HHS Public Access

Author manuscript

Appetite. Author manuscript; available in PMC 2015 August 01.

Published in final edited form as:

Appetite. 2015 August 1; 91: 343–350. doi:10.1016/j.appet.2015.04.072.

Depressed Affect and Dietary Restraint in Adolescent Boys' and Girls' Eating in the Absence of Hunger

Nichole R. Kelly[a,b,c,*], **Lauren B. Shomaker**[b,c,*], **Courtney K. Pickworth**[b], **Mariya V. Grygorenko**[b], **Rachel M. Radin**[a,b], **Anna Vannucci**[a,b], **Lisa M. Shank**[a,b], **Sheila M. Brady**[b], **Amber B. Courville**[d], **Marian Tanofsky-Kraff**[a,b], and **Jack A. Yanovski**[b]

[a]Department of Medical and Clinical Psychology, Uniformed Services University of the Health Sciences (USUHS), 4301 Jones Bridge Road, Bethesda, MD, 20814, USA

[b]Section on Growth and Obesity, Program in Developmental Endocrinology and Genetics, *Eunice Kennedy Shriver* National Institute of Child Health and Human Development (NICHD), National Institutes of Health (NIH), Department of Health and Human Services (DHHS), 10 Center Drive, Bethesda, MD, 20892, USA

[c]Colorado State University, 303A Behavioral Sciences Building, Campus Delivery 1570, 410 Pitkin Street, Fort Collins, CO, 80523, USA

[d]Nutrition Department, Clinical Center, NIH, 10 Center Drive, Bethesda, MD, 20892, USA

Abstract

Data suggest that depressed affect and dietary restraint are related to disinhibited eating patterns in children and adults. Yet, experimental research has not determined to what extent depressed affect acutely affects eating in the absence of physiological hunger (EAH) in adolescents. In the current between-subjects experimental study, we measured EAH in 182 adolescent (13-17y) girls (65%) and boys as *ad libitum* palatable snack food intake after youth ate to satiety from a buffet meal. Just prior to EAH, participants were randomly assigned to view either a sad or neutral film clip. Dietary restraint was measured with the Eating Disorder Examination. Adolescents who viewed the sad film clip reported small but significant increases in state depressed affect relative to adolescents who viewed the neutral film clip ($p < .001$). Yet, there was no main effect of film condition on EAH ($p = .26$). Instead, dietary restraint predicted greater EAH among girls, but not boys ($p < .001$). These findings provide evidence that adolescent girls' propensity to report restrained eating is associated with their greater disinhibited eating in the laboratory. Additional experimental research, perhaps utilizing a more potent laboratory stressor and manipulating both affective state and dietary restraint, is required to elucidate how state affect may interact with dietary restraint to influence EAH during adolescence.

Keywords

Eating in the absence of hunger; Dietary restraint; Mood; Negative affect; Emotional eating

Correspondence to: Dr. Lauren Shomaker, 303A Behavioral Sciences Building, Campus Delivery 1570, 410 Pitkin Street, Fort Collins, CO, 80523, USA, Tel: 970-491-3217, Fax: 970-491-7975, lauren.shomaker@colostate.edu.

*These authors contributed equally to this work.

Eating in the absence of hunger (EAH) refers to consuming foods in the absence of perceived physiological hunger (Kral & Faith, 2007). Typically measured as intake of palatable snack foods after eating a meal to satiety, EAH is one behavioral manifestation of food disinhibition that may be important for obesity risk (French, Epstein, Jeffery, Blundell, & Wardle, 2012). Increased exposure to large portions of inexpensive, readily available, palatable, and energy-dense foods in contemporary Western cultures is a well-recognized contributor to positive trends in overeating behaviors that promote a positive energy balance (J. O. Hill & Peters, 1998). Indeed, overweight and obese youth (body mass index [BMI, kg/m^2] ≥ 85^{th} percentile for age and sex) consume more energy from palatable snack foods in the absence of hunger than youth who are not overweight (Cutting, Fisher, Grimm-Thomas, & Birch, 1999; Fisher & Birch, 2002; Fisher, et al., 2007; C. Hill, et al., 2008; Moens & Braet, 2007; Shomaker, et al., 2010). Despite widespread access to palatable foods, frequency of EAH varies substantially at the individual level (Kral, et al., 2010; Moens & Braet, 2007). Research is needed to understand potentially modifiable factors that explain the significant variation in EAH that persists between individuals.

From a number of theoretical perspectives, depressed affect is hypothesized to play a role in disinhibited eating. Emotion regulation models posit that acute increases in negative affect trigger disinhibited eating episodes as an attempt to alleviate or escape from emotional distress (R. C. Hawkins & Clement, 1984; Heatherton & Baumeister, 1991). Indeed, depressive symptoms are positively associated with adolescents' self-reported consumption of sugary foods and percent calories from fat (Fulkerson, et al., 2004; Kim, Yang, Kim, & Lim, 2013), as well as the onset of disinhibited eating among girls (Skinner, Haines, Austin, & Field, 2012; Stice, Presnell, & Spangler, 2002). Similarly, we have found that adolescents' depressive symptoms were associated with greater observed total energy intake and greater intake of sweet snack foods at a buffet lunch meal, controlling for inter-individual variations in body composition (Mooreville, et al., 2014). Data from our laboratory have also illustrated that children's and adolescents' pre-meal state depressed affect was positively correlated with energy intake at a buffet lunch meal, even after adjusting for individual differences in body composition (Ranzenhofer, et al., 2013; Vannucci, et al., 2012). However, these correlational studies evaluated eating in a fasted or hungry state and the extent to which depressive symptoms and/or state depressed affect influence adolescents' eating in the absence of physiological hunger is unclear. Studies utilizing experimental methods are essential for determining to what extent state depressed mood has an acute effect on disinhibited eating.

Relatively few experimental studies have evaluated the effect of negative state affect, depressive or otherwise, on EAH. Furthermore, existing data are mixed. In several studies of adults, exposure to a laboratory stressor, compared to a neutral control condition, resulted in greater EAH, particularly among overweight participants (Born, et al., 2010; Lemmens, Rutters, Born, & Westerterp-Plantenga, 2011; Rutters, Nieuwenhuizen, Lemmens, Born, & Westerterp-Plantenga, 2009). In contrast, among children ages 6-13y, there was no effect of a negative or neutral mood induction on EAH in the laboratory (Hilbert, Tuschen-Caffier, & Czaja, 2010). The effect of negative affect on EAH in adolescents has not been experimentally evaluated.

Adolescence is an especially salient developmental period to elucidate the potential effects of depressed affect on disinhibited eating patterns. Marked by increases in negative affect, particularly among girls (Flook, 2011; Weinstein, Mermelstein, Hankin, Hedeker, & Flay, 2007), adolescence also is an important time for increases in dietary restraint, which refers to intentions to cut back or reduce an individual's energy intake, regardless of whether a person is successful (Engelsen, 2000). According to theoretical models of restraint, efforts to limit energy intake may increase vulnerability to disinhibited overeating, including eating in the absence of hunger, when self-imposed dietary rules are violated or through heightened responsiveness to environmental food cues, regardless of whether intake is actually limited (Lowe & Levine, 2005; Polivy & Herman, 1985). Consistent with this theoretical framework, one meta-analysis indicates that dietary restraint is a prospective risk factor for the onset of reported disinhibited eating episodes in adolescents (Stice, 2002).

