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A laboratory-based study of mood and binge eating behavior in overweight children

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Abstract

Purpose—Associations between negative mood and binge eating in the laboratory are well-established in adults, but such data are limited in youth. We investigated the relation between mood and binge eating in children using a laboratory feeding paradigm.

Method—Overweight girls, aged 6–12y, with (BE; $n = 23$) and without (control, CON; $n = 23$) reported objective and/or subjective binge eating underwent both sad and neutral mood inductions, followed by multi-item buffet meals.

Results—The Group X Mood Condition interaction for overall energy intake was non-significant. However, BE girls consumed more energy from fat in the sad condition as compared to the neutral condition. Baseline mood predicted BE girls' likelihood of reporting loss of control during the sad condition test meal.

Conclusions—Results suggest that emotional eating episodes in children reporting aberrant eating may be characterized by the experience of loss of control, rather than the consumption of objectively large amounts of food. Interventions focused on affect regulation may minimize the adverse consequences of pediatric binge eating.

Keywords

children; binge eating; loss of control eating; emotional eating; overweight; negative affect; feeding laboratory; eating behavior; energy intake

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1. Introduction

The prevalence of pediatric obesity has dramatically increased in the past several decades, with recent estimates suggesting that up to 17% of children and adolescents in the United States are overweight or obese (Ogden et al., 2006). In addition to its myriad physical health sequelae (Dietz, 1998), pediatric obesity is associated with a host of psychosocial problems (Strauss & Pollack, 2003), including eating pathology (Goldschmidt, Passi Aspen, Sinton, Tanofsky-Kraff, & Wilfley, 2008). In particular, binge eating is a prevalent behavior among overweight youth that is marked by physical and psychosocial impairment (Goldschmidt & Wilfley, 2009; Tanofsky-Kraff, 2008; Tanofsky-Kraff, Yanovski et al., 2009). Binge eating may complicate or exacerbate childhood obesity, and thus may represent a potential target of interventions for preventing the long-term negative consequences associated with chronic obesity and disordered eating (Jones et al., 2008; Tanofsky-Kraff, Wilfley et al., 2007; Tanofsky-Kraff et al., in press). In accordance with affect regulation theories of binge eating (Heatherton & Baumeister, 1991; Kenardy, Arnow, & Agras, 1996), negative mood has been identified as a proximal trigger to binge eating in adults and children (Hilbert, Rief, Tuschen-Caffier, de Zwaan, & Czaja, 2009; Stein et al., 2006; Tanofsky-Kraff, Goossens et al., 2007; Tanofsky-Kraff, Theim et al., 2007; Wolfe, Baker, Smith, & Kelly-Weeder, 2009); however, most research in children is limited by self-reports of eating behavior. The purpose of the current study was to examine the relation between binge eating and negative affect in children using a laboratory feeding paradigm.

Binge eating is characterized primarily by the experience of loss of control while eating (i.e., the sense that one cannot control what or how much one is eating). Both objective (i.e., consumption of an unambiguously large amount of food accompanied by loss of control while eating) and subjective binge eating (i.e., consumption of an amount of food consumed that is *not* unambiguously large, but is perceived as large by the respondent, accompanied by loss of control while eating) in children are associated with increased eating-related and general psychopathology, including emotional eating, shape and weight concerns, depression symptoms, and anxiety (Goldschmidt, Jones et al., 2008; Tanofsky-Kraff, Goossens et al., 2007; Tanofsky-Kraff, Theim et al., 2007; Tanofsky-Kraff et al., 2004). Moreover, pediatric binge eating predicts weight gain and the onset of obesity (Field et al., 2003; Tanofsky-Kraff et al., 2006; Tanofsky-Kraff, Yanovski et al., 2009), marking it as a problem with significant public health implications.

