely as intended. Specifically, both 3-way interactions (anxiety*rating type*time and sadness*rating type*time) were significant (see Table 5). We then conducted follow-up simple effects analyses to unpack these effects. People did not differ in their sadness or anxiety ratings prior to watching the film clips between the different conditions, all ps $> .34$. Looking at the change in emotion ratings before versus after the film clip, as expected, people reported an increase in sadness following the sadness clip, $p < .001$, and an increase in anxiety following the anxiety clip, $p < .001$. Also as expected, people did not report an increase in anxiety, $p = .19$, or in sadness, $p = .93$, following the neutral clip. Contrary to expectations, people also reported an increase in sadness following the anxiety clip, $p = .001$, and an increase in anxiety following the sadness clip, $p <.001$. However, their reports of anxiety following the anxiety clip were higher than those following the sadness clip, $p < .001$, and their reports of sadness following the sadness clip were higher than those following the anxiety clip, $p < .001$.

In sum, the neutral clip worked as intended and did not lead to an increase in sadness or anxiety ratings. Sadness and anxiety ratings were higher following both the sadness and anxiety film clips, but ratings of sadness were highest following the sadness clip, and ratings of anxiety were highest following the anxiety clip, providing support that our manipulation worked largely as intended, but did not necessarily lead to a pure experience of either emotion. Of note, however, is that even the post-film clip sadness and anxiety values hovered between scores of 2 and 3, which correspond to “slightly” and “somewhat” on the DEQ scale. Therefore, while we succeeded in inducing the intended emotions, the intensity in which they were felt was somewhat low when considering the full range of the scale (1-7). See Figure 3 for a visual representation of these findings.

Confirmatory analyses

Did self-reported anxious- and sad-eating scores interact with manipulated emotion to predict food intake? We used the lme4 package in R (Bates et al., 2015) to conduct a linear mixed-effects regression (LMER) model with a continuous outcome variable, specifically the difference in food intake in the emotion conditions minus that in the neutral condition, measured in grams. We had three fixed effects predictors of interest: one for laboratory emotion induction (categorical; 0 = sad-eating [sad-neutral] and 1 = anxious-eating [anxiety-neutral]), self-reported anxious eating (continuous; anxEE), and self-reported sad eating (continuous; sadEE). We allowed the intercept for food intake to vary randomly across subjects. Gender (time-invariant categorical; -0.5 = men and 0.5 = women) and BMI (time-invariant continuous) and hunger (time-varying continuous; anxiety-neutral and sad-neutral) were included as fixed effect covariates of no interest. All continuous variables were mean-centered. Evidence in support of our hypothesis would be a significant impact of the two-way interaction terms (emotion*anxious-eating and emotion*sad-eating) on people’s food intake. More specifically, we expected that those who are higher on the sadEE scale would engage in higher sad-eating (than anxious-eating) in the lab, and that those who are higher on the anxEE scale would engage in higher anxious-eating (than sad-eating) in the lab.

Because self-reported anxious- and sad-eating scores were significantly correlated, we checked for multicollinearity in our model using the car package in R (Fox & Weisberg, 2019). All VIF values were less than 1.5, indicating that multicollinearity was not an issue for this model. Results indicated when people were hungrier, they engaged in more emotional food intake (emotion - neutral) overall, $p < .001$. In addition, people engaged in more anxious-eating (anxious - neutral) than sad-eating (sad - neutral), $p < .001$. There was no effect of gender, BMI, self-reported sad-eating, self-reported anxious-eating, or their hypothesized interactions on food intake, all *p*s > .18 (see Table 6). In sum, our hypotheses were not supported. See Figure 4 for a visual representation of these results.

Exploratory analyses

We also conducted models like the one described above but including other factors that could serve as potential moderators to the relationship between emotion and eating, like measured emotion ratings (sadness and anxiety) during the lab sessions (rather than manipulated emotion condition), dietary restraint, daily perceived and actual stress, general distress, and somatic anxiety (see Table 7). All VIF values were less than 2 for the “emotion ratings”, “dietary restraint”, “general distress”, and “somatic anxiety” models, and less than 3 for the “perceived stress” and “actual stress” models, indicating that multicollinearity was likely not an issue for these models. None of these factors significantly moderated the hypothesized two-way interactions between emotion condition and self-reported sad- and anxious-eating. The effect of hunger and emotion condition (or sadness ratings in the “emotion ratings” model) remained significant (without considerable change in the estimate size) in all models, indicating that people engaged in more overall emotional eating when hungrier, and they engaged in more anxious-eating than sad-eating (or that they ate less when feeling sad in the “emotion ratings” model). We also included gender and BMI as moderators instead of covariates; neither variable significantly moderated our hypothesized interaction term. In sum, none of our exploratory predictors significantly moderated our hypothesized interaction terms.

Discussion

Results from previous laboratory studies indicate that we cannot reliably observe increased eating following negative emotion inductions, even among people who self-identify as emotional eaters. We argued that people may vary in which specific emotions they have learned to associate with eating, and therefore, may only engage in emotional eating when experiencing those emotions, rather than any emotion. Accordingly, the main goal of Study 1 was to determine whether acknowledging the variation in which *specific* emotions lead people to eat more could help us reliably observe emotional eating in the lab. To this end, participants completed a measure of emotional eating that differentiated between sad eating and anxious eating. Subsequently, they came into the lab for three sessions, each of which involved watching a film clip that was meant to induce either sadness, anxiety, or a neutral emotional state. Their food intake during these emotional film clips was measured. We expected that participants’ self-reported anxious-eating and sad-eating scores would significantly moderate the relationship between emotion inductions and food intake, while controlling for their hunger, gender, and BMI. We found that people ate more when they were hungrier, and they engaged in more anxiety-eating (anxious - neutral) than sad-eating (sadness - neutral). However, we found no support for our hypotheses, not even when accounting for our exploratory predictors. This may have been due to methodological limitations, specifically in how we induced emotions, and how we measured food intake.

To induce sadness and anxiety (as well as a neutral control state), we elected to use film clips, which have been shown to successfully elicit intended emotions while keeping stimuli standardized across all participants (Gross & Levenson, 1995). We also selected film clips to reduce demand characteristics as much as possible, as other, more personally relevant emotion induction procedures, such as the autobiographical recall procedure (Baker & Guttfreund, 1993) where participants are asked to remember an event that made them feel a certain way in the past, require participants to be aware that their emotional experiences are being manipulated more so than the present context.

On the flipside of keeping stimuli standardized and reducing demand characteristics, however, is the fact that stimuli are not personally relevant to participants themselves and involve clearly fictional characters and events. The effects of this limitation may be twofold. First, this may have been one of the reasons why our film clips elicited low intensity sadness and anxiety. Prior research comments on the inhibiting role of high intensity emotions on eating in both humans and in rodents (Macht, 2008); however, it is not clear whether variations in low to moderate levels of intensity of emotion differentially affect eating behavior, and whether this varies between people (do some sad eaters eat more when they're mildly sad, and some when they're intensely sad?). Perhaps, as evidenced by the main effect of emotion condition on food intake (i.e. people engaged in more sad-eating than anxious-eating), the emotions we elicited were intense enough to elicit changes in eating. However, it is still an open question whether the levels of sadness and anxiety induced in our study were intense enough to allow us to detect a significant moderation between their past experiences and current behaviors, especially considering the fact that our self-report measures of sad-eating and anxious-eating did not take into account variations in the intensity of emotions that led people to eat in the past. Second, if people's experiences of emotional eating are in fact based specifically on associations they have made between eating and emotions from their own past and are highly context-specific (as we have argued), it may be less likely that emotional eating would be elicited for emotions that are not personally relevant for participants. It is possible, then, that our emotion induction procedure led to a low intensity, non-personal emotional experience that may have been insufficient to prompt specific emotional eating. In sum, the use of film clips may have reduced our ability to detect specific emotional eating, and furthermore, may have reduced the generalizability of our findings to other, more intense, or more personally relevant emotional experiences in daily life.

Our choice of methodology for measuring food intake was an important strength of this study. Most studies in the literature use the Bogus Taste Test

(Robinson et al., 2017) to measure food intake, where participants are asked to rate the palatability of several foods, while unbeknownst to them, experimenters measure the amount of food they consume while doing this. There are several potential issues related to the use of this measure. First, people tend to eat less than usual when they feel that they are being observed (Robinson et al., 2015). Second, this measure requires that participants sample each food, and therefore doesn’t allow them to choose not to eat. Third, having to test the palatability of food items is not a situation that is often encountered in daily life, and therefore may represent non-normative eating and lack external validity. Instead, our food intake measure allowed participants to simply consume as much popcorn as they would like while watching an emotional film clip. They weren’t made aware that their eating behavior was being measured, and were alone in a room while eating; we therefore minimized the observation effect and any additional demand effects that are associated with the Bogus Taste Test. In addition, participants were in a situation where eating is often normative (namely, watching a movie), which meant that our results were more externally valid.

However, while we did our best to make participants feel comfortable and alone, participants may have still felt observed, and therefore may have changed their eating behavior accordingly. In fact, more than half of our participants had at least partial awareness that their food intake was being measured. Even though this awareness did not seem to reduce their food intake, it is possible that despite not voicing awareness, all participants felt observed simply by being part of a psychological study, and therefore were less likely to engage in emotional eating, which can be a highly personal, and sometimes secretive experience (Hernandez-Hons & Woolley, 2012).

Also related to our food intake measure was the fact that we elected to only offer popcorn to our participants. We deemed this appropriate considering the context of our study (watching movie clips), and the fact that selecting one food item allowed us to standardize food consumption across participants. To reduce the effect of personal taste preferences on food intake, we recruited only those who did not voice a dislike for popcorn. However, it is still possible that popcorn was not enticing enough for emotional eating; in fact, only one third of participants ranked popcorn as their top movie-watching snack. It may even be possible that people's preferred foods for emotional eating are different from their preferred foods in emotionally neutral circumstances. It is therefore possible that our results would be different if we offered participants their favorite snacks, or even better, snacks that they specifically tend to consume when feeling sad or anxious.

Finally, we chose to measure food intake *while* participants were watching the film clips, which allowed us to measure their eating while the induced emotions were unfolding. However, it is unclear whether emotional eating is likely to occur during specific emotional experiences or following them. Studies that use the Bogus Taste Test inherently measure food intake *following* the mood induction, as the two measures are often pitched as separate measures that are independent from each other. To the best of our knowledge, the effect of timing on emotional eating has not been systematically studied thus far in the empirical literature. Do people engage in emotional eating *while* experiencing emotions, or after, perhaps as a means to regulate said emotions? And if we attempt to measure emotional eating *while* the emotions are unfolding, how do we disentangle the effects of the stimuli themselves from the effect of the emotions they induce? Anecdotally, we noticed that many participants stopped eating during the sadness clip right around the moment when they found out that the main character was dying, which may explain why people ate more during the anxiety clip. Was this in response to them feeling sad, or simply due to not wanting to eat *while* watching someone die? Would their eating behaviors be different if we kept measuring their food intake after the film clip? Even though we allowed participants to continue eating for another minute following the film clips, it is possible that the eating reaction may have happened after the emotional event itself as a way to cope with or regulate said emotions.

In conclusion, while the lack of support for our preregistered hypotheses may indicate that our hypotheses were unfounded, it is also possible that due to the nuanced and highly personal nature of emotional eating, some of our methodological decisions may have made it less likely that we could observe it in our lab setting. We conducted Study 2 to examine this complex phenomenon in people’s daily lives.

Study 2

The main goal of this study was parallel to that of Study 1: to determine whether acknowledging the variation in the discrete emotions that lead people to eat more could help us reliably observe emotional eating, but this time, in daily life. This allowed us to test our hypothesis with personally relevant and more externally valid emotional experiences. In addition, because this study allowed us to measure emotional eating behaviors in a more flexible, open context (i.e. daily life), we explored the potential effects of social context on emotional eating behaviors. To this end, participants completed the self-reported measure of their emotional eating tendencies in response to sadness and anxiety from Study 1. Subsequently, they were asked to complete an online survey daily for three consecutive days asking about their daily experiences with sadness and anxiety, their food intake, as well as information about the social context of their food intake.

Our pre-registered hypotheses (https://osf.io/8vqfj) were as follows:

H1a) Those who self-report that they tend to eat more when feeling sad will eat more on days when they are sadder.

H2a) Those who self-report that they tend to eat more when feeling anxious will eat more on days when they are more anxious.

Importantly, as mentioned in Study 1, prior literature has commonly used measures of emotional eating that only assess the frequency of overeating when emotional. Scores on the measure we used, however, indicated both overeating and undereating when emotional. While there is lack of empirical research on emotional undereating, our theory led us to predict a crossover interaction where:

H1b) Those who self-report that they tend to eat less when feeling sad will eat less on days when they are sadder.

H2b) Those who self-report that they tend to eat less when feeling anxious will eat less on days when they are more anxious.

While a crossover interaction was required for full support for our hypothesis, we would consider a spreading interaction (e.g. higher eating on sadder days than more anxious days at higher levels of self-reported sad-eating, but perhaps no difference at lower levels of self-reported sad-eating) as partial support for our hypothesis.

In addition, while we did not have specific hypotheses about the effect of social context on emotional eating due to the lack of prior research on this topic, we took the opportunity to explore whether the presence of others while eating affected the relationship between emotion and food intake.

Method

Participants

We recruited participants of all genders using Amazon MTurk via the TurkPrime interface. Participants first completed an online eligibility survey. People with eating disorders, as well as any conditions that might affect their appetite (e.g. pregnancy, lactation, smoking) were excluded. To circumvent problems that may arise due to the online and anonymous nature of MTurk, we allowed TurkPrime to block participants with duplicate IP addresses and duplicate or suspicious geolocations and only recruited those who had at least a 95% approval rating. We limited our sample to those who resided in the USA and whose native language was English or those who started learning English before the age of 7 because 1) language comprehension was an important requisite due to our reliance on English-language questionnaire measures, 2) it would have been quite labor intensive to assess people's language abilities, and 3) due to the online nature of the study, we did not have a direct line of communication with participants in case English comprehension was an issue.