The relationship between dietary restraint and EAH in adolescents is not fully understood. Some laboratory eating studies suggest that the interaction of restraint and negative affect, in both state and more sustained forms, may be relevant for overeating behavior in youth. For instance, adolescents who were high in depressive symptoms and high in dietary restraint consumed the greatest energy from sweet snack foods during a laboratory buffet meal delivered after an overnight fast (Mooreville, et al., 2014). Likewise, while change in total energy intake following a laboratory-induced stress (versus a neutral condition) did not differ for children (8-12y) (Roemmich, Lambiase, Lobarinas, & Balantekin, 2011), there appears to be a significant interaction between restraint and perceived stress (Balantekin & Roemmich, 2012; Roemmich, et al., 2011; Roemmich, Wright, & Epstein, 2002). Specifically, children who were high (versus low) in both dietary restraint and perceived state stress experienced the most significant increases in total energy and snacks after a small pre-load (Balantekin & Roemmich, 2012; Roemmich, et al., 2011; Roemmich, et al., 2002). Because these investigations studied youth who were fasted (Mooreville, et al., 2014) or moderately hungry (Balantekin & Roemmich, 2012; Roemmich, et al., 2011; Roemmich, et al., 2002), it remains unclear to what extent dietary restraint, state negative affect, and depressive symptoms are relevant to EAH in adolescents.

In the current study, we sought to determine the effect of a negative mood induction on EAH in the laboratory among adolescents. We anticipated that adolescents exposed to a depressed state affect induction would consume more palatable snacks in the absence of hunger than adolescents exposed to a neutral affect induction. In addition, we aimed to evaluate the associations of depressive symptoms and dietary restraint with EAH. We expected that both factors would be positively associated with EAH, after accounting for potential demographic and anthropometric confounds such as body composition. Lastly, we evaluated the interactions among sex, depressive symptoms, dietary restraint, and state affect induction. Based upon prior research, we predicted that depressive symptoms and restraint would have a stronger impact on EAH after a depressed state affect (versus neutral) induction, and we also hypothesized that these effects might be more pronounced for girls as compared to boys (Bernier, Kozyrskyj, Benoit, Becker, & Marchessault, 2010; de Lauzon-Guillain, et al., 2009; Madowitz, et al., 2014; Nguyen-Rodriguez, Unger, & Spruijt-Metz, 2009).

Methods

Participants and procedure

Participants were healthy adolescent girls and boys, 13 to 17y old, recruited to take part in a study of eating behaviors in adolescents (ClinicalTrials.Gov ID: NCT00631644). The relationship of depressive symptoms and dietary restraint to buffet lunch-meal eating behavior in a fasted stated was previously reported for this sample (Mooreville, et al., 2014) but their EAH after depressed or neutral mood induction has not been previously reported. All participants were in good general health, determined by a physical examination and medical history conducted by an endocrinologist or nurse practitioner. Exclusion criteria were a major medical illness, a psychiatric condition likely to impede compliance to study procedures, use of medication affecting appetite or body weight, pregnancy, ongoing weight loss treatment, or reported dislike of more than 50% of foods offered at the laboratory meals. Adolescents provided written assent. Parental guardians gave written consent for participants. During the consent process, families received a complete description of all study procedures. They were informed that the purpose of the study was to better understand eating behaviors in teenagers. Consistent with similar studies in youth (e.g., Goldschmidt, Tanofsky-Kraff, & Wilfley, 2011), all possible risks or discomforts were reviewed, including that adolescents would be asked to watch a brief film clip on a return visit to the laboratory, which could cause some temporary emotional distress that typically does not last long. They were not aware of the specific films, the film content, or the study hypotheses. The Institutional Review Board of the *Eunice Kennedy Shriver* National Institute of Child Health and Human Development approved the study protocol and all procedures. Participants were financially compensated for their time and inconvenience. Adolescents attended an initial screening appointment at an outpatient pediatric clinic at the National Institutes of Health Clinical Research Center. They returned for a buffet lunch meal appointment on a separate day. For both the screening and buffet lunch meal visits, adolescents were instructed to adhere to a fast after 10:00 pm the night prior to the appointments. Reminder calls were completed 24 hours before participants' scheduled visits. Participants were reminded to begin fasting at 10:00 pm the night prior to their visit. Upon their arrival, compliance to fasting instructions was confirmed by the researcher. If participants reported consuming any food or beverage other than water since 10:00 pm the previous night, their visit was rescheduled for another day.

Measures

Body composition—Height was measured as the average of three heights collected to the nearest millimeter with a calibrated stadiometer (Holtain, Crymmych, Wales). Weight was measured in a fasted state to the nearest 0.1 kg with a calibrated digital scale (Scale-Tronix, Wheaton, IL). BMI (weight in kg/height in m^2) was calculated so that BMI standard deviation scores (BMI *z*) could be determined according to the Centers for Disease Control and Prevention 2000 standards (Kuczmarski, et al., 2000). Fat-free body mass and percentage body fat were estimated with air displacement plethysmography (Life Measurement Inc., Concord, CA) while participants were fasting and wearing only underclothes.

Puberty—Breast development was assigned according to the five stages of Tanner (Marshall & Tanner, 1969), and testicular volume (mL) was measured using a set of orchidometer beads as standards according to Prader (Marshall & Tanner, 1970; Tanner, 1981). Because most participants had begun puberty, breast development and testicular volume staging were used to classify adolescents as those in pre/early/midpuberty (girls: breast Tanner stages 1-3; boys: testes < 15 mL) or late puberty (girls: breast Tanner stages 4-5; boys: testes ≥ 15 mL).

Depressive symptoms—Adolescents self-reported depressive symptoms on the reliable and well-validated Beck Depression Inventory, Second Edition (BDI-II), a 21-item questionnaire used to assess the continuous severity of depressive symptoms over the past two weeks (Beck, Steer, & Brown, 1996). Items are rated on a Likert scale of 0 = absence of symptom to 3 = high severity of symptom, and a total score is calculated as the sum of all items (Beck, et al., 1996). The BDI-II has been used extensively with adolescents and has good estimated internal reliability, sensitivity and specificity, and validity for both clinical and non-clinical samples in this age group (Stockings, et al., 2015).

Dietary restraint—The Eating Disorder Examination (EDE), a semi-structured interview, was administered by trained interviewers to assess dietary restraint, which measures intentions to cut back or reduce an individual's energy intake, regardless of a whether a person is successful, over the past 28 days (Fairburn & Cooper, 1993). The dietary restraint subscale is derived from five items rated by interviewers on a Likert scale of 0 = absence of restraint to 6 = high severity of restraint, and a total score is derived by averaging the items. The EDE shows satisfactory discriminant validity, internal consistency (Wade, Byrne, & R., 2008), concurrent validity and inter-rater reliability in samples of adolescents (Glasofer, et al., 2007).