Although negative affect has been identified as a robust correlate and predictor of binge eating in children (Stice, Killen, Hayward, & Taylor, 1998; Tanofsky-Kraff, Faden, Yanovski, Wilfley, & Yanovski, 2005), little research to date has documented a causal link between the experience of negative emotions and binge eating in the laboratory (Hilbert, Tuschen-Caffier, & Czaja, 2010). While existing studies do indeed suggest that negative emotions may be a trigger for binge eating episodes in youth (Hilbert et al., 2009; Tanofsky-Kraff, Goossens et al., 2007; Tanofsky-Kraff, Theim et al., 2007), such work has relied primarily upon self-report methodology, which is often biased in children. The feeding laboratory paradigm offers a method for avoiding many of the confounding factors inherent in self-report. Feeding laboratory paradigms have long been utilized to directly observe eating behavior in a range of samples, including children (Hilbert et al., 2010; Tanofsky-Kraff, Haynos, Kotler, Yanovski, & Yanovski, 2007) and individuals with eating disorders (Mitchell, Crow, Peterson, Wonderlich, & Crosby, 1998). Feeding laboratory data suggest that eating episodes of children with binge eating problems differ from those of their peers in quantity and/or quality (Hilbert et al., 2010; Mirch et al., 2006; Tanofsky-Kraff, McDuffie et al., 2009). Moreover, feeding laboratory studies have been essential in demonstrating links between mood and binge eating behavior in adults (Agras & Telch, 1998; Chua, Touyz, & Hill, 2004; Tanofsky-Kraff, McDuffie et al., 2009; Telch & Agras, 1996). The

laboratory is thus an ideal setting for examining the relation between negative affect and binge eating in children as it enables direct observation of eating behavior and allows for experimental manipulation of mood.ⁱ

The current study utilized a feeding laboratory paradigm to investigate the impact of two distinct affect manipulations, sad and neutral, on subsequent eating behavior among overweight girls with binge eating problems, as compared to overweight controls without binge eating problems. The primary aim was to examine whether induction of a sad mood is related to aberrant eating (i.e., greater overall energy intake and/or the experience of loss of control while eating) among overweight girls reporting binge eating problems. Because the previous literature suggests that binge eating in children is related to the experience of negative emotions (Hilbert et al., 2009; Tanofsky-Kraff, Goossens et al., 2007; Tanofsky-Kraff, Theim et al., 2007) and that binge eating episodes are associated with greater overall energy intake than normal meals (Hilbert & Tuschien-Caffier, 2007; Tanofsky-Kraff, McDuffie et al., 2009), it was expected that children reporting binge eating episodes would consume more kilocalories and be more likely to report a sense of loss of control while eating following a sad mood induction relative to a neutral mood induction. The first secondary aim was to explore whether eating in response to aversive emotional states is a phenomenon specific to overweight youth experiencing binge eating, as opposed to a general function of overweight status. Given limited evidence of emotional eating behavior in the general population of overweight youth (Caccialanza et al., 2004; Jansen et al., 2003; Nguyen-Rodriguez, Chou, Unger, & Spruijt-Metz, 2008; Shapiro et al., 2007; Snoek, van Strien, Janssens, & Engels, 2007; Tanofsky-Kraff, Theim et al., 2007), an interaction between binge eating status and mood condition was predicted whereby children with binge eating problems would consume more kilocalories following a sad versus neutral mood induction, and overweight controls without binge eating problems would consume a similar quantity of food regardless of mood condition. The next secondary aim was to investigate whether level of negative affect after the sad mood induction was related to the presence of loss of control while eating during the test meal among girls reporting binge eating problems. Based on findings from the adult literature (Engelberg, Steiger, Gauvin, & Wonderlich, 2007; Smyth et al., 2007), it was predicted that higher negative mood following the sad mood induction would be related to a stronger likelihood of losing control during the subsequent test meal. The final secondary aim was to examine differences in macronutrient intake during the sad versus neutral mood inductions among girls reporting binge eating problems and overweight controls. It was expected that binge eating participants would consume a greater percentage of energy intake from carbohydrates and fat in the sad condition relative to the neutral condition, as compared to non-binge eating participants, given that carbohydrate and fat consumption is associated with both binge eating (e.g., Hilbert et al., 2010; Tanofsky-Kraff, McDuffie et al., 2009) and mood improvements (Gibson, 2006).