Similar to Study 1, to determine our sample size, we conducted power analyses using the simr R package (Green & Macleod, 2016). Specifically, first, we simulated data for 10,000 studies, each with N = 50 participants. While doing this, we took into account a pattern of estimated correlations between our predictors, as well as between these predictors and food intake. We then estimated power for a model predicting food intake from our predictors, namely, daily sadness and anxiety scores, sad-eating scores, anxious-eating scores, the two-way and three-way interactions between these variables, as well as BMI and gender as covariates. To do this, we used simr to extrapolate from the observed simulated sample size of N = 50 to unobserved sample sizes up to N = 150. Simr then determined whether the predicted two-way interaction effects were significant and moderate in size (β = .30) for each sample size for every study, which we then aggregated across the 10,000 studies within each sample size to determine power. Results of this analysis indicated that a sample of 57 participants would give us 80% power to detect both two-way interactions which are part of our confirmatory analyses. Because of our interest in individual-difference predictors, we decided to continue data collection until we had usable data from 100 participants.

Because our main confirmatory analysis concerned the interaction of emotion and self-reported anxious- and sad-eating, we only included participants who had complete scores on both anxious- and sad-eating. Any participants who missed more than one item on these self-report questionnaires were removed from the sample. In addition, because we wanted to account for within-subjects variations in food intake based on daily emotion ratings in our analyses, any participants who completed fewer than 2 days of data collection were removed from the sample. Although our goal sample size was 100, we anticipated losing participants due to the above constraints, so we released the study to 135 potential participants on MTurk. Of these, 6 were ineligible, therefore only 129 were sent the pre-study survey. And of these, 115 completed Day 1 procedures, 111 completed Day 2 procedures, and 110 completed Day 3 procedures. One participant only partially completed Day 3 procedures, but because they had complete data for the first two days, was included in our final sample, which comprised of 111 participants.

Out of the final sample, 64.9% of our participants identified as female, and 35.1% identified as male. The age range was 21-73 years (M = 42.37, SD = 13.02). Our sample was 1.8% Hispanic or Latino, 85.6% White, 6.3% Asian, and 9.9% Black; 1 person declined to provide racial/ethnic information. Mean BMI was 27.67, which is in the overweight range and slightly lower than the mean BMI for a representative US sample (29.1 in men and 29.6 in women; Fryar, Kruszon-Moran, Gu, & Ogden, 2018). According to the Centers for Disease Control and Prevention BMI guidelines (Centers for Disease Control and Prevention, 2017), 0.9% of our sample were within the underweight range, 39.6%

were within the normal range, 34.2% were within the overweight range, and 25.2% were within the obese range.

Materials

Confirmatory measures.

Emotional eating. As in Study 1, participants completed the sadness and anxiety subscales of the Salzburg Emotional Eating Scale (SEES; Meule et al., 2018). In the present study, the internal consistency was good for both the sadness subscale (α = .80) and good for the anxiety subscale (α = .92).

Emotion ratings. Participants were asked to report on their sadness and anxiety during the previous day using the DEQ (Harmon-Jones, Bastian, & Harmon-Jones, 2016), which was described in detail in Study 1. The internal consistency was good for both the sadness subscale (α = .85, .87, and .88 for days 1, 2, and 3 respectively) and the anxiety subscale (α = .90, .93, and .91 for days 1, 2, and 3 respectively).

Food intake. Participants completed the Automated Self-Administered 24-Hour Dietary Recall tool (ASA-24; Subar et al., 2012). The ASA-24 is a public-access, freely available, web-based tool that measures daily food intake during the previous day, as well as questions related to food intake, such as where the food was consumed and whether others were present during intake. First, participants were asked to select a meal, and answered questions about the context of the meal, such as where it was consumed and whether others were around. They did this for each subsequent meal. Then, for each meal, participants browsed and selected the food items they consumed for each meal. Then, participants answered detailed questions about portion size (using images to assist with estimation) and additional ingredients. Participants were then prompted to think about several frequently forgotten items and completed a final review of all foods they consumed. A demonstration of survey flow can be viewed at: https://asa24.nci.nih.gov/demo/. This measure has been shown to perform similarly to interview-based 24-hour recall measures of food intake (Subar et al., 2012). We used the daily calorie intake calculations from this measure (in kcal) as our food intake variable. In addition, we calculated the ratio of meals where they ate with others by summing the number of meals they had with others and dividing it by the total number of meals consumed that day.

Exploratory measures.

Perceived stress. As in Study 1, participants completed the 4-item version of the Perceived Stress Scale at the end of each daily survey (PSS-4; Cohen, Kamarck, & Mermelstein, 1983). In the present study, the internal consistency was good (α = .86, .83, and .86 for days 1, 2, and 3 respectively).

Daily stressors. As in Study 1, participants completed the Daily Stress Inventory at the end of each daily survey (DSI; Brantley, Waggoner, Jones, & Rappaport, 1987). In the present study, the internal consistency was good for both the FREQ subscale (α = .81, .74, and .75 for days 1, 2, and 3 respectively) and the SUM subscale (α = .86, .78, and .79 for days 1, 2, and 3 respectively).

Dietary restraint. As in Study 1, participants completed the restraint subscale of the revised, abbreviated Three Factor Eating Questionnaire (TFEQ-R18v2; Cappelleri et al., 2009). In the present study, the internal consistency was good (α = .85).

Depression and anxiety. As in Study 1, participants reported on their mood and anxiety using the Anxiety Depression Distress Inventory-27 (ADDI-27; Osman et al., 2011). In the present study, the internal consistency was excellent for the positive affect subscale (α = .92) and the general distress subscale (α = .95), and the somatic anxiety subscale (α = .89).

Procedure.

After piloting our procedures, we proceeded with real data collection. On the first day, following online consent, participants first provided information about eligibility criteria (eating disorders, pregnancy, lactation, smoking). If they were eligible, they were redirected to the pre-study survey, where they completed another online consent form for the remainder of the study. Then, they completed a survey that included the SEES, and measures of dietary restraint, depressive and anxious symptoms. They also reported their height and weight for later BMI calculations, demographic information, and a brief open-ended question asking them to describe their day thus far. Upon checking these open-ended responses for good faith participation, all participants were invited to complete three consecutive days of daily emotion ratings and their daily stress, as well as reports on their daily food intake; they were sent these measures at midnight and asked to complete them by noon of each day. At the end of the final day of data collection, participants were compensated and debriefed. All study procedures were approved by the Social, Behavioral, and Educational Research Institutional Review Board at Tufts University and the United States Army Human Research Protections Office. See Figure 5 for a visual representation of study procedures.

Results

Preliminary analyses

What were the descriptive statistics of our variables? We computed descriptive statistics for all variables, namely, daily ratings of food intake, sadness, anxiety, ratio of meals had with others, actual stress, and perceived stress, as well as overall self-reported sad- and anxious-eating, BMI, dietary restraint, general distress, positive affect, and somatic anxiety, split by day (see Table 8). Of note, similar to Study 1, average daily levels of sadness and anxiety were quite low. Moreover, average daily food intakes, which were between 1880-1900 calories, were somewhat lower than the average calorie consumption of American adults (2,092 kcals; US Department of Agriculture, 2014).

Were variables correlated with each other? We conducted bivariate correlations between variables, namely, daily ratings of food intake, sadness, anxiety, ratio of meals had with others, actual and perceived stress, as well as overall self-reported sad- and anxious-eating, BMI, dietary restraint, general distress, positive affect, and somatic anxiety, split by day. Here, we highlight significant moderate or large correlations ($r \geq .30$; see Table 9 for a complete correlation matrix). Daily sadness ratings were strongly and positively correlated with daily anxiety ratings, actual and perceived stress, general distress, and somatic anxiety, and moderately and negatively correlated with positive affect on all three days. Similarly, daily anxiety ratings were strongly and positively correlated with actual and perceived stress, general distress, and somatic anxiety, and moderately and negatively correlated with positive affect on all three days. Those who had higher somatic anxiety also had more meals with others on all three days. Daily ratings of actual stress were positively correlated with perceived stress, general distress, and somatic anxiety, and negatively correlated with positive affect on all three days. Finally, daily ratings of perceived stress were positively correlated with general distress and somatic anxiety, and negatively correlated with positive affect on all three days. Looking at between-subjects measures, self-reported sad-eating was strongly and positively correlated with self-reported anxious eating, and moderately and positively correlated with general distress and negatively correlated with positive affect. Finally, general distress and somatic anxiety were positively correlated with each other, and negatively correlated with positive affect.

Confirmatory Analysis

Did self-reported anxious- and sad-eating scores interact with reported emotion to predict food intake? We used the lme4 package in R (Bates et al., 2015) to conduct a linear mixed-effects regression (LMER) model with a continuous outcome variable, specifically food intake measured in kcals. We had four self-reported, continuous fixed effects predictors of interest: daily sadness ratings, daily anxiety ratings, anxious-eating, and sad eating. We allowed the intercept for food intake to vary randomly across subjects. Gender (time-invariant categorical; -0.5 = men, 0.5 = women), BMI (time-invariant continuous), and Day (time-varying continuous; 0 = Day 1, 1 = Day 2, 2 = Day 3) were included as fixed effect covariates of no interest. All continuous variables were mean-centered. Evidence in support of our hypothesis would be a significant impact of the two-way interaction terms (daily anxiety*anxious-eating and daily sadness*sad-eating) on food intake. More specifically, we expected that those who are higher on the self-reported sad-eating scale will engage in higher food intake when they experience more sadness, and that those who are higher on the self-reported anxious-eating scale will engage in higher food intake when they experience more anxiety.

Because self-reported anxious- and sad-eating scores were significantly and strongly correlated, we checked for multicollinearity in our model using the car package in R (Fox & Weisberg, 2019). As expected, some VIF values were somewhat high (range = 1.04 - 5.13), indicating that multicollinearity may be an issue for this model. Results indicated that there was no effect of gender, BMI, daily sadness ratings, daily anxiety ratings, self-reported sad-eating, self-reported anxious-eating, or their hypothesized interactions on food intake, all ps > .05 (see Table 10). See Figure 6 for a visual representation of these results.

To reduce problems with multicollinearity, we also conducted 2 separate *post hoc* models, one including only sadness ratings and self-reported sad-eating, and the other including only anxiety ratings and self-reported anxious-eating, along with gender, BMI, and Day as covariates. All VIF values were less than 1.2, indicating that multicollinearity was not an issue for these models. Results indicated that none of our predictors, or their interactions significantly predicted daily calorie intake (see Table 11). In sum, our hypotheses were not supported.

Exploratory analyses

We had also aimed to conduct models like the confirmatory one described above, but including other factors that could serve as potential moderators to the relationship between emotion and eating, like the presence of others during eating episodes, dietary restraint, general distress, and perceived and actual daily stress.

However, due to very high multicollinearity (VIF values up to 76), we decided to similarly conduct these models separately for sadness and anxiety (see Table 12). All VIF values were less than 3.2, indicating that multicollinearity was less of an issue for these models. None of these factors convincingly moderated the hypothesized two-way interactions between emotion condition and self-reported sad- and anxious-eating. We also included gender and BMI as moderators instead of covariates; neither variable convincingly moderated our hypothesized interaction term.

Discussion

Current naturalistic studies of emotional eating rarely consider individual variation in people's past experiences with emotional eating. Often, studies assume that it is the emotion itself that prompts emotional eating, and therefore that people should eat following any emotion. Similar to Study 1, the main goal of this study was to determine whether acknowledging the variation in the discrete emotions that generally tend to lead people to eat more could help us more reliably observe emotional eating, but this time, in daily life. To this end, eligible participants first completed a self-reported measure of their emotional eating tendencies in response to sadness and anxiety, as well as other relevant measures such as dietary restraint, depressive and anxious symptoms, gender, and BMI. Then, participants completed a daily online survey for three days. This survey asked about the extent to which they experienced sadness and anxiety during the previous day and their total food intake for that day, as well as information about eating episodes such as location and the presence of others, and their daily stress.

One of the most important strengths of this study design was that participants reported on their own personal experiences with emotion and eating on a daily basis. This allowed us to examine emotional eating in participants' real lives, which gave our results more external validity. In addition, daily measurements of both emotion and eating reduced participant memory biases in reporting the occurrence of emotional eating, relative to measures that require longer retrospection periods.

Despite the strengths of our study, some limitations remained. First, as is the case for most studies, increases in external validity often come at the cost of internal validity. Because we collected information on emotions that people experience in their daily lives, it was likely that participants' experiences would vary both between and within people. We attempted to capture some of this variation in emotional experience by collecting daily information on the perceived intensity of emotional experiences, the presence of others during meals, daily stress, as well as general tendencies towards dietary restraint, depression, anxiety, and BMI. However, there are inevitably other sources of variation that we did not control or measure.

Collecting information on people's daily lives without experimental manipulation also meant that we were unable to detect a wide range of daily sadness and anxiety, as most people reported low levels of these emotions in their daily lives. It is possible, then, that there weren't many opportunities for emotional eating to take place, which may explain the lack of support for our hypothesis.

Finally, although we selected one of the most reliable measures of food intake, it is possible that participants still underreported their food intake (Kirkpatrick et al., 2014), given that the average reported calories per day was below the average calorie consumption of American adults (2,092 kcals; US Department of Agriculture, 2014). This may have especially been the case considering the participant burden of completing such a detailed measure of food intake; participants may have skipped entering certain foods to reduce the burden.

In conclusion, while the lack of support for our preregistered hypotheses may indicate that our hypotheses were unfounded, it is also possible that limitations in our methodology may have made it less likely that we could observe emotional eating.

General discussion

The overall goal of these two studies was to determine whether acknowledging the variation in the discrete emotions that people report generally lead them to eat more could help us more reliably observe emotional eating both in the lab (Study 1) and in daily life (Study 2). The key strength of this set of studies was that they answered this question while complementing each other's strengths and limitations. Specifically, Study 1 tested our hypothesis in a controlled lab setting; Study 2 tested the same hypothesis in an uncontrolled, but more naturalistic and therefore more externally valid setting. Another strength of this set of studies lies in our choice of SEES as a measure of self-reported emotional eating. Perhaps most important for our set of studies, unlike the DEBQ, the SEES differentiates participants' past eating behaviors following several discrete emotions. Furthermore, instead of measuring participants' past *desire* to eat (like the DEBQ), the SEES measures *actual* past eating, which we speculate may be more predictive of actual food intake in the lab and in daily life. In addition, unlike most previous studies (Bongers & Jansen, 2016), we retained the continuous nature of these emotional eating scores, increasing our power to detect the effect in which we are most interested (J. Cohen, 1983; MacCallum, Zhang, Preacher, & Rucker, 2002). Despite these strengths, however, we found no evidence[3] that self-professed sad- or anxious-eaters ate more when they were made to feel sad or anxious in the lab, or when they experienced sadness or anxiety in their daily lives.