Eating in the absence of hunger (EAH)—At 11:00 am each participant was individually served a multi-item buffet lunch meal of lunch-type foods consisting of approximately 11,000 kcal that varied in macronutrient content (overall macronutrient content: 55% carbohydrate, 33% fat, and 12% protein): six slices of white bread, six slices of wheat bread, three Kaiser rolls, ham (180 g), turkey (180 g), American cheese (240 g), tomatoes (200 g), lettuce (50 g), mayonnaise (90 g), mustard (90 g), baby carrots (200 g), ranch dressing (90 g), 18 chicken nuggets, barbecue sauce (90 g), peanut butter (120 g), grape jelly (120 g), three bananas, three oranges, grapes (250 g), jelly beans (120 g), chocolate candy (120 g), 12 sandwich cookies, 12 vanilla wafers, pretzel sticks (150 g), tortilla chips (120 g), mild salsa (250 g), 2% milk (850 g), water (850 g), and apple juice (850 g). The meal was served in a private room. Each participant was given the audio-recorded instruction, “Please eat until you are no longer hungry. Take as much time as you need, and open the door when you’re done.”

Duration of the buffet lunch meal was approximately 20.6 ± 6.5 minutes (range 6.7 to 33.3). Immediately after the buffet lunch meal at approximately 11:20 am, each adolescent was seated in a quiet room and offered magazines devoid of food images. Twenty minutes later, at approximately 11:40 am, each participant viewed a 4-min 20-sec film clip in a private room. Adolescents were randomized to view either a sad film clip, validated in pediatric and

adult populations to induce temporary state negative affect ("The Champ," 1979) or a neutral film clip ("Winged Migration," 2003) (Goldschmidt, et al., 2011; Gross & Levenson, 1995; Rottenberg, Ray, & Gross, 2007). Immediately following the film viewing at approximately 11:45 am, each participant was escorted back to the meal room. The adolescent then was provided with an array of highly palatable snack foods that comprised approximately 4,000 kcal: popcorn (65 g), potato chips, (70 g), pretzel twists (70 g), fig bars (120 g), chocolate chip cookies (90 g), fruit chew candy (150 g; Starbursts, Mars Inc., Hackettstown, NJ), chocolate malt balls (120 g), chocolate ice cream (150 g), strawberry ice cream (150 g), vanilla ice cream (150 g), cherry Italian ice (200 g), and lemon Italian ice (200 g). The participant was instructed, "Please taste each of the foods. Rate your preferences for how much you like or dislike the foods on this rating form. Try to take at least two bites of each food. When you're done, eat as much of the foods as you'd like and feel free to use any of the activities in the room." The food rating scale consisted of a simple 10-point Likert scale from 1 (*I hate the food*) to 10 (*I love the food*). Activities available in the room included a handheld computer game, playing cards, magazines devoid of food content, word and draw games, drawing paper, and crayons/markers. The participant was left alone for a 15-minute period. The snack array was served 50 minutes after the initiation of the buffet lunch meal and approximately 30 minutes after the average teen finished eating. We standardized the timing of EAH delivery from buffet meal initiation because satiety hormones are released at the initiation of food intake (Strubbe & van Dijk, 2002), and to allow participants to take as long as they would like (up to 30 minutes) to eat from the buffet meal until no longer hungry.

State mood and hunger ratings—To check hunger and mood manipulations, adolescents completed brief state ratings of hunger and fullness on visual analog scales (1 = none to 100 = extremely). They also completed ratings of state depressed affect on the reliable and validated Brunel Mood Scale (Terry, Lane, Lane, & Keohane, 1999). The Brunel state depressed affect scale is comprised of four items rated on a Likert scale from 0 = not at all to 4 = extremely. Based upon available age-based norms (Terry & Lane, 2003), T-scores (M=50, SD=10) were utilized. Adolescents completed these ratings after the buffet lunch meal (prior to the film) at approximately 11:40 am and just after the film at 11:45 am, which was immediately prior to the EAH snack array.

Energy intake—Buffet lunch meal intake and snack intake were measured by calculating the difference in weight (g) of each snack before and after the eating period. Energy intakes (kcal) were calculated with data from the U.S. Department of Agriculture (USDA) National Nutrient Database for Standard Reference (USDA, Agricultural Research Service, Beltsville, MD) and food manufacturer nutrient information obtained from food labels.

Data analysis

All analyses were conducted using IBM SPSS Statistics 22. Assumptions for parametric tests were evaluated. Most variables were normally distributed based on absolute skewness and kurtosis values (<3 and 10, respectively). An arcsine of the square root transformation was applied to body fat percentage; to ease interpretation, non-transformed data are presented, when applicable. In descriptive analyses, independent samples *t*-tests were

conducted to compare boys and girls, as well as participants assigned to the sad versus neutral film conditions, on age (y), BMI *z* score, fat-free mass (kg), fat mass (%),depressive symptoms, dietary restraint, buffet meal intake (kcal), and EAH (kcal). Chi-square statistics were used to determine if groups differed significantly by categorical demographic or anthropometric variables, including race (white non-Hispanic compared to other), pubertal status (pre-puberty or early/mid-puberty compared with late puberty), and weight status (non-overweight, overweight or obese). To verify the film experimental manipulation of state affect, general linear models were used to examine change in state depressed affect from pre- to post-film, controlling for level of pre-film state depressed affect. Independent samples *t*-tests were used to describe hunger and fullness ratings by film condition.

Hierarchical multiple regression models were used to evaluate our primary aims. The dependent variable was EAH (snack intake kcal). All covariates were entered into the first level of the model (age in y; sex coded as 0 = male, 1 = female; race coded as 0 = non-Hispanic White versus 1 = other; pubertal status coded as 0 = pre/early/mid-puberty versus 1 = late puberty; fat-free mass in kg; percentage fat mass arcsine transformed; height in cm; and total intake kcal during the buffet lunch meal). Film condition (coded as 0 = neutral versus 1 = sad mood induction) was entered in the second level of the model. The main effects of depressive symptoms and dietary restraint were included in the third step. In the fourth level, all two-way interactions among sex, depressive symptoms, dietary restraint, and film condition were evaluated. Finally, the three-way interaction of depressive symptoms, film condition, and sex, as well as the three-way interaction of dietary restraint, film, and sex, were entered into the final step. After evaluating this full model, a second model was conducted in which only variables with a p value < .10 were retained. This secondary analysis facilitated the evaluation of a more parsimonious model in which concerns regarding overfitting were reduced (D. M. Hawkins, 2004). To avoid concerns associated with multicollinearity, depressive symptoms and dietary restraint were centered based on the grand mean prior to being entered into each model and prior to their entry into interaction terms (Cohen, Cohen, West, & Aiken, 2003). Because all analyses were planned *a priori*, main and interactional effects were considered significant if p values were < .05. All tests were two-tailed.

Results

Sample characteristics

Over 300 families expressed interest in participating in the current study. Seventy-five callers were either not eligible (45%) or were unable to be scheduled (55%). Two hundred fifteen adolescents attended a screening visit. Of these, four participants were excluded for non-compliance with study procedures, three for clinically significant depressive or eating disorder symptoms that resulted in study exclusion and referrals for treatment, three for significant food allergies or reported dislike of more than half of the food items in the study's food arrays, three for taking medications affecting weight or appetite, and one was excluded for a significant medical condition and referred for medical follow-up. Of the 201 remaining eligible participants, 182 attended their test meal visit and had complete data, and thus, were included in the current analyses (three participants were unable to be scheduled

for their second visit and the remaining had incomplete test meal data for a variety of reasons, such as food missing from the array, sudden change in food preferences, etc.).