2. Methods

2.1. Participants

Participants were 46 overweight or obese females (body mass index [BMI; kg/m²] > 85th percentile for age and sex), aged 6–12 years. Of these, 23 participants endorsed at least one episode of objective or subjective binge eating within the past 3 months (BE), while the remaining 23 participants reported no history of binge eating and thus served as a comparison control group (CON). The BE group inclusion criterion was selected based on

ⁱBoth naturalistic and laboratory feeding studies have suggested interactional effects of dietary restraint and negative affect on binge eating and overeating in adults; however, given that the literature is inconsistent regarding associations between binge eating and dietary restraint in children, dietary restraint was not a focus of the current study.

evidence that pediatric binge eating is associated with obesity, weight gain, and psychosocial impairment, independent of episode size or frequency (Goldschmidt, Jones et al., 2008; Tanofsky-Kraff, Yanovski et al., 2009; Tanofsky-Kraff et al., 2004). The sample size provided 80% power to detect a 500 kilocalorie difference between sad and neutral mood conditions (UCLA Department of Statistics, 2004), assuming equal variances and using mean and standard deviation estimates for eating episodes reported in prior studies (Agras & Telch, 1998; Mirch et al., 2006).

Participants were recruited through local schools, children's hospitals, pediatrician referrals, community organizations (e.g., health clubs), and Volunteer for Health, a university-based research referral network. Exclusion criteria included medications or medical conditions affecting appetite, body weight, or ability to sustain attention; food restrictions or preferences precluding consumption of greater than 50% of food items presented during the laboratory test meals; current psychosis or suicidality; and a current diagnosis of bulimia nervosa. A total of 137 participants were screened for participation of the study, of whom 86 were excluded before the baseline assessment (e.g., due to ineligible BMI), and an additional 5 of whom were excluded after randomization (e.g., due to attrition, failure to comply with study procedures).

After receiving a complete description of the study, participants and their parents provided written informed consent. For ethical reasons, participants were informed that the study purpose was to examine the relation between mood and eating behavior; however, this was the extent of their knowledge about the study aims. They were not aware of the specific mood states under investigation, the content of films used for the mood inductions, or study hypotheses. The study was approved by the Washington University School of Medicine Institutional Review Board.

2.2. Procedure

After a baseline assessment visit to determine study eligibility, participants completed two separate experimental study visits, which were scheduled approximately 1 week apart. Participants were provided a Kellogg's Nutri-grain® bar (140 kilocalories, 3 g fat) and a Nestle Juicy Juice® apple juice box (100 kilocalories, 0 g fat) to consume 3 hours prior to each experimental session. At each experimental session, all participants viewed a brief (4 min 20 s) segment from either a sad ("The Champ," 1979) or neutral film ("Winged Migration," 2003). Both films are rated by the Motion Picture Association of America as appropriate for audiences of all ages. Film clips were selected as the method of mood induction because they have been shown to reliably produce the desired mood in children, are relatively rapid to administer, require little participant effort, and present few ethical concerns (Brenner, 2000). The order of film presentations (sad vs. neutral) was counterbalanced across participants. After viewing the film clips, participants were given access to a multi-item 10,000 kilocalorie buffet in a separate room, and instructed to "Please let yourself go and eat as much as you like. You may eat as much of anything as you like, but you do not have to eat anything you don't like." The buffet meal consisted of food and beverage items described by Mirch and colleagues (2006). All participants completed the experimental sessions at 11:00 am, which was selected to coincide with lunch.