There were several methodological limitations in this set of studies that hinder our ability to make conclusions from our findings. First, and perhaps most important, is our reliance on a self-reported, retrospective measure of emotional eating. Recent commentaries on the field of emotional eating have identified several issues with the use of such measures (Bongers & Jansen, 2016; Evers et al., 2018). While the measure we selected, the SEES, addresses several of these issues, some of them are inherent to the retrospective nature of such questionnaires. In the case of emotional eating, these measures require participants to remember 1) their past emotion, 2) their past eating behavior, and 3) the connection between the two, which may lead to what researchers have

[3] Please note, however, that the Null Hypothesis Significance Testing approach we used does not allow us to make clear statements about evidence for the null hypothesis - we can only say that we don't have evidence for the alternative hypothesis. Other statistical approaches such as equivalence testing or Bayesian approaches might be useful supplements to determine to what extent we can confidently claim evidence against the moderating hypotheses we tested.

called a “triple recall bias” (Evers, de Ridder, & Adriaanse, 2009), making it difficult for participants to identify their past emotional eating behaviors. Furthermore, these measures have also been shown to identify people who are likely to attribute their overeating to emotions retroactively, rather than true emotional eaters (Adriaanse, Prinsen, de Witt Huberts, de Ridder, & Evers, 2016).

If it is the case that emotional eating is learned, and not everyone eats when feeling emotional, it is important to be able to identify emotional eating without relying on people’s self-report. To achieve this goal, some researchers have started to develop implicit association tasks (Bongers, Jansen, Houben, & Roefs, 2013), which have been predictive of positive (but not negative) emotional eating in the lab; however, it is unclear whether these tests measure associations between emotions and eating, or emotions and food. Alternatively, researchers could observe associations as they are being formed, both in children, perhaps in the form of emotional feeding by parents (Braden et al., 2014), and in adults, perhaps via ecological momentary assessment studies, where the associations are measured as they are being made, and these assessments are then used to predict future emotional eating behaviors. Future studies can also attempt to break these presumed associations through therapy; if the reduction of these associations in turn reduce the occurrence of emotional eating in daily life, one could deduce the connection between the two.

Second in our list of limitations is the fact that the occurrence and intensity of both sadness and anxiety were quite low in both studies, perhaps rendering us unable to induce or observe emotional eating in the first place.

Furthermore, in this set of studies we chose to focus on people's experiences with sad-eating and anxious-eating for the sake of simplicity. These two emotions were selected for this set of studies because they have been the most examined emotions in the context of emotional eating thus far; but these also may not necessarily be the only or most frequently associated with eating. In fact, more recent studies are suggesting that other discrete states, such as boredom might be often associated with eating (Crockett, Myhre, & Rokke, 2015; Havermans, Vancleef, Kalamatianos, & Nederkoorn, 2015). Moreover, even if we were able to select emotions frequently associated with eating, and successfully induced or captured them with sufficient intensity, it is unclear whether they need to be high in personal relevance to trigger eating. Future studies should therefore a) examine our hypotheses using emotions of varying degrees of intensity, which could be accomplished with more effective emotion induction procedures in the lab, or by selecting high-stress time periods for daily diary studies when the occurrence of these emotions may be more likely (e.g. exam times, times of natural disaster, etc.), b) examine our hypotheses in the context of other, perhaps more frequently occurring discrete emotional states, such as boredom, and c) systematically study the effect of personal relevance of emotions on their ability to prompt eating.

And finally, third in our list of limitations is our inability to create or measure the ideal context for emotional eating, which may indeed vary widely from person to person. Based on our reading of the literature, which we described in the Introduction, we attempted to create a lab environment in Study 1 that we thought would be conducive for emotional eating. Specifically, we decorated our participant booth with paintings, posters, lamps, and added comfortable seating to make it seem more like someone's living room, and we set up our experiment such that we minimized the presence of experimenters during the study, so that participants could feel alone and unobserved. Anecdotally, we observed general comfort with the surroundings (e.g. some people spontaneously commented on how cozy the room felt, or how comfortable the chair was). However, more than half of our participants still reported awareness of our emotion manipulation and of the fact that we were measuring food intake, signaling that they were still highly aware of being observed. Similarly, for Study 2, we measured the presence of others during the meals participants were having, but we did not measure who the companions were, whether they were also eating, or any other nuances. It is unclear what types of contexts are most likely to prompt emotional eating, and whether this varies across people; therefore, a necessary first step may be a rich, detailed qualitative study of people's emotional eating behaviors, which could shed light on not only the necessary context for emotional eating, but also other issues we mentioned earlier, such as emotion intensity, personal relevance, and timing of emotional eating.

Despite these limitations, the work described here has important broader implications. First, and perhaps most important, is the theoretical implication of our work. Currently, there are considerable inconsistencies in the emotional eating literature; while correlational studies are finding that emotional eating scores may be related to serious health consequences, researchers are failing to observe emotional eating in the lab setting, as well as daily life, even in those who self-identify as emotional eaters. These inconsistencies have been unexpected and have likely halted progress in the field. As described in detail in our introduction, they may be due to an untenable assumption made by most researchers that negative emotions inherently cause eating, and therefore, that any negative emotional experience should lead to eating in the lab. In the present set of studies, we challenged this assumption, and hypothesized that emotional eating is learned, and therefore, that people may have made differential associations between different discrete emotional states and eating. We did not find support for our hypotheses, and generally failed to observe emotional eating both in the lab and in daily life. Of course, this lack of support may have been due to the methodological limitations described above. In either case, however, we are still not able to reliably identify and observe emotional eating; future work on solving this critical issue is paramount before moving forward in the field.

Moreover, there are clinical implications for our work. Despite the methodological challenges described above, we conducted a set of well-controlled, well-conceived studies, examining sad- and anxious-eating in both a lab setting and daily life. We failed to observe emotional eating in either study. Even if this lack of support was due to the methodological issues described above, these methodological issues still stem from the idea that emotional eating may be much more nuanced and highly specific to particular emotions and contexts. This points to the idea that perhaps emotional eating in healthy adults is rarer than originally thought.

In sum, the primary goal of these two studies was as follows: to determine whether acknowledging the variation in which discrete emotions lead people to eat more can help us more reliably observe emotional eating both in lab (Study 1) and in daily life (Study 2). Although our hypotheses were not supported, lessons learned from this set of studies point to an even more nuanced view in how emotional eating should be studied in the future.

References

Adriaanse, M. A., Prinsen, S., de Witt Huberts, J. C., de Ridder, D. T. D., & Evers, C. (2016). “I ate too much so I must have been sad”: Emotions as a confabulated reason for overeating. *Appetite*, *103*, 318–323. https://doi.org/10.1016/j.appet.2016.04.028

Altheimer, G., & Urry, H. L. (2019). Do emotions cause eating? The role of previous experiences and social context in emotional eating. *Current Directions in Psychological Science*, *28*(3), 234–240. https://doi.org/10.1177/0963721419837685

Baker, R. C., & Guttfreund, D. G. (1993). The effects of written autobiographical recollection induction procedures on mood. *Journal of Clinical Psychology*, *49*(4), 563–568. https://doi.org/https://doi.org/10.1002/1097-4679(199307)49:4<563::AID-JCLP2270490414>3.0.CO;2-W

Barrett, L. F. (2006). Are emotions natural kinds? *Perspectives on Psychological Science*, *1*(1), 28–58. https://doi.org/10.1111/j.1745-6916.2006.00003.x

Bates, D., Mächler, M., Bolker, B., & Walker, S. (2015). Fitting linear mixed-effects models using lme4. *Journal of Statistical Software*, *67*(1). https://doi.org/10.18637/jss.v067.i01

Baumeister, R. F., DeWall, N. C., Vohs, K. D., & Alquist, J. L. (2009). Does emotion cause behavior (apart from making people do stupid, destructive things)? In C. R. Agnew, D. E. Carlston, W. G. Graziano, & J. R. Kelly (Eds.), *Then a miracle occurs: Focusing on behavior in social psychological theory and research* (pp. 12–27).

https://doi.org/10.1093/acprof:oso/9780195377798.003.0007

Baumeister, R. F., Vohs, K. D., DeWall, N. C., & Zhang, L. (2007). How emotion shapes behavior: Feedback, anticipation, and reflection, rather than direct causation. *Personality and Social Psychology Review, 11*(2), 167–203. https://doi.org/10.1177/1088868307301033

Blair, A. J., Lewis, V. J., & Booth, D. A. (1990). Does emotional eating interfere with success in attempts at weight control? *Appetite*, *15*, 151–157. https://doi.org/10.1016/0195-6663(90)90047-C

Blechert, J., Goltsche, J. E., Herbert, B. M., & Wilhelm, F. H. (2014). Eat your troubles away: Electrocortical and experiential correlates of food image processing are related to emotional eating style and emotional state. *Biological Psychology, 96*, 94–101. https://doi.org/10.1016/j.biopsycho.2013.12.007

Blissett, J., Haycraft, E., & Farrow, C. (2010). Inducing preschool children's emotional eating: Relations with parental feeding practices. *The American Journal of Clinical Nutrition, 92*, 359–365. https://doi.org/10.3945/ajcn.2010.29375.Am

Bongers, P., de Graaff, A., & Jansen, A. (2016). "Emotional" does not even start to cover it: Generalization of overeating in emotional eaters. *Appetite, 96*, 611–616. https://doi.org/10.1016/j.appet.2015.11.004

Bongers, P., & Jansen, A. (2016). Emotional eating is not what you think it is and emotional eating scales do not measure what you think they measure. *Frontiers in Psychology*, *7,* 1–11. https://doi.org/10.3389/fpsyg.2016.01932

Bongers, P., & Jansen, A. (2017). Emotional eating and Pavlovian learning: Evidence for conditioned appetitive responding to negative emotional states. *Cognition and Emotion*, *31*(2), 284–297. https://doi.org/10.1080/02699931.2015.1108903

Bongers, P., Jansen, A., Havermans, R., Roefs, A., & Nederkoorn, C. (2013). Happy eating: The underestimated role of overeating in a positive mood. *Appetite*, *67*, 74–80. https://doi.org/10.1016/j.appet.2013.03.017

Bongers, P., Jansen, A., Houben, K., & Roefs, A. (2013). Happy eating: The Single Target Implicit Association Test predicts overeating after positive emotions. *Eating Behaviors*, *14*, 348–355. https://doi.org/10.1016/j.eatbeh.2013.06.007

Bongers, P., van den Akker, K., Havermans, R., & Jansen, A. (2015). Emotional eating and Pavlovian learning: Does negative mood facilitate appetitive conditioning? *Appetite*, *89*, 226–236. https://doi.org/10.1016/j.appet.2015.02.018

Braden, A., Rhee, K., Peterson, C. B., Rydell, S. A., Zucker, N., & Boutelle, K. (2014). Associations between child emotional eating and general parenting style, feeding practices, and parent psychopathology. *Appetite*, *80*, 35–40. https://doi.org/10.1016/j.appet.2014.04.017

Brantley, P. J., Dietz, L. S., McKnight, G. T., Jones, G. N., & Tulley, R. (1988). Convergence between the Daily Stress Inventory and endocrine measures of stress. *Journal of Consulting and Clinical Psychology*, *56*(4), 549–551. https://doi.org/http://dx.doi.org/10.1037/0022-006X.56.4.549

Brantley, P. J., Waggoner, C. D., Jones, G. N., & Rappaport, N. B. (1987). A daily stress inventory: Development, reliability, and validity. *Journal of Behavioral Medicine*, *10*(1), 61–74. https://doi.org/https://doi.org/10.1007/BF00845128

Bruch, J. (1973). *Eating Disorders: Obesity, Anorexia Nervosa and the Person Within*. New York: Basic Books.

Cappelleri, J. C., Bushmakin, A. G., Gerber, R. A., Leidy, N. K., Sexton, C. C., Lowe, M. R., & Karlsson, J. (2009). Psychometric analysis of the Three-Factor Eating Questionnaire-R21: Results from a large diverse sample of obese and non-obese participants. *International Journal of Obesity*, *33*(6), 611–620. https://doi.org/10.1038/ijo.2009.74

Cardi, V., Leppanen, J., & Treasure, J. (2015). The effects of negative and positive mood induction on eating behaviour: A meta-analysis of laboratory studies in the healthy population and eating and weight disorders. *Neuroscience and Biobehavioral Reviews*, *57*, 299–309. https://doi.org/10.1016/j.neubiorev.2015.08.011

Carney, M. A., Armeli, S., Tennen, H., Affleck, G., & O’Neil, T. P. (2000). Positive and negative daily events, perceived stress, and alcohol use: A diary study. *Journal of Consulting and Clinical Psychology*, *68*(5), 788–798. https://doi.org/10.1037/0022-006X.68.5.788

Centers for Disease Control and Prevention. (2017). Defining Adult Overweight and Obesity. Retrieved from https://www.cdc.gov/obesity/adult/defining.html

Cohen, J. (1983). The Cost of Dichotomization. *Applied Psychological Measurement*, *7*(3), 249–253. https://doi.org/10.1177/014662168300700301

Cohen, S., Kamarck, T., & Mermelstein, R. (1983). A global measure of perceived stress. *Journal of Health and Social Behavior*, *24*(4), 385–395. https://doi.org/10.2307/2136404

Crockett, A. C., Myhre, S. K., & Rokke, P. D. (2015). Boredom proneness and emotion regulation predict emotional eating. *Journal of Health Psychology*, *20*(5), 670–680. https://doi.org/10.1177/1359105315573439

Cruwys, T., Bevelander, K. E., & Hermans, R. C. J. (2015). Social modeling of eating: A review of when and why social influence affects food intake and choice. *Appetite*, *86*, 3–18. https://doi.org/10.1016/j.appet.2014.08.035

Department of Agriculture, U. S. (2014). Food Consumption and Nutrient Intakes. Retrieved from https://www.ers.usda.gov/data-products/food-consumption-and-nutrient-intakes/food-consumption-and-nutrient-intakes/#Food Consumption Estimates

Devonport, T. J., Nicholls, W., & Fullerton, C. (2017). A systematic review of the association between emotions and eating behaviour in normal and overweight adult populations. *Journal of Health Psychology*, 1–22. https://doi.org/10.1177/1359105317697813

Evers, C., de Ridder, D. T. D., & Adriaanse, M. A. (2009). Assessing yourself as an emotional eater: Mission impossible? *Health Psychology*, *28*(6), 717–725. https://doi.org/10.1037/a0016700

Evers, C., Dingemans, A., Junghans, A. F., & Boevé, A. (2018). Feeling bad or feeling good, does emotion affect your consumption of food? A meta-analysis of the experimental evidence. *Neuroscience & Biobehavioral Reviews*, *92*, 195–208. https://doi.org/10.1016/j.neubiorev.2018.05.028

Fay, S. H., & Finlayson, G. (2011). Negative affect-induced food intake in non-dieting women is reward driven and associated with restrained-disinhibited eating subtype. *Appetite*, *56*, 682–688. https://doi.org/10.1016/j.appet.2011.02.004

Finch, L. E., & Tomiyana, A. J. (2014). Stress-induced eating dampens physiological and behavioral stress responses. In R. R. Watson (Ed.), *Nutrition in Prevention and Treatment of Abdominal Obesity* (pp. 189–195). Academic Press. https://doi.org/10.1016/B978-0-12-407869-7.00018-0

Fox, J., & Weisberg, S. (2019). *An {R} companion to applied regression* (Third). Thousand Oaks, CA: Sage. Retrieved from https://socialsciences.mcmaster.ca/jfox/Books/Companion/

Fryar, C. D., Kruszon-Moran, D., Gu, Q., & Ogden, C. L. (2018). *Mean body weight, height, waist circumference, and Body Mass Index among adults: United States, 1999–2000 Through 2015–2016*. Hyattsville, MD. Retrieved from https://www.cdc.gov/nchs/data/nhsr/nhsr122-508.pdf

Furst, S., Goldman, S., Johnson, M., Pacheco, C., Tropper, M., & Cassavetes, N. (2009). *My Sister's Keeper*. United States: New Line Cinema.