Demographic, anthropometric, psychological, and eating behavior information is presented in Table 1. Statistical comparisons of these variables by sex revealed several anticipated between-group differences in height, fat-free mass, percentage fat mass, buffet meal intake, and EAH. Boys, on average, were significantly taller and had more fat-free mass and less percent fat mass compared to girls (*ps* < .001). Boys also consumed significantly more food during their buffet meal and EAH paradigm compared to girls (*ps* < .05).

Mood induction

Ninety-six participants (52.7%) were randomized to the sad film condition and 86 to the neutral film condition. Film condition groups did not differ significantly from one another in any demographic, anthropometric, psychological, or eating behavior variable (see Table 1; *ps* = .20-.99). Immediately after the film clip and prior to the EAH paradigm, adolescents in both the sad and neutral conditions reported similarly low levels of hunger (10.8 ± 14.9 versus 8.7 ± 10.6 on a 1-100 scale), $t(177) = 1.08$, $p = .28$, and high levels of fullness (63.8 ± 25.3 versus 68.2 ± 20.8 on a 1-100 scale), $t(177) = -1.24$, $p = .22$, indicating that the buffet meal was effective in inducing and maintaining satiety. State depressed affect before the film clip was similar between groups (44.7 ± 2.5 versus 44.3 ± 1.7), $t(166.1) = .25$, $p = .25$. A between-groups comparison for change in state depressed affect from prior to immediately after the film clip was significant, accounting for pre-film clip state depressed affect, $F(1, 180) = 14.3$, $p < .001$, partial-eta$^2 = .07$. Youth in the sad film condition reported significantly greater increases in state depressed affect (Δ state depressed affect T-score M ± SD +2.7 ± 5.3, Cohen's $d = 1.09$) compared to youth in the neutral film condition (+.4 ± 2.4, Cohen's $d = .23$).

Eating in the absence of hunger

Results from hierarchical regression models examining the main and interaction effects for sex, depressive symptoms, dietary restraint, and film condition on EAH are summarized in Table 2. After controlling for age, sex, race, pubertal status, fat-free mass, percentage fat mass, height, and buffet meal intake, we found no significant main effect of film condition. EAH (adjusted for the aforementioned variables) did not significantly differ for youth who were exposed to the sad or the neutral film condition (308.3 ± 161.3 vs. 333.8 ± 141.3 kcal, $p = .26$).

In the full model, neither depressive symptoms ($p = .81$) nor dietary restraint ($p = .16$) were significantly related to EAH. However, there was a significant two-way interaction between restraint and sex ($p = .02$). Evaluation of the restraint by sex interaction revealed that girls with higher restraint scores displayed greater EAH, $\beta = 74.0$, $p < .001$, whereas restraint was not associated with EAH in boys, $\beta = -8.4$, $p = .75$ (Figure 1). Neither of the model's three-way interactions were significant (*p*s = .26 and .56).

In a reduced follow-up regression model, in which all non-significant ($p > .10$) effects were removed, results were similar to the full model. Among all covariates retained (sex, race,

fat-free mass, and buffet meal intake), energy intake during the buffet meal had a positive main effect on EAH, β = .07, $p < .01$, as did fat-free mass, β = 2.8, $p < .03$. In terms of main effects, dietary restraint demonstrated a significant and positive association with EAH, β = 37.9, $p < .02$. This effect was qualified by the significant interaction between restraint and sex, β = 81.3, $p < .008$, indicating that restraint was positively associated with EAH among girls, β = 78.1, $p = < .001$, but not among boys, β = −6.7, $p = .80$.

Discussion

Eating in the absence of physiological hunger (EAH) is one specific manifestation of disinhibited eating behavior associated with overweight and obesity in children and adolescents (Cutting, et al., 1999; Fisher & Birch, 2002; Fisher, et al., 2007; C. Hill, et al., 2008; Moens & Braet, 2007; Shomaker, et al., 2010). Clarification of emotional and cognitive factors that may promote EAH during adolescence is relevant for informing obesity intervention efforts aimed at reducing disinhibited eating behaviors. The primary objective of the current between-subjects experimental study was to evaluate the acute effect of state depressed affect on EAH by observing this eating behavior among adolescents following exposure to either a sad or neutral mood induction.

Contrary to our hypotheses, youth who viewed the sad film did not significantly differ in EAH from youth who viewed the neutral film clip, despite experiencing statistically significant increases in state depressed affect. This null effect was observed for adolescent boys as well as girls, and the finding is consistent with existing experimental studies investigating the effects of negative affect on pediatric eating behavior, under conditions of children being mildly (Roemmich, et al., 2011) and fully sated (Hilbert, et al., 2010). Yet, it is inconsistent with similar experimental studies in adults (Born, et al., 2010; Lemmens, et al., 2011; Rutters, et al., 2009). One possible explanation is that a greater propensity for EAH in response to acute increases in negative affect may be a phenomenon demonstrable only in adults, perhaps attributable to more lengthy experience with the mood-related, rewarding properties of food.

Alternatively, it may be the case that the mood induction was insufficiently potent to impact eating behavior. Although the effect of the sad film on state depressed affect was relatively comparable to similar, prior studies in youth (Goldschmidt, et al., 2011; Hilbert, et al., 2010), some data suggest that affective states induced by films last only a few minutes in duration (Fredrickson & Levenson, 1998). Indeed, negative affect induction strategies differ substantially across laboratory studies, from the recall of a negative memory (Hilbert, et al., 2010), to instructing participants to prepare for a public speech (Balantekin & Roemmich, 2012; Roemmich, et al., 2011), to the completion of unsolvable cognitive tasks (Born, et al., 2010; Lemmens, et al., 2011). Although film clips have the advantages of being brief and relatively easy to administer, it is plausible that an alternative stressor may have differentially affected EAH in adolescents. In a similar vein, while the laboratory has the advantage of controlling the exact conditions under which eating behavior is observed, it is also possible that other stressors that induce state negative affect may impact adolescents' EAH to a greater extent in their natural environments and that the most significant sources of stress differ individual-to-individual (Redlin, Miltenberger, Crosby, Wolff, & Stickney,

2002). For example, ecological momentary assessment studies indicate that cognitions and emotions associated with food, eating, body image (Hilbert, Rief, Tuschen-Caffier, de Zwaan, & Czaja, 2009), and interpersonal conflict (Ranzenhofer, et al., 2014; Shingleton, et al., 2013) frequently precede disinhibited eating episodes in youth. Thus, a task for future research may be to consider how to use experimental paradigms to evaluate stressors more salient to specific youth at-risk for food disinhibition. Studies of self-reported disinhibited eating behavior in the natural environment frequently characterize negative affect as a single construct (Berg, et al., 2014; Heron, Scott, Sliwinski, & Smyth, 2014; Ranzenhofer, et al., 2014), and there may be meaningful differences in depressed versus stressed affect, for example. Whether the intensity of a specific emotional experience has an influence on energy intake is also an important area of future research.