2.3. Measures

2.3.1. Baseline study visit—Non-fasting weight and height were measured in triplicate via a calibrated electronic scale and stadiometer, respectively. Participants' z -BMI was calculated based on the mean of the three measurements, using CDC growth charts and accompanying procedures (Kuczmarski et al., 2000). Binge eating status was ascertained using the Eating Disorder Examination Adapted for Children (ChEDE; Bryant-Waugh,

Cooper, Taylor, & Lask, 1996). The ChEDE is a semi-structured interview based on the “gold standard” adult Eating Disorder Examination (EDE; Fairburn & Cooper, 1993). Modifications include the use of simpler language appropriate for a younger audience, and the addition of a card-sort task to supplement items addressing over-valuation of shape and weight. The ChEDE yields three-month frequency ratings for objective and subjective binge eating episodes. The ChEDE has good reliability and validity (Bryant-Waugh et al., 1996; Decaluwe & Braet, 2004; Tanofsky-Kraff et al., 2004; Watkins, Frampton, Lask, & Bryant-Waugh, 2005). Food preferences were determined using the Food Scale Questionnaire (Epstein, Saad, Giacomelli, & Roemmich, 2005), a 5-point Likert-type measure assessing preferences for the 28 food and beverage items presented during the test meals, and 40 intermixed filler food and beverage items.

2.3.2. Experimental study visits—Food items were weighed individually before and after each test meal, and the difference was used to quantify food intake. Energy intake and macronutrient composition of test meals was calculated using Nutritionist Pro Diet Analysis software (Axxya Systems, Stafford, TX, 2007). Mood state was assessed before and after the affect manipulation using the Face Scale. The Face Scale is a brief nonverbal measure assessing mood via a sequence of seven emotionally valenced faces which ranged from “really, really happy” to “really, really sad.” The Face Scale was adapted from the Wong-Baker FACES Pain Rating Scale (Wong & Baker, 1988), a visual analog scale to assess pain in children that has good reliability and validity (Bieri, Reeve, Champion, Addicoat, & Ziegler, 1990; Keck, Gerkensmeyer, Joyce, & Schade, 1996). Hunger, fullness, and desire to eat were measured before the affect manipulation and after the test meal using a 5-point Likert-type scale; these measures were not administered after the affect manipulation in order to minimize the passage of time between the affect manipulation and test meal. A qualitative interview was administered to participants after each test meal to determine loss of control while eating during the test meal. Probes from the ChEDE (e.g., “did you feel like a car without brakes?”) were utilized to ascertain the presence of loss of control. This measure was adapted from a questionnaire used by Fisher and Birch (2000).

2.4. Data Analysis

The primary outcome measure of total energy intake at each test meal was screened for outliers by group (i.e., BE and CON); outliers were defined as individuals with extreme scores at one or both test meals (i.e., > 2.5 standard deviations from their respective group means). Preliminary descriptive analyses were conducted using chi-square and t-tests. T-tests were used to determine whether compliance with instructions to consume a standard breakfast meal prior to each test meal session affected energy intake. A 2 X 2 repeated-measures ANOVA (Time [pre-mood induction vs. post-mood induction] X Mood Condition [sad vs. neutral]) was conducted on Face Scale scores as a manipulation check.

Pearson correlations were computed to examine associations between total energy intake at each test meal and baseline preferences for test meal food items, as well as pre-mood induction hunger, fullness, and desire to eat. Within-group repeated-measures ANCOVA, controlling for z-BMI, was used to examine differences in total energy intake and macronutrient composition across sad and neutral test meals for BE participants; a separate ANCOVA was completed for each dependent variable (total energy intake, percentage of energy intake from protein, percentage of energy intake from carbohydrates, and percentage of energy intake from fat). Age was also considered as a covariate in these analyses given its association with increased energy requirements in children (Butte, Moon, Wong, Hopkinson, & Smith, 1995), but since it did not contribute to any of the models, it was not included in the final ANCOVAs. Chi-square analysis was used to examine BE girls’ likelihood of reporting loss of control in the sad versus neutral film conditions. Logistic

regression was used to examine whether momentary negative affect following the sad mood induction predicted an increased likelihood of BE girls reporting a sense of loss of control during the subsequent test meal. For the dichotomous dependent variable of loss of control (yes vs. no) during the test meal in the sad condition, the first block contained pre-(sad) mood induction Face Scale score, and the second block contained post-(sad) mood induction Face Scale score.