Garcia, A. F., Berzins, T., Acosta, M., Pirani, S., & Osman, A. (2018). The Anxiety Depression Distress Inventory–27 (ADDI–27): New evidence of factor structure, item-level measurement invariance, and validity. *Journal of*

Personality Assessment, *100*(3), 321–332. https://doi.org/10.1080/00223891.2017.1318888

Green, P., & Macleod, C. J. (2016). SIMR: An R package for power analysis of generalized linear mixed models by simulation. *Methods in Ecology and Evolution*, *7*(4), 493–498. https://doi.org/10.1111/2041-210X.12504

Gross, J. J., & Levenson, R. W. (1995). Emotion elicitation using films. *Cognition and Emotion*, *9*(1), 87–108. https://doi.org/10.1080/02699939508408966

Hanks, T., Rapke, J., Starkey, S., & Zemeckis, R. (2000). *Cast Away*. United States: 20th Century Fox.

Harmon-Jones, C., Bastian, B., & Harmon-Jones, E. (2016). The Discrete Emotions Questionnaire: A new tool for measuring state self-reported emotions. *PLoS ONE*, *11*(8), 1–25. https://doi.org/10.1371/journal.pone.0159915

Havermans, R. C., Vancleef, L., Kalamatianos, A., & Nederkoorn, C. (2015). Eating and inflicting pain out of boredom. *Appetite*, *85*, 52–57. https://doi.org/10.1016/j.appet.2014.11.007

Herle, M., Fildes, A., Rijsdijk, F., Steinsbekk, S., & Llewellyn, C. (2017). The Home Environment Shapes Emotional Eating. *Child Development*, *00*(0), 1–12. https://doi.org/10.1111/cdev.12799

Herle, M., Fildes, A., Steinsbekk, S., Rijsdijk, F., & Llewellyn, C. H. (2017). Emotional over- and under-eating in early childhood are learned not inherited. *Scientific Reports*, *7*(9092), 1–9. https://doi.org/10.1038/s41598-017-09519-0

Herman, C. P., Roth, D. A., & Polivy, J. (2003). Effects of the Presence of Others on Food Intake: A Normative Interpretation. *Psychological Bulletin*, *129*(6), 873–886. https://doi.org/10.1037/0033-2909.129.6.873

Hernandez-Hons, A., & Woolley, S. R. (2012). Women's experiences with emotional eating and related attachment and sociocultural processes. *Journal of Marital and Family Therapy*, *38*(4), 589–603. https://doi.org/10.1111/j.1752-0606.2011.00239.x

Kaplan, H. I., & Kaplan, H. S. (1957). The psychosomatic concept of obesity. *Journal of Nervous & Mental Disease*, *125*, 181–201.

Karlsen, E., Woolley, S., Vachon, C., & Haynes, T. (2015). *Carol*. United Kingdom: Studio Canal.

Keller, C., & Siegrist, M. (2015). Ambivalence toward palatable food and emotional eating predict weight fluctuations. Results of a longitudinal study with four waves. *Appetite*, *85*, 138–145. https://doi.org/10.1016/j.appet.2014.11.024

Kenardy, J., Butler, A., Carter, C., & Moor, S. (2003). Eating, mood, and gender in a noneating disorder population. *Eating Behaviors*, *4*, 149–158. https://doi.org/10.1016/S1471-0153(03)00019-9

Kirkpatrick, S. I., Subar, A. F., Douglass, D., Zimmerman, T. P., Thompson, F. E., Kahle, L. L., … Potischman, N. (2014). Performance of the Automated Self-Administered 24-hour Recall relative to a measure of true intakes and to an interviewer-administered 24-h recall. *American Journal of Clinical Nutrition*, *100*, 233–240. https://doi.org/10.3945/ajcn.114.083238

Koenders, P. G., & van Strien, T. (2011). Emotional eating, rather than lifestyle behavior, drives weight gain in a prospective study in 1562 employees. *Journal of Occupational and Environmental Medicine, 53*(11), 1287–1293. https://doi.org/10.1097/JOM.0b013e31823078a2

Konttinen, H., Haukkala, A., Sarlio-Lähteenkorva, S., Silventoinen, K., & Jousilahti, P. (2009). Eating styles, self-control and obesity indicators. The moderating role of obesity status and dieting history on restrained eating. *Appetite*, *53*, 131–134. https://doi.org/10.1016/j.appet.2009.05.001

Lakens, D. (2014). Performing high-powered studies efficiently with sequential analyses. *European Journal of Social Psychology*, *44,* 701–710. https://doi.org/10.1002/ejsp.2023

MacCallum, R. C., Zhang, S., Preacher, K. J., & Rucker, D. D. (2002). On the practice of dichotomization of quantitative variables. *Psychological Methods*, *7*(1), 19–40. https://doi.org/10.1037/1082-989X.7.1.19

Macht, M. (2008). How emotions affect eating: A five-way model. *Appetite*, *50*, 1–11. https://doi.org/10.1016/j.appet.2007.07.002

Meule, A., Reichenberger, J., & Blechert, J. (2018). Development and preliminary validation of the Salzburg Emotional Eating Scale. *Frontiers in Psychology*, *9*(88). https://doi.org/10.3389/fpsyg.2018.00088

Oliver, G., Wardle, J., & Gibson, E. L. (2000). Stress and food choice: A laboratory study. *Psychosomatic Medicine*, *62,* 853–865. https://doi.org/10.1097/00006842-200011000-00016

Osman, A., Freedenthal, S., Gutierrez, P. M., Wong, J. L., Emmerich, A., &

Lozano, G. (2011). The Anxiety Depression Distress Inventory-27 (ADDI-27): A short version of the Mood and Anxiety Symptom Questionnaire-90. *Journal of Clinical Psychology*, *67*(6), 591–608. https://doi.org/10.1002/jclp.20784

Péneau, S. P., Ménard, E. M., Méjean, C. M., Bellisle, F. B., & Hercberg, S. H. (2013). Gender and dieting modify the association between emotional eating and weight status. *American Journal of Clinical Nutrition*, *97*, 1307–1313. https://doi.org/10.3945/ajcn.112.054916

Perugini, M., Gallucci, M., & Costantini, G. (2014). Safeguard power as a protection against imprecise power estimates. *Perspectives on Psychological Science*, *9*(3), 319–332. https://doi.org/10.1177/1745691614528519

Raspopow, K., Abizaid, A., Matheson, K., & Anisman, H. (2014). Anticipation of a psychosocial stressor differentially influences ghrelin, cortisol and food intake among emotional and non-emotional eaters. *Appetite*, *74*, 35–43. https://doi.org/10.1016/j.appet.2013.11.018

Reboussin, D. M., Demets, D. L., Kim, K., & Lan, K. K. G. (2000). Computations for group sequential boundaries using the Lan-DeMets spending function method. *Controlled Clinical Trials*, *21*, 190–207. https://doi.org/10.1016/S0197-2456(00)00057-X

Reichenberger, J., Kuppens, P., Liedlgruber, M., Wilhelm, F. H., Tiefengrabner, M., Ginzinger, S., & Blechert, J. (2018). No haste, more taste: An EMA study of the effects of stress, negative and positive emotions on eating behavior. *Biological Psychology*, *131*, 54–62.

https://doi.org/10.1016/j.biopsycho.2016.09.002

Robinson, E. (2015). Perceived social norms and eating behaviour: An evaluation of studies and future directions. *Physiology and Behavior*, *152*, 397–401. https://doi.org/10.1016/j.physbeh.2015.06.010

Robinson, E., Hardman, C. A., Halford, J. C. G., & Jones, A. (2015). Eating under observation: A systematic review and meta-analysis of the effect that heightened awareness of observation has on laboratory measured energy intake. *American Journal of Clinical Nutrition*, *102*(2), 324–337. https://doi.org/10.3945/ajcn.115.111195

Robinson, E., Haynes, A., Hardman, C. A., Kemps, E., Higgs, S., & Jones, A. (2017). The bogus taste test: Validity as a measure of laboratory food intake. *Appetite*, *116*, 223–231. https://doi.org/10.1016/j.appet.2017.05.002

Robinson, E., Thomas, J., Aveyard, P., & Higgs, S. (2014). What everyone else is eating: A systematic review and meta-analysis of the effect of informational eating norms on eating behavior. *Journal of the Academy of Nutrition and Dietetics*, *114*(3), 414–429. https://doi.org/10.1016/j.jand.2013.11.009

Royal, J. D., & Kurtz, J. L. (2010). I ate what?! The effect of stress and dispositional eating style on food intake and behavioral awareness. *Personality and Individual Differences*, *49*, 565–569. https://doi.org/10.1016/j.paid.2010.04.022

Samson, A. C., Kreibig, S. D., Soderstrom, B., Wade, A. A., & Gross, J. J. (2016). Eliciting positive, negative and mixed emotional states: A film library for affective scientists. *Cognition and Emotion*, *30*(5), 827–856.

https://doi.org/10.1080/02699931.2015.1031089

Schneider, K. L., Panza, E., Appelhans, B. M., Whited, M. C., Oleski, J. L., & Pagoto, S. L. (2012). The Emotional Eating Scale: Can a self-report measure predict observed emotional eating? *Appetite*, *58*(2), 563–566. https://doi.org/10.1016/j.appet.2012.01.012

Schubert, M. M., Irwin, C., Seay, R. F., Clarke, H. E., Allegro, D., & Desbrow, B. (2017). Caffeine, coffee, and appetite control: A review. *International Journal of Food Sciences and Nutrition*, *68*(8), 901–912. https://doi.org/10.1080/09637486.2017.1320537

Sproesser, G., Schupp, H. T., & Renner, B. (2014). The bright side of stress-induced eating: Eating more when stressed but less when pleased. *Psychological Science*, *25*(1), 58–65. https://doi.org/10.1177/0956797613494849

Steinsbekk, S., Barker, E. D., Llewellyn, C., Fildes, A., & Wichstrøm, L. (2017). Emotional Feeding and Emotional Eating: Reciprocal Processes and the Influence of Negative Affectivity. *Child Development*, *00*(0), 1–13. https://doi.org/10.1111/cdev.12756

Stice, E., Cooper, J. A., Schoeller, D. A., Tappe, K., & Lowe, M. R. (2007). Are dietary restraint scales valid measures of moderate- to long-term dietary restriction? Objective biological and behavioral data suggest not. *Psychological Assessment*, *19*(4), 449–458. https://doi.org/10.1037/1040-3590.19.4.449

Stice, E., Fisher, M., & Lowe, M. R. (2004). Are dietary restraint scales valid measures of acute dietary restriction? Unobtrusive observational data suggest not. *Psychological Assessment*, *16*(1), 51–59. https://doi.org/10.1037/1040-3590.16.1.51

Stice, E., Sysko, R., Roberto, C. A., & Allison, S. (2010). Are dietary restraint scales valid measures of dietary restriction? Additional objective behavioral and biological data suggest not. *Appetite*, *54*(2), 331–339. https://doi.org/10.1016/j.appet.2009.12.009

Subar, A. F., Kirkpatrick, S. I., Mittl, B., Zimmerman, T. P., Thompson, F. E., Bingley, C., … Potischman, N. (2012). The Automated Self-Administered 24-Hour Dietary Recall (ASA24): A resource for researchers, clinicians, and educators from the National Cancer Institute. *Journal of the Academy of Nutrition and Dietetics*, *112*, 1134–1137. https://doi.org/10.1016/j.jand.2012.04.016

Sung, J., Lee, K., & Song, Y.-M. (2009). Relationship of eating behavior to long-term weight change and body mass index: The Healthy Twin study. *Eating and Weight Disorders*, *14*(2–3), e98–e105. https://doi.org/http://dx.doi.org/10.1007/BF03327806

Tsenkova, V., Boylan, J. M., & Ryff, C. (2013). Stress eating and health. Findings from MIDUS, a national study of US adults. *Appetite*, *69*, 151–155. https://doi.org/10.1016/j.appet.2013.05.020

Van Strien, T., Cebolla, A., Etchemendy, E., Gutiérrez-Maldonado, J., Ferrer-García, M., Botella, C., & Baños, R. (2013). Emotional eating and food intake after sadness and joy. *Appetite, 66*, 20–25.

https://doi.org/10.1016/j.appet.2013.02.016

Van Strien, T., Frijters, J. E. R., Bergers, G. P. A., & Defares, P. B. (1986). The Dutch Eating Behavior Questionnaire (DEBQ) for Assessment of Restrained, Emotional, and External Eating Behavior. *International Journal of Eating Disorders*, *5*(2), 295–315.