Contrary to our hypotheses, depressive symptoms did not demonstrate a main effect or interactional effect by film condition or sex on EAH. While it is tempting to attribute these variations in findings to the current study's non-clinical sample with low levels of depressive symptoms, depressive symptoms, as previously reported (Mooreville, et al., 2014), were significantly related to total energy intake at the buffet lunch meal, following an overnight fast. Depressive symptoms may be a more robust predictor of energy intake in hungry versus sated states. Perhaps, when an adolescent is sated, palatable food is perceived as less reinforcing than when hungry for those with higher depressive symptoms. Alternatively, youth may need to have higher levels of depression than in the current study to consume more energy in the absence of hunger relative to their non-depressed peers (Goldschmidt, et al., 2014). It may also be the case that food consumption during the buffet lunch meal produced physiological changes associated with improvements in mood (Gibson, 2006), thereby dampening the severity of participants' emotional reactions to the sad film and/or the expected influence of negative affect on energy intake during the EAH paradigm. There are no published data, to our knowledge, that describe the association between depressive symptoms and EAH, in youth or adults, and additional research in this area is needed.

While dietary restraint did not demonstrate a significant main effect on EAH in our entire sample, data were partially consistent with our hypotheses in that such a link was found exclusively among girls. This pattern could be due to a number of factors, including the relatively smaller number of boys in our study, which may have reduced our ability to detect statistically significant differences in this subsample, and/or the stronger link between disinhibited eating behavior and restraint among girls (de Lauzon-Guillain, et al., 2009; Neumark-Sztainer, et al., 2007). Our results may also simply reflect a greater relevance of restraint for impacting EAH among girls as compared to boys. Future work is required to determine psychological factors promoting EAH in boys.

The lack of an interaction between dietary restraint and film condition was also surprising, based on prior data from adults and children (Chua, Touyz, & Hill, 2004; Cools, Schotte, & McNally, 1992; Munro, 1979; Roemmich, et al., 2011; Roemmich, et al., 2002; Schotte, Cools, & McNally, 1990; Yeomans & Coughlan, 2009). Our null results may be attributable to two major differences in study design: the specific negative emotion induced in our study (i.e., depressed affect) and our assessment of eating behavior in a sated as opposed to a

hungry state. Previous studies that found a link between restraint and state negative mood primarily used anxiety- or stress-provoking tasks in their mood induction paradigm (Balantekin & Roemmich, 2012; Roemmich, et al., 2011; Roemmich, et al., 2002), while the current study induced depressed affect. Perhaps stress or anxiety, which is a relatively active emotional state, is more strongly related to increased caloric intake among youth who practice dietary restraint. State depressed mood, in contrast, may have a dampening influence on the link between restraint and EAH. Future research should explore whether and how specific emotional states influence EAH in youth and whether these mood states interact differently with restraint.

One strength of the current study is the use of an objective measurement of energy intake in the laboratory. Such paradigms offer a number of important advantages, including reducing bias associated with self-reported energy intake (Stice & Durant, 2014). However, laboratory data provide only a single example of an EAH episode and could be subject to demand characteristics. Future research using ecological momentary assessment methods would help capture more day-to-day fluctuations in EAH in response to a range of affective states, and longitudinal studies are needed to evaluate how EAH, restraint, and negative affect influence one another over time. Also, while mood was induced experimentally, dietary restraint was not. Therefore, the direction of the link between EAH and restraint remains unclear. Girls high in restraint might be driven to eat more and/or having EAH may lead to subsequent dietary restriction. It is also necessary to highlight that both cognitive and behavioral aspects of dietary restraint were assessed together as a single measure (Fairburn & Cooper, 1993). Research suggests that dietary restraint is a complex phenomenon, with cognitive (i.e., the expressed intent to restrict food intake) and behavioral (i.e., actual dieting) aspects, as well as temporal dimensions (French & Jeffery, 1997; Lowe, et al., 2006; Stice, Fisher, & Lowe, 2004; Williamson, et al., 2007). Future studies need to examine if particular dimensions of dietary restraint uniquely relate to EAH and negative affect. As noted previously, additional research is also needed to determine if the quality and/or intensity of state affect induced in the laboratory differentially influences energy intake in the absence of hunger.

Although the snack foods provided during the EAH free-access array were novel foods, they may have shared similar sensory properties with some of the food items presented at the buffet lunch meal, raising the possibility that sensory-specific satiety could have reduced EAH snack intake (Birch & Deysher, 1986; Rolls, 1986). Yet, in a prior validation study, we found no differences between pleasantness ratings of free-access snack foods when EAH was measured after a large buffet meal compared to after a standardized meal, not including snack-type foods (Shomaker, et al., 2010). Another possibility is that exposure to and/or consumption of such palatable snack foods prior to the EAH array, particularly foods which might be considered “off limits” or “forbidden,” could have actually facilitated subsequent disinhibited or overeating behavior in restrained eaters (Herman & Polivy, 1980). Additionally, the delay between lunch and EAH snacks exposure in the current study was longer (approximately 30 minutes) as compared to the delay in previous studies (ranging from a few minutes to 20 minutes; (Fisher, et al., 2007; Francis, Ventura, Marini, & Birch, 2007; Kral, et al., 2010), which potentially affected the amount of observed EAH in the current study. Despite these variations across studies, EAH caloric consumption (average of

318 kcal) was very similar to previous investigations in adolescents (Fisher, et al., 2007). Finally, the current study utilized a convenience sample, which may limit the generalizability of our findings to other youth (e.g., clinical samples) and had a relatively small proportion of boys. Despite these limitations, few studies have experimentally evaluated the acute effects of negative affect on EAH in youth, and none in adolescents specifically. The current study assessed this eating behavior using a well-validated, laboratory paradigm (Shomaker, et al., 2010) with a large sample of boys and girls of varied body weights, thereby enhancing generalizability to community samples of youth.

In summary, the current study did not find evidence for a link between acute increases in state depressed affect and EAH in adolescents. Depressive symptoms also were not associated with EAH. Dietary restraint, in contrast, demonstrated a positive association with EAH, among girls. The dearth of research on the complex relationship between dietary restraint, depressive symptoms, state negative affect, and EAH calls for more extensive research.

Acknowledgments

Research support: NIH Intramural Research Program Grant 1ZIAHD000641 (J. Yanovski) from NICHD with supplemental funding from the NIH Bench to Bedside Program and the Office of Behavioral and Social Sciences Research; NIH National Research Service Award F32HD056762 and Pathway to Independence Award K99/R00HD069516 (L. Shomaker) from NICHD.

References

Balantekin KN, Roemmich JN. Children's coping after psychological stress. Choices among food, physical activity, and television. Appetite. 2012; 59:298–304. [PubMed: 22634198]

Beck, AT.; Steer, RA.; Brown, GK. Beck Depression Inventory. 2nd. Psychological Corporation; San Antonio: 1996.