Planned t-tests were conducted comparing the total energy intake of BE and CON children in the neutral film condition to confirm that children accurately reported on their binge eating status during the baseline study visit, based on evidence that objective and subjective binge eating episodes are both associated with greater energy intake than normal meals (Hilbert & Tuschen-Caffier, 2007; Tanofsky-Kraff, McDuffie et al., 2009). Repeated-measures ANCOVA (controlling for z-BMI) was used to examine interactional effects of binge eating status and mood condition on total energy intake and macronutrient composition of sad and neutral test meals; a separate ANCOVA was completed for each dependent variable (total energy intake, percentage of energy intake from protein, percentage of energy intake from carbohydrates, and percentage of energy intake from fat). Age was again considered as a covariate in these analyses; however, it did not contribute to any of the models and thus was not included in any of the final analyses.

3. Results

3.1. Outlier Screening

Two participants were determined to have total energy intake > 2.5 standard deviations above their respective group mean for each of their test meals. It was discovered that methodological deviations occurred during their testing sessions (one of these cases completed both of her test meals an hour later than directed, while the other case did not consume the standard breakfast meal prior to one of her test meals), and thus their data were excluded from all analyses as outliers. Although analyses yielded similar results with and without these outliers, the data reported henceforth do not include these outliers.

3.2. Participant Demographics

Participants were, on average, 10.5 years old ($SD = 1.9$). Children self-identified as African-American (54.5%, $n = 24$), Caucasian (31.8%, $n = 14$), or Other (13.6%, $n = 6$). Participants' BMI z-scores ranged from 1.2 to 3.0 ($M = 2.2$; $SD = 0.4$). There were no significant differences between BE and CON participants regarding age, z-BMI, or race/ethnicity ($ps \geq .18$). Table 1 includes a full description of sample characteristics.

Within the BE group, 1 girl reported objective binge eating episodes only; 6 girls reported both objective binge eating and subjective binge eating episodes; and the remaining 15 girls reported only subjective binge eating episodes. BE participants reported, on average, 3.5 ($SD = 8.8$) objective binge episodes (range = 0 to 35); 8.5 ($SD = 6.5$) subjective binge episodes (range = 0 to 25); and 12.0 ($SD = 13.5$) total binge eating (i.e., objective or subjective) episodes (range = 1 to 52) over the past 3 months.

3.3. Adherence to the Experimental Protocol

Participants complied with instructions to consume a standard prescribed breakfast meal on the majority of test meal occasions (94.3%, $n = 83$ out of 88 test meal occasions; i.e., 2 test meals for each of 44 participants). Non-compliers did not significantly differ from compliers in terms of overall energy intake in either the sad ($t(44) = 0.79$, $p = .44$) or neutral condition ($t(44) = 0.71$, $p = .48$).

3.4. Manipulation Check

The results of the 2 X 2 repeated-measures ANOVA conducted on Face Scale scores revealed significant main effects for both time ($F(1, 44) = 82.13, p < .001$) and mood condition ($F(1, 44) = 36.67, p < .001$), and a significant interactional effect of Time X Mood Condition ($F(1, 44) = 50.77, p < .001$), such that the sad mood induction resulted in significantly greater increases in negative affect than the neutral mood induction (see Figure 1).

3.5. Analysis of Test Meal Data

Total energy intake, and percentage energy intake from protein, from carbohydrate, and from fat were all normally distributed across both the sad and neutral test meals. Overall energy intake in both the sad and neutral conditions was positively associated with z-BMI (both $r_s = .34; p_s \geq .03$), but was unrelated to age, baseline preferences for test meal foods, and to pre-mood induction hunger, fullness, and desire to eat (absolute r range = .02 to .22; $p_s > .05$).