Van Strien, T., Roelofs, K., & De Weerth, C. (2013). Cortisol reactivity and distress-induced emotional eating. *Psychoneuroendocrinology*, *38*, 677–684. https://doi.org/10.1016/j.psyneuen.2012.08.008

Van Strien, Tatjana, Herman, C. P., Anschutz, D. J., Engels, R. C. M. E., & de Weerth, C. (2012). Moderation of distress-induced eating by emotional eating scores. *Appetite*, *58*, 277–284. https://doi.org/10.1016/j.appet.2011.10.005

van Strien, Tatjana, Peter Herman, C., & Verheijden, M. W. (2012). Eating style, overeating and weight gain. A prospective 2-year follow-up study in a representative Dutch sample. *Appetite*, *59*, 782–789. https://doi.org/10.1016/j.appet.2012.08.009

Vartanian, L. R. (2015). Impression management and food intake. Current directions in research. *Appetite*, *86*, 74–80. https://doi.org/10.1016/j.appet.2014.08.021

Vartanian, L. R., Spanos, S., Herman, C. P., & Polivy, J. (2015). Modeling of food intake: A meta-analytic review. *Social Influence*, *10*(3), 119–136. https://doi.org/10.1080/15534510.2015.1008037

Vartanian, L. R., Spanos, S., Herman, C. P., & Polivy, J. (2017). Conflicting internal and external eating cues: Impact on food intake and attributions. *Health Psychology*, *36*(4), 365–369. https://doi.org/http://dx.doi.org/10.1037/hea0000447

Wallis, D. J., & Hetherington, M. M. (2004). Stress and eating: The effects of ego-threat and cognitive demand on food intake in restrained and emotional eaters. *Appetite*, *43*(1), 39–46. https://doi.org/10.1016/j.appet.2004.02.001

Wardle, J. (1990). Conditioning processes and cue exposure in the modification of excessive eating. *Addictive Behaviors*, *15*(4), 387–393. https://doi.org/10.1016/0306-4603(90)90047-2

Werthmann, J., Renner, F., Roefs, A., Huibers, M. J. H., Plumanns, L., Krott, N., & Jansen, A. (2014). Looking at food in sad mood: Do attention biases lead emotional eaters into overeating after a negative mood induction? *Eating Behaviors*, *15*, 230–236. https://doi.org/10.1016/j.eatbeh.2014.02.001

Table 1

Summary of experimental studies examining the interaction of self-reported emotional eating and induced negative emotion on eating behavior in healthy adults.

	N	Design	Emotional Eating Measure	Induced Emotion	Compared to
Dimensional approach					
Bongers, Jansen, Havermans, Roefs, & Nederkoorn, 2013	86	Between	DEBQ	Negative	Positive & Neutral
Bongers, Jansen, Houben, & Roefs, 2013	112	Between	DEBQ	Negative	Positive
Evers, de Ridder, & Adriaanse, 2009, Study 2	60	Between	DEBQ	Negative	Positive
Evers et al. 2009, Study 4	57	Between	DEBQ	Negative	Positive & Neutral
Kenardy, Butler, Carter, & Moor, 2003	114	Between	EES-II	Negative	Positive
Werthmann et al., 2014	85	Between	DEBQ	Negative	Neutral
Discrete approach					
Bongers, de Graaff, & Jansen, 2016*	43	Within	DEBQ	Sadness	Happiness
Evers et al. 2009, Study 3	37	Between	DEBQ	Sadness	Neutral
Fay & Finlayson, 2011*	30	Within	DEBQ	Sadness	Neutral
Van Strien, Herman, Anschutz, Engels, & de Weerth, 2012, Study 1*	124	Between	DEBQ	Sadness	Neutral
Van Strien et al., 2013*	60	Between	DEBQ	Sadness	Joy
Blechert, Goltsche, Herbert, & Wilhelm, 2014*	45	Within	DEBQ	Stress/Anxiety	Neutral
Oliver, Wardle, & Gibson, 2000*	68	Within	DEBQ	Stress/Anxiety	Neutral
Raspopow, Abizaid, Matheson, & Anisman, 2014	103	Between	DEBQ	Stress/Anxiety	Neutral
Royal & Kurtz, 2010	52	Between	DEBQ	Stress/Anxiety	Control
Van Strien et al., 2012, Study 2*	47	Within	DEBQ	Stress/Anxiety	Control
Van Strien, Roelofs, & De Weerth, 2013*	46	Within	DEBQ	Stress/Anxiety	Neutral
Wallis & Hetherington, 2004*	38	Within	DEBQ	Stress/Anxiety	Control
Sproesser, Schupp, & Renner, 2014*	251	Between	Single question	Exclusion	Inclusion, neutral

Note. Studies that found a significant moderation between emotional eating status and induced emotion on eating behavior are denoted with an asterisk.

Table 2

Descriptive statistics for variables in Study 1, split by emotion condition.

		Sadness		Anxiety		Neutral	
Variable	Scale range	N	Mean (SD)	N	Mean (SD)	N	Mean (SD)
Within subjects							
Food intake (grams, post-pre)	N/A	118	16.24 (14.07)	118	20.97 (14.50)	118	20.35 (14.76)
Sadness (pre-film clip)	1-7	118	1.25 (0.45)	118	1.21 (0.37)	118	1.24 (0.42)
Sadness (post-film clip)	1-7	118	2.84 (1.10)	118	1.51 (0.70)	118	1.23 (0.44)
Anxiety (pre-film clip)	1-7	118	1.50 (0.75)	118	1.59 (0.75)	118	1.46 (0.66)
Anxiety (post-film clip)	1-7	118	2.40 (1.21)	118	2.96 (1.39)	118	1.34 (0.55)
Hunger	1-7	118	4.40 (0.95)	118	4.37 (1.10)	118	4.44 (0.99)
Actual stress	1-7	117	3.54 (0.80)	118	3.50 (0.82)	117	3.54 (0.89)
Perceived stress	0-4	118	1.59 (0.77)	118	1.67 (0.74)	117	1.58 (0.78)
Between subjects							
Self-reported sad-eating	1-5	118	3.22 (0.68)				
Self-reported anxious-eating	1-5	118	2.54 (0.90)				
BMI	N/A	118	23.12 (3.42)				
Dietary restraint	1-4	118	2.27 (0.77)				
General distress	9-45	118	20.75 (6.50)				
Positive affect	9-45	117	25.03 (6.16)				
Somatic anxiety	9-45	118	14.36 (4.28)				

Table 3

Correlations between variables in Study 1, split by emotion condition.

			(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
Sadness	(1)	Food intake	1										
	(2)	Hunger	.30**	1									
	(3)	Stressful events	-0.01	0.02	1								
	(4)	Perceived stress	-0.01	-0.10	.44**	1							
	(5)	Self-reported sad-eating	-0.08	0.11	0.00	0.06	1						
	(6)	Self-reported anxious-eating	0.04	-0.04	-0.03	0.17	.32**	1					
	(7)	BMI	0.02	-0.04	0.04	-0.08	-0.02	0.12	1				
	(8)	Restrained eating	0.06	-.18*	.26**	.28**	0.08	.18*	.26**	1			
	(9)	General distress	0.12	-0.01	.38**	.51**	-0.08	-0.11	-0.03	.19*	1		
	(10)	Positive affect	0.02	0.09	-.25**	-.56**	0.01	0.08	0.08	-0.13	-.40**	1	
	(11)	Somatic anxiety	0.05	0.00	0.11	.31**	-0.14	-0.14	0.11	-0.04	.45**	-0.13	1
Anxiety	(1)	Food intake	1										
	(2)	Hunger	.39**	1									
	(3)	Stressful events	-0.01	0.01	1								
	(4)	Perceived stress	-0.05	0.00	.51**	1							
	(5)	Self-reported sad-eating	-0.07	-0.10	-.19*	-0.10	1						
	(6)	Self-reported anxious-eating	-0.02	0.02	-0.06	0.02	.32**	1					
	(7)	BMI	0.05	-0.05	0.14	0.06	-0.02	0.12	1				
	(8)	Restrained eating	-0.08	-0.06	0.09	0.18	0.08	.18*	.26**	1			
	(9)	General distress	0.15	0.15	.38**	.57**	-0.08	-0.11	-0.03	.19*	1		
	(10)	Positive affect	0.12	-0.06	-.28**	-.51**	0.01	0.08	0.08	-0.13	-.40**	1	
	(11)	Somatic anxiety	0.08	0.00	.27**	.42**	-0.14	-0.14	0.11	-0.04	.45**	-0.13	1
Neutral	(1)	Food intake	1										
	(2)	Hunger	.34**	1									
	(3)	Stressful events	0.04	-0.01	1								
	(4)	Perceived stress	-0.07	-0.08	.64**	1							
	(5)	Self-reported sad-eating	0.00	0.01	-0.09	-0.04	1						
	(6)	Self-reported anxious-eating	0.02	-0.02	-0.03	0.10	.32**	1					
	(7)	BMI	0.06	-0.06	-0.04	-0.01	-0.02	0.12	1				
	(8)	Restrained eating	0.00	0.07	0.18	.25**	0.08	.18*	.26**	1			
	(9)	General distress	0.09	0.09	.46**	.60**	-0.08	-0.11	-0.03	.19*	1		
	(10)	Positive affect	0.09	-0.05	-.28**	-.45**	0.01	0.08	0.08	-0.13	-.40**	1	
	(11)	Somatic anxiety	0.13	0.08	.29**	.30**	-0.14	-0.14	0.11	-0.04	.45**	-0.13	1

Note. N = 118 for all measures except actual stress and positive affect during sadness condition, positive affect during anxiety condition, and actual stress, perceived stress, and positive affect during neutral condition, where N = 117. * p < .05, ** p < .01.

Table 4

Linear mixed-effect regression model examining the effect of emotion manipulation and food intake measurement awareness on emotional food intake in grams in Study 1.

	Estimate (SE)
(Intercept) Sad-Neu	-0.99 (3.00)
Hunger	2.82 (0.71)***
Gender	-2.25 (2.36)
BMI	-0.20 (0.32)
Anx-Neu	4.81 (1.06)***
Food awareness	-3.98 (3.49)
Emotion awareness	-1.43 (3.37)
Food awareness x Emotion awareness	4.40 (4.45)
Observations	236.00
Log Likelihood	-899.47
Akaike Inf. Crit.	1818.95
Bayesian Inf. Crit.	1853.59

Note: All continuous predictors were mean-centered. *p<0.05; **p<0.01; ***p<0.001

Table 5

Linear mixed-effect regression model examining the effect of emotion condition, rating type (sadness or anxiety), and time on emotion ratings in Study 1.

	Estimate (SE)
(Intercept)	1.32 (0.05)***
Sadness Condition	0.68 (0.05)***
Anxiety Condition	0.50 (0.05)***
Rating Type	-0.16 (0.06)*
Time	-0.06 (0.06)
Sadness Condition x Rating type	0.25 (0.09)**
Anxiety Condition x Rating type	-0.76 (0.09)***
Sadness Condition x Time	1.31 (0.09)***
Anxiety Condition x Time	0.90 (0.09)***
Rating type x Time	0.11 (0.13)
Sadness Condition x Rating type x Time	0.57 (0.18)**
Anxiety Condition x Rating type x Time	-1.19 (0.18)***
Observations	1416.00
Log Likelihood	-1615.25
Akaike Inf. Crit.	3258.49
Bayesian Inf. Crit.	3332.07

Note. *$p < 0.05$; **$p < 0.01$; ***$p < 0.001$

Table 6

Confirmatory linear mixed-effect regression model examining predictors of emotional food intake in grams in Study 1.

	Estimate (SE)
(Intercept) Sad-Neu	-2.65 (2.02)
Hunger	3.02 (0.72)***
Gender (0.5 = F)	-2.08 (2.36)
BMI	-0.19 (0.32)
Anx-Neu	4.72 (1.11)***
Self-Reported Anxious-Eating (anxEE)	1.02 (1.43)
Self-Reported Sad-Eating (sadEE)	-2.55 (1.87)
Anx-Neu × anxEE	-1.58 (1.27)
Anx-Neu × sadEE	1.80 (1.67)
anxEE × sadEE	-0.34 (1.76)
Anx-Neu × anxEE × sadEE	0.47 (1.56)
Observations	236
Log Likelihood	-896.69
Akaike Inf. Crit.	1819.39
Bayesian Inf. Crit.	1864.42

Note. All continuous predictors were mean-centered. anxEE = Self-reported anxious-eating, sadEE = Self-reported sad-eating. *$p < 0.05$; **$p < 0.01$; ***$p < 0.001$

Table 7

Exploratory linear mixed-effect regression model examining predictors of emotional food intake in grams in Study 1.