Berg KC, Peterson CB, Crosby RD, Cao L, Crow SJ, Engel SG, Wonderlich SA. Relationship between daily affect and overeating-only, loss of control eating-only, and binge eating episodes in obese adults. Psychiatry Research. 2014; 215:185–191. [PubMed: 24200217]

Bernier CD, Kozyrskyj AL, Benoit C, Becker AB, Marchessault G. Body image and dieting attitudes among preadolescents. Canadian Journal of Dietetic Practice and Research. 2010; 71:e34–e40. [PubMed: 20825692]

Birch LL, Deysher M. Caloric compensation and sensory specific satiety: Evidence for self regulation of food intake by young children. Appetite. 1986; 7:323–331. [PubMed: 3789709]

Born JM, Lemmens SG, Rutters F, Nieuwenhuizen AG, Formisano E, Goebel R, Westerterp-Plantenga MS. Acute stress and food-related reward activation in the brain during food choice during eating in the absence of hunger. International Journal of Obesity. 2010; 34:172–181. [PubMed: 19844211]

Chua JL, Touyz S, Hill AJ. Negative mood-induced overeating in obese binge eaters: an experimental study. International Journal of Obesity and Related Metabolic Disorders. 2004; 28:606–610. [PubMed: 14968127]

Cohen, J.; Cohen, P.; West, SG.; Aiken, LS. Applied multiple regression/correlation analysis for the behavioral sciences. 3rd. Lawrence Erlbaum Associates; Mahwah: 2003.

Cools J, Schotte DE, McNally RJ. Emotional arousal and overeating in restrained eaters. Journal of Abnormal Psychology. 1992; 101:348–351. [PubMed: 1583231]

Cutting TM, Fisher JO, Grimm-Thomas K, Birch LL. Like mother, like daughter: Familial patterns of overweight are mediated by mothers' dietary disinhibition. American Journal of Clinical Nutrition. 1999; 69:608–613. [PubMed: 10197561]

de Lauzon-Guillain B, Romon M, Musher-Eizenman D, Heude B, Basdevant A, Charles MA, Fleurbaix-Laventie Ville Santé Study Group. Cognitive restraint, uncontrolled eating and

emotional eating: correlations between parent and adolescent. Maternal and Child Nutrition. 2009; 5:171–178. [PubMed: 19292751]

en BK. Prevalence and dimensionality in adolescent eating problems. Eating and Weight Disorders. 2000; 5:87–91. [PubMed: 10941606]

Fairburn, CG.; Cooper, Z. The Eating Disorder Examination. In: Fairburn, CG.; Wilson, GT., editors. Binge eating, nature, assessment and treatment. 12th. Guilford; New York: 1993. p. 317-360.

Fisher JO, Birch LL. Eating in the absence of hunger and overweight in girls from 5 to 7 y of age. American Journal of Clinical Nutrition. 2002; 76:226–231. [PubMed: 12081839]

Fisher JO, Cai G, Jaramillo SJ, Cole SA, Comuzzie AG, Butte NF. Heritability of hyperphagic eating behavior and appetite-related hormones among Hispanic children. Obesity. 2007; 15:1484–1495. [PubMed: 17557986]

Flook L. Gender differences in adolescents' daily interpersonal events and well-being. Child Development. 2011; 82:454–461. [PubMed: 21410907]

Francis LA, Ventura AK, Marini M, Birch LL. Parent overweight predicts daughters' increase in BMI and disinhibited overeating from 5 to 13 years. Obesity. 2007; 15:1544–1553. [PubMed: 17557992]

Fredrickson BL, Levenson RW. Positive emotions speed recovery from the cardiovascular sequelae of negative emotions. Cognition & Emotion. 1998; 12:191–220. [PubMed: 21852890]

French SA, Epstein LH, Jeffery RW, Blundell JE, Wardle J. Eating behavior dimensions. Associations with energy intake and body weight. A review. Appetite. 2012; 59:541–549. [PubMed: 22796186]

French SA, Jeffery RW. Current dieting, weight loss history, and weight suppression: behavioral correlates of three dimensions of dieting. Addictive Behavior. 1997; 22:31–44.

Fulkerson JA, Sherwood NE, Perry CL, Neumark-Sztainer D, Story M. Depressive symptoms and adolescent eating and health behaviors: A multifaceted view in a population-based sample. Preventive Medicine: An International Journal Devoted to Practice and Theory. 2004; 38:865–875.

Gibson EL. Emotional influences on food choice: sensory, physiological and psychological pathways. Physiology & Behavior. 2006; 89:53–61. [PubMed: 16545403]

Glasofer DR, Tanofsky-Kraff M, Eddy KT, Yanovski SZ, Theim KR, Mirch MC, Ghorbani S, Ranzenhofer LM, Haaga D, Yanovski JA. Binge eating in overweight treatment-seeking adolescents. Journal of Pediatric Psychology. 2007; 32:95–105. [PubMed: 16801323]

Goldschmidt AB, Crosby RD, Engel SG, Crow SJ, Cao L, Peterson CB, Durkin N. Affect and eating behavior in obese adults with and without elevated depression symptoms. International Journal of Eating Disorders. 2014; 47:281–286. [PubMed: 24014067]

Goldschmidt AB, Tanofsky-Kraff M, Wilfley DE. A laboratory-based study of mood and binge eating behavior in overweight children. Eating Behaviors. 2011; 12:37–43. [PubMed: 21184971]

Gross JJ, Levenson RW. Emotion elicitation using films. Cognition & Emotion. 1995; 9:87–108.

Hawkins DM. The problem of overfitting. Journal of Chemical Information and Computer Sciences. 2004; 44:1–12. [PubMed: 14741005]

Hawkins, RC.; Clement, PF. Binge-eating: Measurement problems and a conceptual model. In: Hawkins, RC.; Fremouw, WJ.; Clement, PF., editors. The binge-purge syndrome. Springer; New York: 1984. p. 229-253.

Heatherton TF, Baumeister RF. Binge eating as escape from self-awareness. Psychological Bulletin. 1991; 110:86–108. [PubMed: 1891520]

Herman, CP.; Polivy, J. Retrained eating. In: Stunkard, AJ., editor. Obesity. Saunders; Philadelphia: 1980. p. 208-225.

Heron KE, Scott SB, Sliwinski MJ, Smyth JM. Eating behaviors and negative affect in college women's everyday lives. International Journal of Eating Disorders. 2014; 47:853–859. [PubMed: 24797029]

Hilbert A, Rief W, Tuschen-Caffier B, de Zwaan M, Czaja J. Loss of control eating and psychological maintenance in children: An ecological momentary assessment study. Behaviour Research and Therapy. 2009; 47:26–33. [PubMed: 19010458]

Hilbert A, Tuschen-Caffier B, Czaja J. Eating behavior and familial interactions of children with loss of control eating: a laboratory test meal study. American Journal of Clinical Nutrition. 2010; 91:510–518. [PubMed: 20089727]

Hill C, Llewellyn CH, Saxton J, Webber L, Semmler C, Carnell S, van Jaarsveld CH, Boniface D, Wardle J. Adiposity and 'eating in the absence of hunger' in children. International Journal of Obesity. 2008; 32:1499–1505. [PubMed: 18645573]

Hill JO, Peters JC. Environmental contributions to the obesity epidemic. Science. 1998; 280:1371–1374. [PubMed: 9603719]

Kim Y, Yang HY, Kim AJ, Lim Y. Academic stress levels were positively associated with sweet food consumption among Korean high-school students. Nutrition. 2013; 29:213–218. [PubMed: 23237650]

Kral TV, Faith MS. Child eating patterns and weight regulation: A developmental behaviour genetics framework. Acta Pediatrica. Supplement. 2007; 96:29–34.