3.5.1. Within-Group Analyses—Within the BE group, total energy intake did not differ between the sad and neutral mood conditions ($F(1, 22) = 0.66; p = .43$; partial $\eta^2 = .03$; see Figure 2). However, BE participants consumed a significantly higher percentage of energy from fat in the sad condition ($M = 44.6; SD = 6.7$) relative to the neutral condition ($M = 43.5; SD = 6.6$), after controlling for z-BMI ($F(1, 22) = 5.50; p = .03$; partial $\eta^2 = .22$). There was no significant difference between the sad and neutral conditions in terms of percentage of energy intake from protein ($F(1, 22) = 0.00; p = .98$; partial $\eta^2 = 0.00$) or carbohydrates ($F(1, 22) = 3.35; p = .08$; partial $\eta^2 = .14$).

None of the girls in the CON group self-reported loss of control during either the sad or neutral mood condition. Most BE girls reported that they felt in control of their eating during both the sad and neutral mood conditions (59.1%, $n = 13$); however, those who did report loss of control were more likely than expected to have experienced a sense of loss of control in both mood conditions (22.7%, $n = 5$), as compared to reporting loss of control in only in the sad condition (9.9%, $n = 2$) or in only the neutral condition (9.9%, $n = 2$). Logistic regression revealed that pre-mood induction negative affect and post-mood induction negative affect together predicted an increased likelihood of reporting loss of control in the sad condition ($\chi^2(2, N = 22) = 7.08; p = .03$). Most of the model's predictive power was accounted for by pre-mood induction negative affect ($\chi^2(1, N = 22) = 7.07; p = .01$).

3.5.2. Full Sample Analyses—Within the full sample, a planned t-test revealed that BE girls ate significantly more kilocalories than CON girls in the neutral film condition ($t(44) = 2.7; p = .04$). These results were attenuated in the full interactional model, as the repeated-measures ANCOVA revealed no main effect for binge eating status ($F(1, 44) = 2.44; p = .13$). There also was no main effect for mood condition ($F(1, 44) = 0.61; p = .44$), nor an interactional effect between binge eating status and mood condition ($F(1, 44) = 0.60; p = .44$; partial $\eta^2 = .01$; see Figure 2).

The repeated-measures ANCOVA for percentage energy intake from fat revealed neither main effects for binge eating status ($F(1, 44) = 3.10; p = .09$) or mood condition ($F(1, 44) = 0.00; p = .95$), nor an interactional effect between binge eating status and mood condition ($F(1, 44) = 0.53; p = .47$; partial $\eta^2 = .01$), after controlling for z-BMI. Similarly, the repeated-measures ANCOVA for percentage energy intake from protein revealed no main effects for binge eating status ($F(1, 44) = 0.02; p = .89$) or mood condition ($F(1, 44) = 0.36; p = .55$), nor an interactional effect between binge eating status and mood condition ($F(1, 44) = 2.19; p = .15$; partial $\eta^2 = .05$). Regarding percentage energy intake from

carbohydrates, the repeated-measures ANCOVA demonstrated no main effects for binge eating status ($F(1, 44) = 2.48$; $p = .12$) or mood condition ($F(1, 44) = 0.16$; $p = .70$), and no interaction effect between binge eating status and mood condition ($F(1, 44) = 0.06$; $p = .81$; partial $\eta^2 = 0.00$).

4. Discussion

The current study examined the relation between mood and binge eating behavior among overweight girls. Although there was no differential effect of the mood inductions (i.e., sad vs. neutral) on objectively measured overall energy intake among girls reporting binge eating, a greater percentage of energy intake from fat was observed in the sad condition relative to the neutral condition among girls with binge eating. These results provide some support for negative affect as a proximal determinant of eating behavior among overweight girls reporting binge eating.

Although binge eating participants were no more likely to report a sense of loss of control while eating during the sad mood condition relative to the neutral mood condition, level of negative affect prior to the test meal did predict an increased likelihood of reporting loss of control in the sad condition. Interestingly, most of these effects were attributed to negative mood *before* the sad mood induction. Although reported mood state after the mood induction did not significantly contribute to the logistic regression model, it is possible that the negative mood induction compounded the effects of baseline low mood, and these cumulative effects elicited binge eating. Previous findings suggest the presence of a distinct subset of youth with binge eating problems who are characterized by high negative affect; these youth also report more frequent episodes of binge eating (Goldschmidt, Tanofsky-Kraff et al., 2008). Taken together, findings suggest that children predisposed to high negative affect may be more likely to lose control over their eating in response to an acute negative mood trigger.