	Emotion Ratings		Dietary Restraint	Perceived Stress	Actual Stress	General Distress	Somatic Anxiety
	Estimate (SE)		Estimate (SE)	Estimate (SE)	Estimate (SE)	Estimate (SE)	Estimate (SE)
(Intercept)	-1.04 (1.87)	(Intercept) Sad-Neu	-2.05 (2.13)	-2.56 (2.06)	-2.30 (2.13)	-2.25 (1.99)	-2.37 (2.02)
Hunger	3.37 (0.72)***	Hunger	3.09 (0.74)***	2.95 (0.75)***	2.90 (0.74)***	2.65 (0.73)***	2.80 (0.73)***
Gender (0.5 = F)	-0.97 (2.25)	Gender (0.5 = F)	-2.67 (2.46)	-2.42 (2.42)	-2.42 (2.50)	-2.59 (2.34)	-2.22 (2.34)
BMI	-0.18 (0.31)	BMI	-0.31 (0.33)	-0.11 (0.33)	-0.18 (0.34)	-0.19 (0.31)	-0.08 (0.32)
Sad	-3.34 (0.68)***	[Predictor]	2.08 (1.73)	-1.16 (1.66)	1.22 (1.29)	0.04 (0.20)	-0.32 (0.32)
sadEE	-1.75 (1.63)	Anx-Neu	4.26 (1.11)***	5.07 (1.15)***	4.70 (1.09)***	4.76 (1.12)***	4.69 (1.15)***
Anx	0.34 (0.59)	anxEE	1.06 (1.46)	1.25 (1.47)	0.63 (1.49)	1.11 (1.42)	0.91 (1.47)
anxEE	0.45 (1.25)	sadEE	-2.76 (1.91)	-2.66 (1.92)	-2.09 (1.97)	-2.49 (1.83)	-2.46 (1.88)
Sad × sadEE	-0.42 (1.12)	[Predictor] × Anx-Neu	-3.25 (1.46)*	-0.95 (2.05)	-0.73 (1.55)	0.10 (0.18)	0.17 (0.29)
Sad × Anx	0.32 (0.36)	[Predictor] × anxEE	-0.96 (1.86)	2.38 (2.04)	-0.68 (1.46)	0.49 (0.23)*	0.61 (0.32)
Anx × sadEE	0.88 (0.94)	Anx-Neu × anxEE	-1.30 (1.27)	-2.09 (1.30)	-1.64 (1.28)	-1.76 (1.30)	-1.59 (1.33)
Sad × anxEE	0.35 (0.85)	[Predictor] × sadEE	-4.05 (2.52)	1.69 (2.45)	1.69 (1.74)	-0.60 (0.33)	-0.53 (0.48)
anxEE × sadEE	-0.40 (1.52)	Anx-Neu × sadEE	1.51 (1.67)	1.75 (1.71)	1.55 (1.69)	1.70 (1.69)	1.97 (1.72)
Anx × anxEE	0.62 (0.70)	anxEE × sadEE	-0.01 (1.80)	-0.60 (1.80)	-0.88 (1.87)	-0.13 (1.76)	0.07 (1.78)
Sad × sadEE × Anx	0.44 (0.66)	[Predictor] × Anx-Neu × anxEE	2.39 (1.61)	-3.11 (2.36)	-1.33 (1.73)	0.21 (0.21)	0.21 (0.29)
Sad × sadEE × anxEE	-1.39 (1.10)	[Predictor] × Anx-Neu × sadEE	1.44 (2.18)	-1.59 (2.92)	0.04 (2.04)	-0.01 (0.30)	-0.17 (0.44)
Sad × Anx × anxEE	-0.35 (0.47)	[Predictor] × anxEE × sadEE	1.05 (2.32)	-1.85 (2.42)	-2.10 (1.97)	0.28 (0.29)	0.52 (0.46)
sadEE × Anx × anxEE	-0.18 (0.86)	Anx-Neu × anxEE × sadEE	0.62 (1.57)	-0.20 (1.71)	0.19 (1.63)	0.92 (1.61)	0.74 (1.62)
sad × sadEE × Anx × anxEE	0.55 (0.78)	[Predictor] × Anx-Neu × anxEE × sadEE	1.99 (2.02)	-1.50 (3.17)	0.14 (2.03)	-0.23 (0.27)	-0.07 (0.42)
Observations	236		236	234	233	236	236
Log Likelihood	-885.35		-878.45	-873.04	-871.41	-895.35	-893.91
Akaike Inf. Crit.	1812.71		1798.91	1788.08	1784.82	1832.70	1829.82
Bayesian Inf. Crit.	1885.45		1871.65	1860.64	1857.29	1905.44	1902.56

Note. All continuous predictors were mean-centered. Anx = Self-reported anxiety (difference score), Sad = Self-reported sadness (difference score), anxEE = Self-reported anxious-eating, sadEE = Self-reported sad-eating, [Predictor] refers to the additional exploratory predictor for each model, denoted in its title. **p* < 0.05; ***p* < 0.01; ****p* < 0.001

Table 8

Descriptive statistics for variables in Study 2, split by day.

		Day 1		Day 2		Day 3	
Variable	Scale range	N	Mean (SD)	N	Mean (SD)	N	Mean (SD)
Within subjects							
Food intake (kcal)	N/A	111	1879.81 (701.05)	111	1900.90 (740.79)	110	1881.92 (730.50)
Sadness	1-7	111	1.67 (0.99)	111	1.61 (1.02)	111	1.58 (1.01)
Anxiety	1-7	111	2.11 (1.30)	111	2.14 (1.40)	111	2.02 (1.25)
Ratio of meals with others	0-1	111	0.23 (0.25)	111	0.32 (0.35)	111	0.30 (0.27)
Actual stress	1-7	111	3.20 (1.12)	111	3.09 (1.09)	111	3.16 (1.23)
Perceived stress	0-4	111	1.34 (0.91)	111	1.26 (0.87)	111	1.23 (0.89)
Between subjects							
Self-reported sad-eating	1-5					111	3.01 (0.86)
Self-reported anxious-eating	1-5					111	2.60 (1.03)
BMI	N/A					111	27.67 (6.10)
Dietary restraint	1-4					111	2.51 (0.82)
General distress	9-45					111	17.70 (8.28)
Positive affect	9-45					111	25.03 (7.39)
Somatic anxiety	9-45					111	12.18 (4.82)

Table 9

Correlations between variables in Study 2, split by day.

			(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)
Day 1	(1)	Food intake (kcal)	1												
	(2)	Sadness	0.02	1											
	(3)	Anxiety	0.05	.71**	1										
	(4)	Ratio of meals had with others	0.04	0.01	0.11	1									
	(5)	Actual stress	0.03	.50**	.47**	.20*	1								
	(6)	Perceived stress	-0.03	.63**	.67**	0.03	.52**	1							
	(7)	Self-reported sad-eating	0.14	0.06	0.13	0.11	0.16	0.09	1						
	(8)	Self-reported anxious-eating	0.00	0.09	0.01	0.07	0.05	0.04	.60**	1					
	(9)	BMI	0.09	0.09	0.05	-0.04	.25**	0.16	.29**	.25**	1				
	(10)	Dietary restraint	-0.02	.26**	.27**	0.15	.35**	0.19	0.13	-0.01	0.12	1			
	(11)	General distress	0.01	.65**	.67**	0.10	.49**	.66**	.29**	.23*	.21*	.25**	1		
	(12)	Positive affect	-0.02	-.37**	-.43**	0.04	-.38**	-.51**	-.31**	-0.14	-.28**	-0.16	-.61**	1	
	(13)	Somatic anxiety	-0.08	.47**	.42**	.25**	.32**	.37**	0.00	0.04	-0.07	0.10	.63**	-.19*	1
Day 2	(1)	Food intake (kcal)	1												
	(2)	Sadness	-0.09	1											
	(3)	Anxiety	-0.02	.63**	1										
	(4)	Ratio of meals had with others	0.12	0.10	0.09	1									
	(5)	Actual stress	0.14	.39**	.59**	0.11	1								
	(6)	Perceived stress	-0.12	.64**	.73**	0.10	.56**	1							
	(7)	Self-reported sad-eating	0.06	0.10	.23*	0.16	0.12	.19*	1						
	(8)	Self-reported anxious-eating	-0.01	0.09	0.09	0.15	0.04	0.02	.60**	1					
	(9)	BMI	0.12	0.07	0.07	-0.07	0.13	0.10	.29**	.25**	1				
	(10)	Dietary restraint	-0.07	0.09	.26**	0.07	.27**	.21*	0.13	-0.01	0.12	1			
	(11)	General distress	-0.11	.67**	.67**	.20*	.43**	.68**	.29**	.23*	.21*	.25**	1		
	(12)	Positive affect	0.07	-.38**	-.46**	-0.06	-.33**	-.61**	-.31**	-0.14	-.28**	-0.16	-.61**	1	
	(13)	Somatic anxiety	-0.16	.48**	.40**	.26**	.26**	.39**	0.00	0.04	-0.07	0.10	.63**	-.19*	1
Day 3	(1)	Food intake (kcal)	1												
	(2)	Sadness	-0.02	1											
	(3)	Anxiety	0.04	.71**	1										
	(4)	Ratio of meals had with others	0.01	-0.03	0.04	1									
	(5)	Actual stress	0.07	.53**	.56**	0.05	1								
	(6)	Perceived stress	-0.05	.66**	.69**	0.05	.55**	1							
	(7)	Self-reported sad-eating	.20*	-0.01	0.01	.21*	0.12	0.08	1						
	(8)	Self-reported anxious-eating	.26**	0.07	0.08	.19*	0.14	0.11	.60**	1					
	(9)	BMI	.23*	0.01	0.03	0.00	0.05	0.08	.29**	.25**	1				
	(10)	Dietary restraint	0.04	0.10	.25**	0.17	0.19	0.13	0.13	-0.01	0.12	1			
	(11)	General distress	-0.05	.65**	.66**	.22*	.46**	.72**	.29**	.23*	.21*	.25**	1		
	(12)	Positive affect	0.08	-.31**	-.37**	-0.07	-.27**	-.54**	-.31**	-0.14	-.28**	-0.16	-.61**	1	
	(13)	Somatic anxiety	-0.12	.48**	.42**	.31**	.30**	.45**	0.00	0.04	-0.07	0.10	.63**	-.19*	1

Note. N = 111 for all correlations except those with food intake, and all measures on Day 3, where N = 110. * p < .05, ** p < .01.

Table 10

Confirmatory linear mixed-effect regression model examining predictors of food intake in kcal in Study 2.

	Estimate (SE)
(Intercept)	2030.37 (111.81)***
Gender	-242.04 (123.31)
BMI	15.60 (10.32)
Day	8.83 (33.99)
Anx	-25.21 (60.21)
Sad	65.58 (86.12)
anxEE	-64.23 (80.75)
sadEE	127.13 (92.99)
Anx × Sad	9.03 (37.66)
Anx × anxEE	-79.33 (61.52)
Sad × anxEE	64.07 (84.69)
Anx × sadEE	39.79 (64.00)
Sad × sadEE	11.48 (82.55)
anxEE × sadEE	24.43 (65.84)
Anx × Sad × anxEE	27.35 (34.99)
Anx × Sad × sadEE	-37.41 (41.80)
Anx × anxEE × sadEE	59.29 (58.24)
Sad × anxEE × sadEE	-47.25 (56.86)
Anx × Sad × anxEE × sadEE	-39.94 (30.97)
Observations	332.00
Log Likelihood	-2514.06
Akaike Inf. Crit.	5070.11
Bayesian Inf. Crit.	5150.02

Note. All continuous predictors were mean-centered. Anx = Daily anxiety, Sad = Daily sadness, anxEE = Self-reported anxious-eating, sadEE = Self-reported sad-eating. * p <0.05; ** p <0.01; *** p <0.001

Table 11

Linear mixed-effect regression model examining confirmatory predictors of food intake in kcal in Study 2, split by emotion.

	Anxiety only		Sadness only
	Estimate (SE)		Estimate (SE)
(Intercept)	2035.72 (101.11)***	(Intercept)	2032.67 (100.81)***
Gender	-229.28 (119.16)	Gender	-226.90 (119.03)
BMI	16.94 (9.66)	BMI	14.13 (9.72)
Day	0.64 (33.25)	Day	0.45 (33.24)
Anx	9.12 (35.64)	Sad	4.47 (47.23)
anxEE	26.99 (56.98)	sadEE	75.84 (69.15)
Anx × anxEE	-11.98 (33.76)	Sad × sadEE	17.60 (44.60)
Observations	332		332
Log Likelihood	-2575.37		-2574.08
Akaike Inf. Crit.	5168.74		5166.16
Bayesian Inf. Crit.	5202.99		5200.41

Note: All continuous predictors were mean-centered. Anx = Daily anxiety, Sad = Daily sadness, anxEE = Self-reported anxious-eating, sadEE = Self-reported sad-eating. * $p < 0.05$; ** $p < 0.01$; *** $p < 0.001$

Table 12

Exploratory linear mixed-effect regression model examining predictors of food intake in kcal in Study 2.

		Restrained Eating	Perceived Stress	Actual Stress	General Distress	Somatic Anxiety	Presence of Others
		Estimate (SE)	Estimate (SE)	Estimate (SE)	Estimate (SE)	Estimate (SE)	Estimate (SE)
ANXIETY	(Intercept)	2027.99 (104.92)***	2029.26 (107.59)***	2056.76 (104.43)***	1983.14 (108.37)***	2005.67 (102.64)***	2016.90 (108.53)***
	Gender	-242.09 (123.19)	-199.39 (121.53)	-261.87 (121.51)*	-201.32 (120.34)	-201.74 (119.23)	-241.45 (119.47)*
	BMI	18.64 (10.10)	16.62 (9.81)	15.84 (9.76)	17.07 (10.02)	16.62 (9.69)	16.99 (9.67)
	Day	0.97 (33.12)	-4.59 (33.54)	-1.61 (33.46)	0.95 (33.39)	2.91 (33.39)	-1.11 (33.67)
	[Predictor]	1.15 (74.93)	-100.12 (66.05)	30.29 (42.59)	-14.63 (9.15)	-24.48 (13.50)	119.56 (142.07)
	Anx	-6.74 (41.04)	58.91 (53.53)	7.14 (48.08)	40.56 (48.61)	29.55 (38.84)	-13.35 (45.73)
	anxEE	41.25 (59.04)	38.62 (62.23)	5.17 (61.68)	79.76 (66.28)	23.58 (59.90)	69.84 (70.47)
	[Predictor] × Anx	45.01 (50.06)	-13.33 (36.78)	-0.98 (30.01)	2.17 (4.12)	3.57 (6.54)	78.93 (100.11)
	[Predictor] × anxEE	45.60 (72.48)	51.01 (58.10)	77.68 (41.78)	9.17 (8.18)	16.74 (13.79)	-172.56 (138.60)
	Anx × anxEE	-4.77 (37.67)	-23.95 (49.36)	-50.06 (46.86)	-6.16 (52.12)	-43.11 (41.00)	-56.26 (50.82)
	[Predictor] × Anx × anxEE	-43.10 (47.43)	-15.96 (30.72)	9.74 (27.95)	-4.36 (3.61)	1.70 (6.08)	127.74 (108.11)
	Observations	332	332	332	332	332	332
	Log Likelihood	-2554.07	-2554.93	-2555.51	-2562.77	-2560.55	-2550.25
	Akaike Inf. Crit.	5134.13	5135.86	5137.01	5151.54	5147.09	5126.49
	Bayesian Inf. Crit.	5183.60	5185.33	5186.48	5201.00	5196.56	5175.96
		Estimate (SE)	Estimate (SE)	Estimate (SE)	Estimate (SE)	Estimate (SE)	Estimate (SE)
SADNESS	(Intercept)	2041.45 (102.86)***	2033.56 (105.58)***	2055.13 (103.47)***	2007.41 (104.41)***	1995.19 (101.94)***	2009.70 (107.90)***
	Gender	-230.33 (121.42)	-196.02 (119.70)	-245.72 (120.86)*	-192.27 (118.61)	-218.18 (118.50)	-217.54 (118.82)
	BMI	12.61 (10.03)	15.76 (9.70)	13.97 (9.79)	17.65 (9.80)	15.31 (9.87)	14.56 (9.73)
	Day	-0.78 (33.49)	-7.04 (33.83)	2.03 (33.64)	3.81 (33.53)	-1.23 (33.21)	-7.77 (33.79)
	[Predictor]	-32.03 (72.16)	-91.23 (63.13)	32.98 (40.59)	-15.25 (8.89)	-27.37 (13.73)*	106.68 (142.24)
	Sad	33.87 (52.94)	77.02 (74.27)	-1.30 (62.21)	97.04 (76.44)	-11.41 (56.16)	-63.03 (60.81)
	sadEE	97.52 (70.85)	139.48 (77.48)	59.18 (72.38)	154.11 (73.99)*	75.56 (69.54)	131.86 (82.88)
	[Predictor] × Sad	-37.39 (73.10)	-17.71 (54.81)	-17.13 (36.39)	2.68 (5.73)	14.85 (7.69)	167.22 (113.35)
	[Predictor] × sadEE	-14.61 (76.33)	-26.50 (66.58)	-19.45 (45.28)	-2.76 (8.64)	4.87 (16.10)	-184.76 (161.29)
	Sad × sadEE	51.10 (52.35)	110.58 (79.37)	3.49 (62.14)	87.75 (65.07)	2.85 (47.50)	-57.87 (58.56)
	[Predictor] × Sad × sadEE	-92.08 (60.18)	-111.38 (71.02)	30.02 (37.65)	-9.42 (4.55)*	0.73 (8.50)	231.50 (145.53)
	Observations	332	332	332	332	332	332
	Log Likelihood	-2552.24	-2551.80	-2554.87	-2559.27	-2557.84	-2547.38
	Akaike Inf. Crit.	5130.49	5129.59	5135.73	5144.54	5141.69	5120.77
	Bayesian Inf. Crit.	5179.95	5179.06	5185.20	5194.01	5191.15	5170.24