Kral TV, Moore RH, Stunkard AJ, Berkowitz RI, Stettler N, Stallings VA, Tanaka LM, Kabay AC, Faith MS. Adolescent eating in the absence of hunger and relation to discretionary calorie allowance. Journal of the American Dietetic Association. 2010; 110:1896–1900. [PubMed: 21111097]

Kuczmarski RJ, Ogden CL, Grummer-Strawn LM, Flegal KM, Guo SS, Wei R, Mei Z, Curtin LR, Roche AF, Johnson CL. CDC growth charts: United States. Advance Data. 2000; 314:1–27. [PubMed: 11183293]

Lemmens SG, Rutters F, Born JM, Westerterp-Plantenga MS. Stress augments food 'wanting' and energy intake in visceral overweight subjects in the absence of hunger. Physiology & Behavior. 2011; 103:157–163. [PubMed: 21241726]

Lowe MR, Annunziato RA, Markowitz JT, Didie E, Bellace DL, Riddell L, Maille C, McKinney S, Stice E. Multiple types of dieting prospectively predict weight gain during the freshman year of college. Appetite. 2006; 47:83–90. [PubMed: 16650913]

Lowe MR, Levine AS. Eating motives and the controversy over dieting: Eating less than needed versus less than wanted. Obesity Research. 2005; 13:797–806. [PubMed: 15919830]

Madowitz J, Liang J, Peterson CB, Rydell S, Zucker NL, Tanofsky-Kraff M, Harnack L, Boutelle KN. Concurrent and convergent validity of the eating in the absence of hunger questionnaire and behavioral paradigm in overweight children. International Journal of Eating Disorders. 2014; 47:287–295. [PubMed: 24186043]

Marshall WA, Tanner JM. Variations in pattern of pubertal changes in girls. Archives of Disease in Childhood. 1969; 44:291–303. [PubMed: 5785179]

Marshall WA, Tanner JM. Variations in the pattern of pubertal changes in boys. Archives of Disease in Childhood. 1970; 45:13–23. [PubMed: 5440182]

Moens E, Braet C. Predictors of disinhibited eating in children with and without overweight. Behaviour Research and Therapy. 2007; 45:1357–1368. [PubMed: 17101117]

Mooreville M, Shomaker LB, Reina SA, Hannallah LM, Cohen LA, Courville AB, Kozlosky M, Brady SM, Condarco T, Yanovski SZ, Tanofsky-Kraff M, Yanovski JA. Depressive symptoms and observed eating in youth. Appetite. 2014; 75:141–149. [PubMed: 24424352]

Munro JF. Clinical aspects of the treatment of obesity by drugs: a review. International Journal of Obesity. 1979; 3:171–180. [PubMed: 393645]

Neumark-Sztainer D, Wall MM, Haines JI, Story MT, Sherwood NE, van den Berg PA. Shared risk and protective factors for overweight and disordered eating in adolescents. American Journal of Preventive Medicine. 2007; 33:359–369. [PubMed: 17950400]

Nguyen-Rodriguez ST, Unger JB, Spruijt-Metz D. Psychological determinants of emotional eating in adolescence. Eating Disorders. 2009; 17:211–224. [PubMed: 19391020]

Polivy J, Herman CP. Dieting and binging. A causal analysis. The American Psychologist. 1985; 40:193–201. [PubMed: 3857016]

Ranzenhofer LM, Engel SG, Crosby RD, Anderson M, Vannucci A, Cohen LA, Cassidy O, Tanofsky-Kraff M. Using ecological momentary assessment to examine interpersonal and affective predictors of loss of control eating in adolescent girls. 2014; 47:748–757.

Ranzenhofer LM, Hannallah L, Field SE, Shomaker LB, Stephens M, Sbrocco T, Tanofsky-Kraff M. Pre-meal affective state and laboratory test meal intake in adolescent girls with loss of control eating. Appetite. 2013; 68:30–37. [PubMed: 23603224]

Redlin JA, Miltenberger RG, Crosby RD, Wolff GE, Stickney MI. Functional assessment of binge eating in a clinical sample of obese binge eaters. Eating and Weight Disorders. 2002; 7:106–115. [PubMed: 17644864]

Roemmich JN, Lambiase MJ, Lobarinas CL, Balantekin KN. Interactive effects of dietary restraint and adiposity on stress-induced eating and the food choice of children. Eating Behavior. 2011; 12:309–312.

Roemmich JN, Wright SM, Epstein LH. Dietary restraint and stress-induced snacking in youth. Obesity Research. 2002; 10:1120–1126. [PubMed: 12429875]

Rolls BJ. Sensory-specific satiety. Nutrition Reviews. 1986; 44:93–101. [PubMed: 3515243]

Rottenberg, J.; Ray, RD.; Gross, JJ. Emotion elicitation using films. In: Coan, JA.; Allen, JJB., editors. The handbook of emotion elicitation and assessment. Oxford University Press; London: 2007. p. 9-28.

Rutters F, Nieuwenhuizen AG, Lemmens SG, Born JM, Westerterp-Plantenga MS. Acute stress-related changes in eating in the absence of hunger. Obesity. 2009; 17:72–77. [PubMed: 18997672]

Schotte DE, Cools J, McNally RJ. Film-induced negative affect triggers overeating in restrained eaters. Journal of Abnormal Psychology. 1990; 99:317–320. [PubMed: 2212283]

Shingleton RM, Eddy KT, Keshaviah A, Franko DL, Swanson SA, Yu JS, Krishna M, Nock MK, Herzog DB. Binge/purge thoughts in nonsuicidal self-injurious adolescents: an ecological momentary analysis. International Journal of Eating Disorders. 2013; 46:684–689. [PubMed: 23729243]

Shomaker LB, Tanofsky-Kraff M, Zocca JM, Courville A, Kozlosky M, Columbo KM, Yanovski JA. Eating in the absence of hunger in adolescents: Intake after a large-array meal compared with that after a standardized meal. American Journal of Clinical Nutrition. 2010; 92:697–703. [PubMed: 20720255]

Skinner HH, Haines J, Austin SB, Field AE. A Prospective Study of Overeating, Binge Eating, and Depressive Symptoms Among Adolescent and Young Adult Women. Journal of Adolescent Health. 2012; 50:478–483. [PubMed: 22525111]

Stice E. Risk and maintenance factors for eating pathology: A meta-analytic review. Psychological Bulletin. 2002; 128:825–848. [PubMed: 12206196]

Stice E, Durant S. Elevated objectively measured but not self-reported energy intake predicts future weight gain in adolescents. Appetite. 2014; 81C:84–88. [PubMed: 24930597]

Stice E, Fisher M, Lowe MR. Are dietary restraint scales valid measures of acute dietary restriction? Unobtrusive observational data suggest not. Psychological Assessment. 2004; 16:51–59. [PubMed: 15023092]

Stice E, Presnell K, Spangler D. Risk factors for binge eating onset in adolescent girls: A 2-year prospective investigation. Health Psychology. 2002; 21:131–138. [PubMed: 11950103]