Alternatively, the findings that baseline mood, but not post-mood induction mood state, was related to reported loss of control during the sad condition test meal may reflect that there is a longer “lag time” between the onset of negative mood and compensatory loss of control eating than was measured in the current study. This is supported by preliminary ecological momentary assessment data (Hilbert et al., 2009). It is important to understand the cognitive and emotional processes taking place during the interlude between the onset of negative mood, and the initiation of binge eating. Preliminary data suggest that children with binge eating problems endorse significantly greater use of maladaptive coping strategies in response to negative mood than age-, sex- and weight-matched controls (Czaja, Rief, & Hilbert, 2009). Frequently reported strategies include “giving up” and “perseveration” (Czaja et al., 2009); this combination of avoidance and rumination may result in a delayed reaction to the original event that precipitated the onset of negative mood. More generally, alexithymia, which involves an inability to identify, articulate, and cope with emotions (Sifneos, 1996), has been proposed as a central feature of binge eating in children (Tanofsky-Kraff, Goossens et al., 2007), given children’s self-reports of numbing and dissociation during loss of control eating episodes. Further research is warranted to explore interoceptive awareness and coping in children with binge eating in order to inform intervention development.

While the mood inductions did not differentially impact overall energy intake, binge eating girls consumed a greater percentage of energy from fat in the sad condition relative to the neutral condition. Negative affect has been associated with increased fat intake in human samples (Cartwright et al., 2003; Habbab, Sheldon, & Loeb, 2009), especially among emotional eaters (Nguyen-Michel, Unger, & Spruijt-Metz, 2007; Oliver, Wardle, & Gibson,

2000; Wallis & Hetherington, 2009), and higher fat intake has in turn been associated with reduced cognitive alertness and attention (Dye, Luch, & Blundell, 2000; Gibson, 2006), perhaps reflecting an enhanced state of relaxation. Binge eating girls' greater energy intake from fat during the sad mood condition may reflect a tendency to seek comfort from high-fat foods during times of increased negative affect. While a greater energy intake from fat did not translate to increased energy intake in the sad mood condition, this pattern of eating may in fact lead to a positive energy balance over a longer duration of time, given that fat contains more kilocalories per gram (9 kilocalories per gram) than either carbohydrates or protein (each 4 kilocalories per gram). Furthermore, as excess intake of dietary fat has been associated with weight gain, obesity, and binge eating (Moussavi, Gavino, & Receveur, 2008; Yanovski et al., 1992), recurrent bouts of emotional eating that are characterized by elevated fat intake may promote the development and maintenance of obesity in children. However, since the effect size for fat intake fell within the small range, our findings require replication.

There are a number of plausible explanations as to why the mood inductions did not differentially impact overall energy intake among binge eating girls as hypothesized. Results indicated that negative affect was somewhat increased following the neutral mood induction; however, as the average mood rating after the neutral film was 2.73 (corresponding to "sort of happy," with a rating of "4" corresponding to "just ok"), the goal of the mood induction to elicit a more "neutral" mood appears to have been fulfilled. Thus, it is unlikely that a failure of the experimental mood inductions precluded expected differences in overall energy intake. Instead, while the manipulation check indicated that the sad film resulted in significantly greater levels of negative affect than the neutral film, it is possible that the affect manipulation did not induce a sufficient *intensity* (Brehm, 1999; Crosby et al., 2009) or *type* of negative affect to impact eating behavior (Baumeister, DeWall, Ciarocco, & Twenge, 2005; Oliver et al., 2000; Tanofsky-Kraff, Wilfley, & Spurrell, 2000). Alternatively, the laboratory setting may not elicit the type of eating behavior that occurs in children's natural environment; this may be especially salient when examining binge eating, which tends to be secretive in nature (Tanofsky-Kraff, Goossens et al., 2007). Thus, other forms of methodology (e.g., ecological momentary assessment) may be better suited to capture the relation negative affect and binge eating in children (Hilbert et al., 2009). Finally, it is possible that emotional eating in children with binge eating problems is related to the experience of loss of control while eating, rather than amount of food consumed.