Note. All continuous predictors were mean-centered. Anx = Daily anxiety, Sad = Daily sadness, anxEE = Self-reported anxious-eating, sadEE = Self-reported sad-eating, [Predictor] refers to the additional exploratory predictor for each model, denoted in its title. **p* < 0.05; ***p* < 0.01; ****p* < 0.001

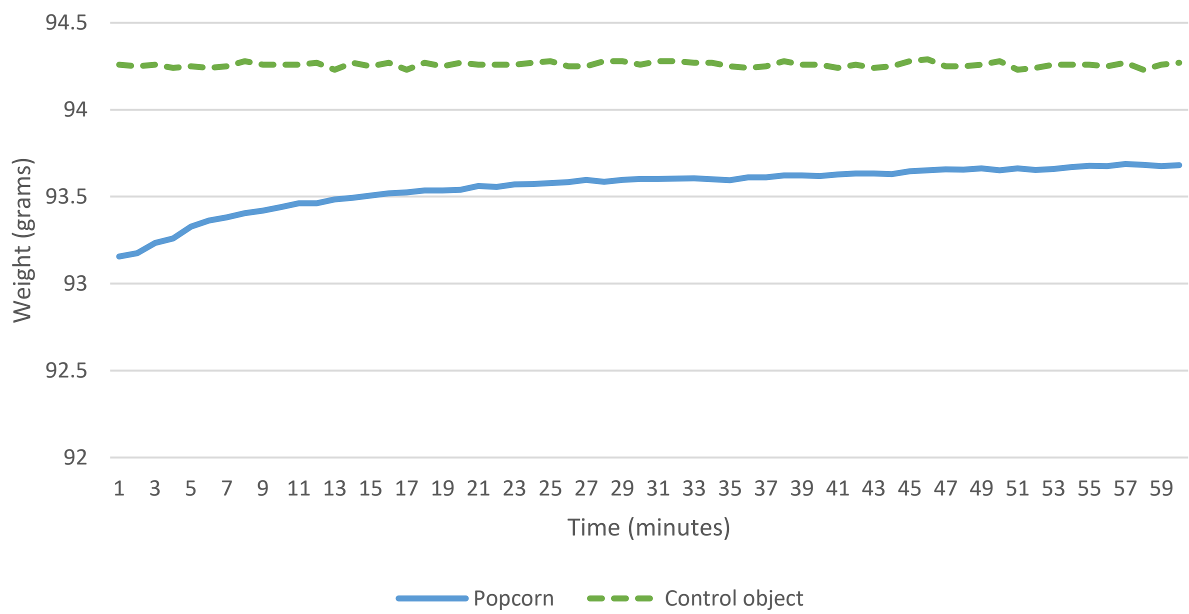

Figure 1. Weight of a bowl of popcorn (including the bowl) and a control object, over time. Popcorn measurements were made on 5 separate occasions; the mean of these measurement occasions is displayed in this figure.

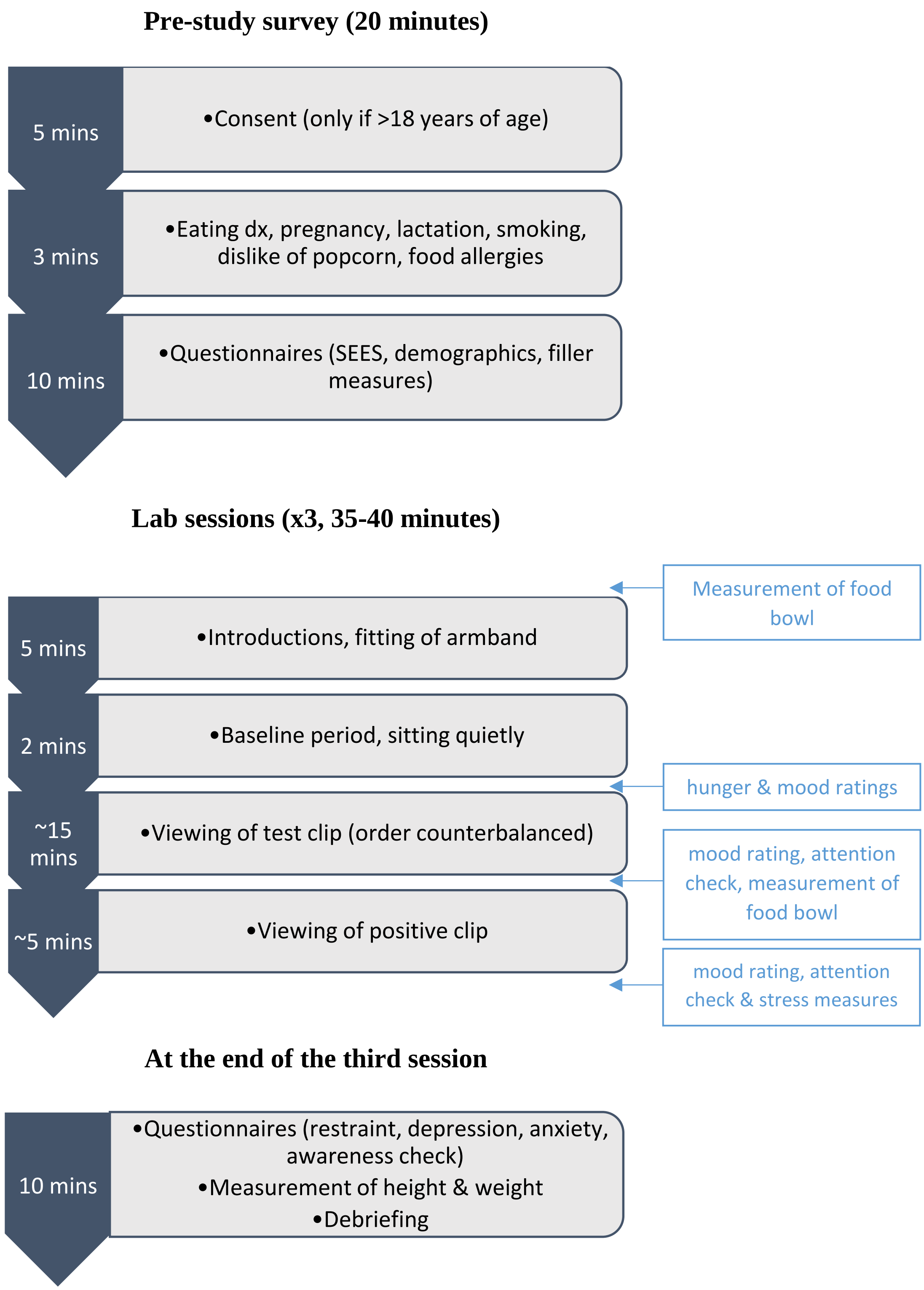

Figure 2. Visual representation of study procedures for Study 1.

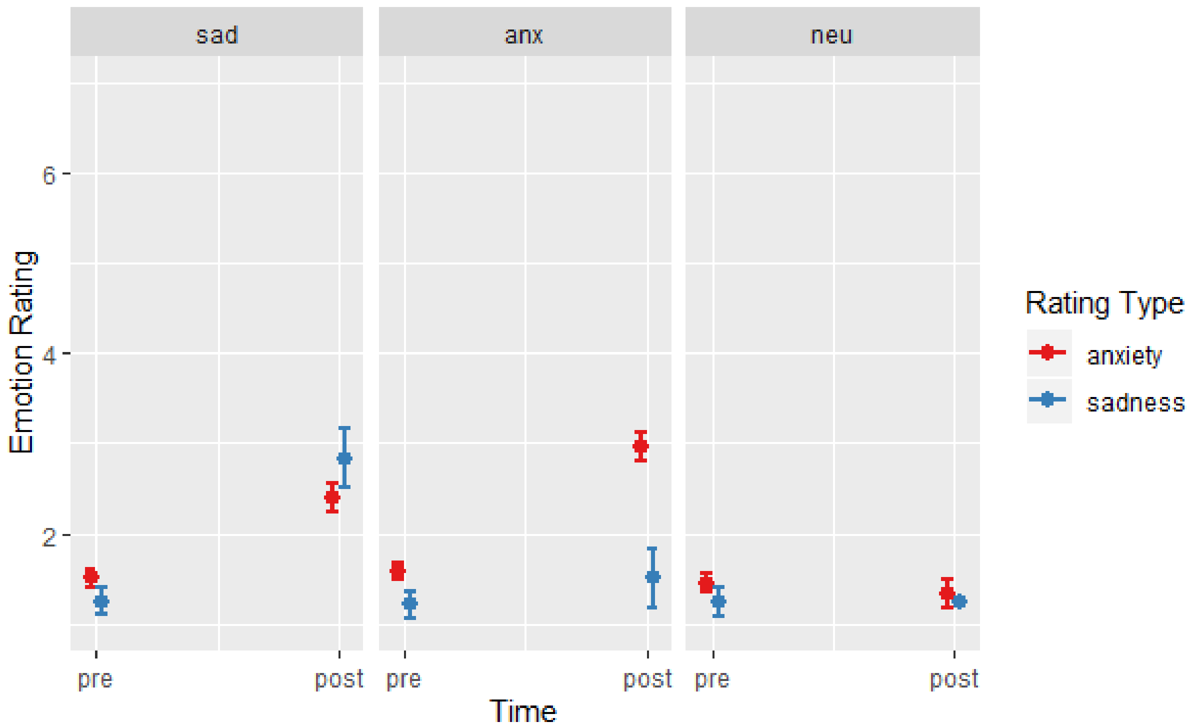

Figure 3. Emotion ratings by time for each emotion condition and rating type in Study 1.

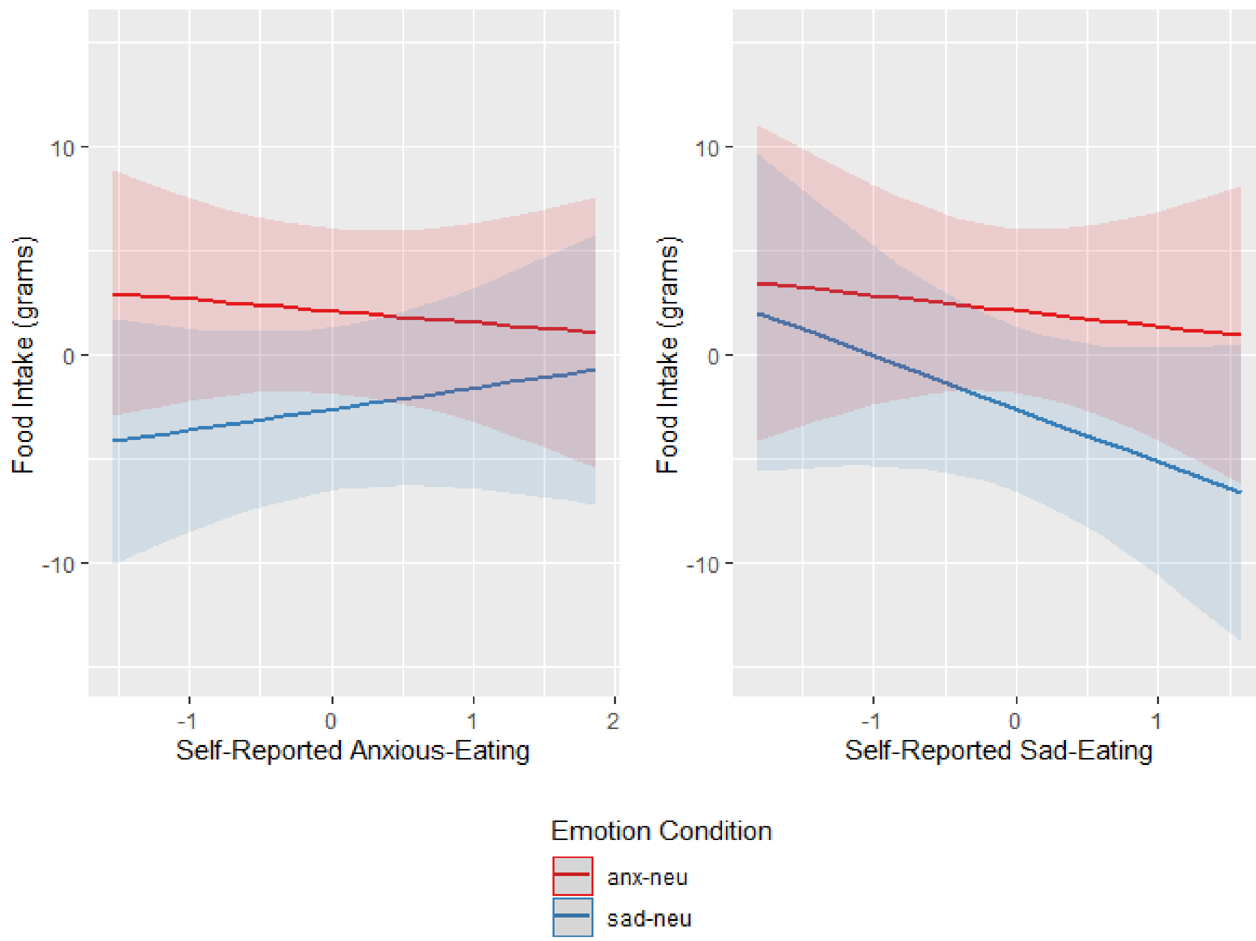

Figure 4. Food intake by self-reported emotional eating and emotion condition differences with self-reported anxious-eating on the left and self-reported sad-eating on the right for Study 1.