The current study has important clinical implications. Given that negative mood was associated with increased likelihood of reporting loss of control while eating, interventions focused on improving affect regulation may reduce the occurrence of binge eating and slow the trajectory of weight gain observed in children reporting binge eating episodes. Cognitive behavioral therapy and interpersonal psychotherapy, both of which seek to modify negative affect as a mode of reducing binge eating, have shown initial promise in the reducing the frequency of binge eating episodes among children and adolescents (Jones et al., 2008; Tanofsky-Kraff et al., in press). The current study's findings that negative mood predicted self-reported loss of control while eating may help explain these positive results, as reducing negative affect may in turn decrease reliance on food for comfort or alleviation of distress. Further research is necessary to elucidate whether the mechanism of action of these treatments is through decreasing negative affect-related binge eating among children.

Strengths of the current study include the community-based, ethnically diverse sample, and the use of well-validated measures for the assessment of binge eating. Most components of the experimental protocol, including the mood induction procedures (Gross & Levenson, 1995; Rottenberg, Ray, & Gross, 2007) and the laboratory test meal (Mirch et al., 2006; Tanofsky-Kraff, McDuffie et al., 2009), had been validated in previous studies. Finally,

while loss of control during the test meals was ascertained via self-report, the brief time lapse between the eating episode and assessment of loss of control while eating reduces concerns about retrospective recall that are typically encountered in other studies based on self-report. Limitations include the restricted sample of overweight girls, precluding generalization of study findings to males and non-overweight children. Moreover, as mentioned above, the laboratory-based study design may limit generalizability of study findings to eating behavior in the natural environment.

In summary, emotional eating appears to be a phenomenon that is relevant to overweight children reporting binge eating problems. Results of the current study are consistent with the previous literature documenting associations between binge eating and negative affective states (Tanofsky-Kraff, Goossens et al., 2007; Wolfe et al., 2009), and provide some support for affect regulation theories of binge eating. Further exploration of the phenomenology of binge eating and emotional eating in overweight children is warranted in order to inform the development of effective prevention and treatment interventions for aberrant eating and obesity in childhood.

Research Highlights

- We investigated the relation between mood and eating behavior in overweight children with and without reported binge eating problems using a laboratory feeding paradigm.
- Overall energy intake in children with binge eating problems did not differ between sad and neutral mood conditions.
- Binge eating children consumed more energy from fat in a sad mood condition as compared to a neutral mood condition.
- Baseline mood predicted binge eating children's likelihood of reporting loss of control during a sad mood condition test meal.

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Figure 1. Changes in mood patterns before and after mood inductions in sad and neutral mood conditions

Figure 2.
Mean overall energy intake during sad and neutral mood conditions among participants with and without binge eating problems

Table 1

Demographic characteristics of study participants

Variable	CON (<i>n</i> = 22)	BE (<i>n</i> = 22)	Total (<i>N</i> = 44)
Age	10.33 (1.99)	10.60 (1.84)	10.47 (1.90)
Ethnicity, % (<i>n</i>)			
Black	50.0 (11)	59.1 (13)	54.5 (24)
White	40.9 (9)	22.7 (5)	31.8 (14)
Other	9.1 (2)	18.2 (4)	13.6 (6)
z-BMI	2.10 (0.44)	2.27 (0.40)	2.19 (0.43)
BMI percentile	97.20 (3.27)	98.25 (2.00)	97.72 (2.73)

Note: For all variables, *M* (*SD*) are reported unless otherwise specified. BE = at least one objective or subjective binge eating episode in the past 3 months; CON = no history of binge eating