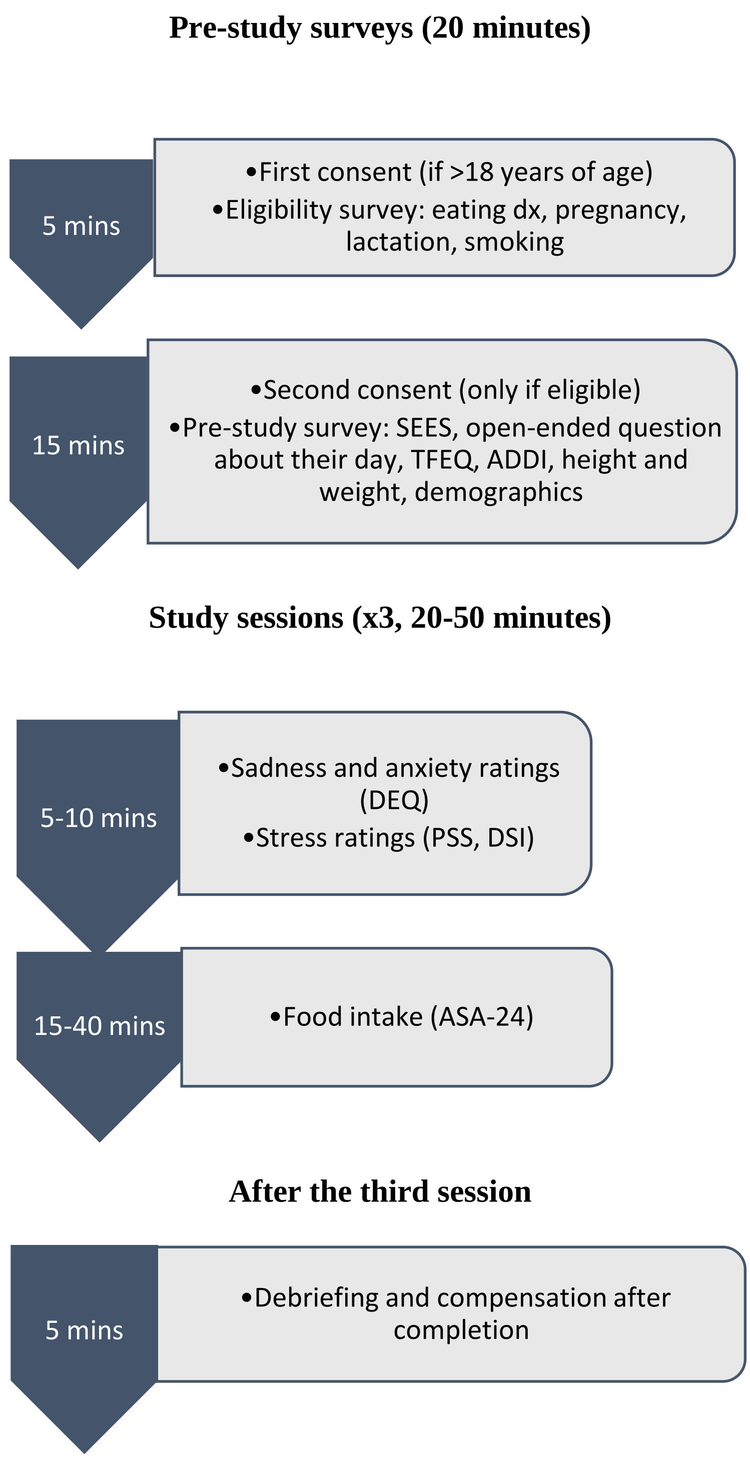

Figure 5. Visual representation of study procedures for Study 2.

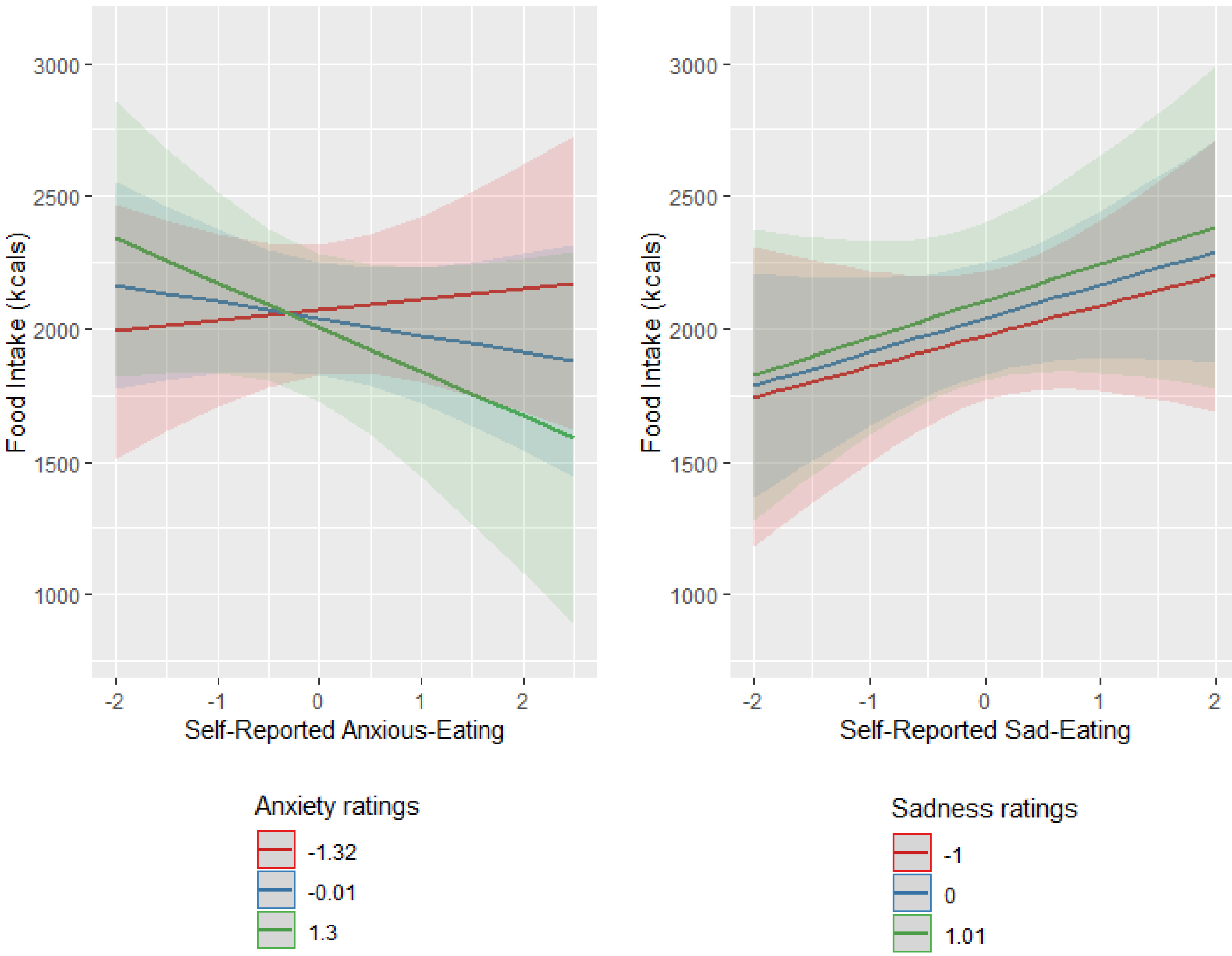

Figure 6. Food intake by self-reported emotional eating and emotion ratings with self-reported anxious-eating on the left and self-reported sad-eating on the right for Study 2. Red and green lines represent +/- 1 SD.

Appendix A

Salzburg Emotional Eating Questionnaire

When I am/feel…

1	2	3	4	5
I eat much less than usual				I eat much more than usual

Lonely (Sad)

Depressed (Sad)

Sad (Sad)

Bored (Sad)

Frustrated (Sad)

Tense (Anx)

Anxious (Anx)

Worried (Anx)

Nervous (Anx)

Uneasy (Anx)

The Discrete Emotions Questionnaire (sadness and anxiety subscales)

Please indicate your response using the scale provided.

To what extent are you experiencing these emotions, right now, in this moment?

1	2	3	4	5	6	7
Not at all	Slightly	Somewhat	Moderately	Quite a bit	Very much	An extreme amount

Dread (Anxiety)	Nervous (Anxiety)
Sad (Sadness)	Lonely (Sadness)
Grief (Sadness)	Empty (Sadness)
Anxiety (Anxiety)	Worry (Anxiety)

Perceived Stress Scale (4-item version)

Instructions: The questions in this scale ask you about your feelings and thoughts during the last 24 hours. In each case, please indicate with a check how often you felt or thought a certain way.

1. In the last 24 hours, how often have you felt that you were unable to control the important things in your life?

___0=never ___1=almost never ___2=sometimes ___3=fairly often ___4=very often

2. In the last 24 hours, how often have you felt confident about your ability to handle your personal problems?

___0=never ___1=almost never ___2=sometimes ___3=fairly often ___4=very often

3. In the last 24 hours, how often have you felt that things were going your way?

___0=never ___1=almost never ___2=sometimes ___3=fairly often ___4=very often

4. In the last 24 hours, how often have you felt difficulties were piling up so high that you could not overcome them?

___0=never ___1=almost never ___2=sometimes ___3=fairly often ___4=very often

Daily Stress Inventory

Below are listed a variety of events that may be viewed as stressful or unpleasant. Read each item carefully and decide whether or not that event occurred within the past 24 hours. If the event did not occur, place an "X" in the space next to that item. If the event did occur, indicate the amount of stress that it caused you by placing a number from 1 to 7 in the space next to that item (see numbers below). Please answer as honestly as you can so that we may obtain accurate information.

X	1	2	3	4	5	6	7
Did not occur (past 24 hours)	Occurred but was not stressful	Caused very little stress	Caused a little stress	Caused some stress	Caused much stress	Caused very much stress	Caused me to panic

1.Performed poorly at task
2.Performed poorly due to others
3.Thought about unfinished work
4.Hurried to meet deadline
5.Interrupted during task/activity
6.Someone spoiled your completed task
7.Did something you are unskilled at
8.Unable to complete a task
9.Was unorganized
10.Criticized or verbally attacked
11.Ignored by others
12.Spoke or performed in public
13.Dealt with rude person
14.Interrupted while talking
15.Was forced to socialize
16.Someone broke a promise/appointment
17.Competed with someone
18.Was stared at
19.Did not hear from someone you expected to hear from
20.Experienced unwanted physical contact (crowded, pushed)
21.Was misunderstood
22.Was embarrassed
23.Had your sleep disturbed
24.Forgot something
25.Feared illness/pregnancy
26.Experienced illness/physical discomfort
27.Someone borrowed something without your permission
28.Your property was damaged
29.Had minor accident (broke something, tore clothing)
30.Thought about the future
31.Ran out of food/personal article
32.Argued with spouse/boyfriend/girlfriend
33.Argued with another person
34.Waited longer than you wanted
35.Interrupted while thinking/relaxing
36.Someone "cut" ahead of you in line
37.Performed poorly at sport/game
38.Did something that you did not want to do
39.Unable to complete all plans for today
40.Had car trouble
41.Had difficulty in traffic
42.Money problems
43.Store lacked a desired item
44.Misplaced something
45.Bad weather
46.Unexpected expenses (fines, traffic ticket, etc.)
47.Had confrontation with an authority figure
48.Heard some bad news
49.Concerned over personal appearance
50.Exposed to feared situation or object
51.Exposed to upsetting TV show, movie, book
52."Pet peeve" violated (someone fails to knock, etc.)
53.Failed to understand something
54.Worried about another's problems
55.Experienced narrow escape from danger
56.Stopped unwanted personal habit (overeating, smoking, nailbiting)
57.Had problem with family
58.Was late for work/appointment

Any stressors that we missed? (list below)
59. ____
60. ____

The Three-Factor Eating Questionnaire-Revised 18-Item Version 2, Restraint subscale

	Definitely true	Mostly true	Mostly false	Definitely false
1. I deliberately take small helpings to control my weight.	1	2	3	4
2. I don't eat some foods because they make me fat.	1	2	3	4
3. I consciously hold back on how much I eat at meals to keep from gaining weight.	1	2	3	4

Anxiety, Depression, Distress Inventory - 27

Below is a list of feelings, sensations, problems, and experiences that people sometimes have. Please read each item and then select the appropriate choice to the right of that item. Use the choice that best describes how much you have felt or experienced things this way during the past week.

	Not at all	A little bit	Moderately	Quite a bit	Extremely
1. Felt sad	1	2	3	4	5
2. Felt discouraged	1	2	3	4	5
3. Felt worthless	1	2	3	4	5
4. Felt really happy	1	2	3	4	5
5. Felt nervous	1	2	3	4	5
6. Felt hopeless	1	2	3	4	5
7. Blamed myself for a lot of things	1	2	3	4	5
8. Felt numbness or tingling in my body	1	2	3	4	5
9. Felt like I had accomplished a lot	1	2	3	4	5
10. Felt like I had a lot of interesting things to do	1	2	3	4	5
11. Felt like I had a lot to look forward to	1	2	3	4	5
12. Felt like a failure	1	2	3	4	5
13. Was proud of myself	1	2	3	4	5
14. Felt dizzy or lightheaded	1	2	3	4	5
15. Was short of breath	1	2	3	4	5
16. Hands were shaky	1	2	3	4	5
17. Felt really "up" lively	1	2	3	4	5
18. Had a very dry mouth	1	2	3	4	5
19. Felt confident about myself	1	2	3	4	5
20. Muscles twitched and trembled	1	2	3	4	5
21. Felt like I had a lot of energy	1	2	3	4	5
22. Was disappointed in myself	1	2	3	4	5
23. Heart was racing or pounding	1	2	3	4	5
24. Was trembling or shaking	1	2	3	4	5
25. Worried a lot about things	1	2	3	4	5
26. Felt really good about myself	1	2	3	4	5
27. Had trouble swallowing	1	2	3	4	5