Stockings E, Degenhardt L, Lee YY, Mihalopoulos C, Liu A, Hobbs M, Patton G. Symptom screening scales for detecting major depressive disorder in children and adolescents: A systematic review and meta-analysis of reliability, validity and diagnostic utility. Journal of Affective Disorders. 2015; 174C:447–463. [PubMed: 25553406]

Strubbe JH, van Dijk G. The temporal organization of ingestive behaviour and its interaction with regulation of energy balance. Neuroscience and Biobehavioral Reviews. 2002; 26:485–498. [PubMed: 12204194]

Tanner JM. Growth and maturation during adolescence. Nutrition Reviews. 1981; 39:43–55. [PubMed: 7010232]

Terry PC, Lane AM. User Guide for the Brunel Mood Scale (BRUMS). University of Southern Queensland. 2003

Terry PC, Lane AM, Lane HJ, Keohane L. Development and validation of a mood measure for adolescents. Journal of Sports Sciences. 1999; 17:861–872. [PubMed: 10585166]

Vannucci A, Tanofsky-Kraff M, Shomaker LB, Ranzenhofer LM, Matheson BE, Cassidy OL, Zocca JM, Kozlosky M, Yanovski SZ, Yanovski JA. Construct validity of the Emotional Eating Scale

adapted for children and adolescents. International Journal of Obesity. 2012; 36:938–943. [PubMed: 22124451]

Wade TD, Byrne S, R. B-W. The eating disorder examination: norms and construct validity with young and middle adolescent girls. International Journal of Eating Disorders. 2008; 41:551–558. [PubMed: 18433026]

Weinstein SM, Mermelstein RJ, Hankin BL, Hedeker D, Flay BR. Longitudinal patterns of daily affect and global mood during adolescence. Journal of Research on Adolescence. 2007; 17:587–600. [PubMed: 18461148]

Williamson DA, Martin CK, York-Crowe E, Anton SD, Redman LM, Han H, Ravussin E. Measurement of dietary restraint: validity tests of four questionnaires. Appetite. 2007; 48:183–192. [PubMed: 17101191]

Yeomans MR, Coughlan E. Mood-induced eating. Interactive effects of restraint and tendency to overeat. Appetite. 2009; 52:290–298. [PubMed: 19022307]

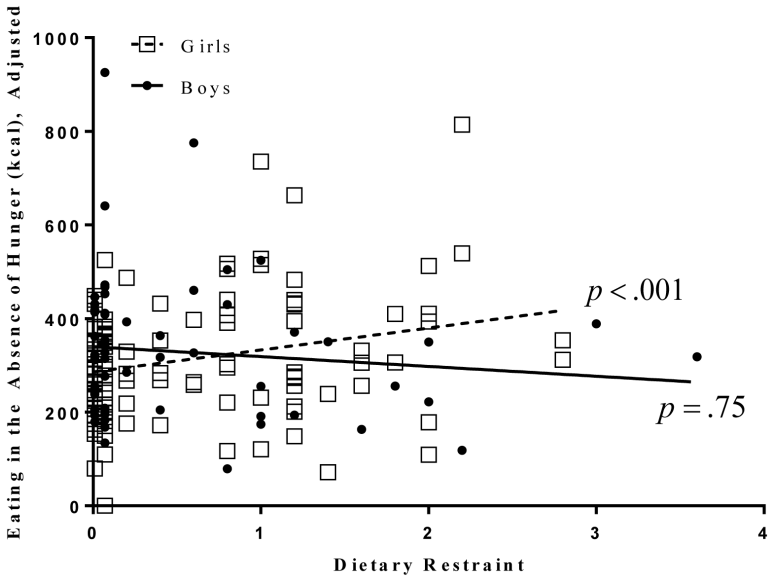

Figure 1. Association between dietary restraint and eating in the absence of hunger (EAH) for girls and boys

After controlling for age, race, pubertal status, fat-free mass, percentage fat mass, height, buffet meal intake, film condition, and depressive symptoms, restraint was positively associated with EAH among girls, β = 74.0, $p < .001$, whereas restraint was not associated with EAH in boys, β = −8.4, $p = .75$.

Table 1

Demographic, anthropometric, psychological, and eating behavior characteristics for the total sample, participants in the sad or neutral film clip, boys and girls

Characteristics[a]	Total Sample (*N*=182)	Sad Film (*n*=96)	Neutral Film (*n*=86)	Boys (*n*=63)	Girls (*n*=119)
Age (y)	15.3±1.4 (13.0-17.98)	15.3±1.4 (13.0-17.98)	15.4±1.4 (13.0-17.8)	15.1±1.3 (13.0-17.98)	15.4±1.4 (13.0-17.94)
Height (cm)	165.2±8.3 (147.3-189.9)	165.0±8.5 (147.3-189.9)	165.4±8.0 (148.2-184.0)	170.5±9.3 (151.6-189.9)**	162.4±6.0 (147.3-177.8)
Non-Hispanic White (%)	55.9	58.3	53.1	53.2	57.4
Late pubertal status[b] (%)	79.1	78.1	75.3	71.2	83.2
BMI[c] z score	0.7±1.0 (−2.2-2.8)	0.8±1.0 (−1.5-2.8)	0.7±1.1 (−2.2-2.6)	0.6±1.0 (−2.2-2.0)	0.8±1.0 (−1.5-2.8)
Overweight/obese[d] (%)	14.8/23.6	17.7/20.8	11.6/26.7	11.1/19.0	16.8/26.1
Fat-free mass (kg)	47.5±10.2 (31.2-79.1)	48.0±13.2 (31.6-122.3)	47.3±9.4 (31.2-73.4)	51.9±10.8 (31.2-79.1)**	45.1±9.0 (32.0-73.4)
Fat mass (%)	26.6±11.2 (4.8-56.8)	26.5±11.0 (4.8-56.8)	26.8±11.6 (5.9-53.0)	19.2±10.1 (4.8-42.9)**	30.6±9.7 (6.2-56.8)
Dietary restraint	0.5±0.7 (0-3.6)	0.5±0.8 (0-3.6)	0.5±0.8 (0-3.0)	0.5±0.8 (0-3.6)	0.6±0.7 (0-2.8)
Depressive symptoms	5.8±5.2 (0-23)	6.3±5.5 (0-23.0)	5.3±4.8 (0-22.0)	5.2±4.1 (0-19)	6.1±5.7 (0-23)
Buffet lunch meal (kcal)	1232.5±509.7 (275.3-2961.1)	1252.9±526.2 (275.3-2951.0)	1209.6±492.9 (347.9-2961.1)	1527.8±483.5 (745.0-2961.1)**	1076.1±452.2 (275.3-2838.3)
EAH[e] snack array (kcal)	318.3±152.0 (39.1-1042.6)	312.1±161.3 (39.1-1042.6)	325.5±141.3 (82.1-821.8)	354.8±171.4 (39.1-1042.6)*	299.2±137.7 (63.6-821.8)

[a] Values presented are mean ± standard deviation (range), unless otherwise noted as percentage.

[b] Late pubertal status refers to breast Tanner stages 4-5 for girls and testicular volume ≥15cc for boys.

[c] BMI = body mass index;

[d] Overweight refers to a BMI 85-94th percentile for age and sex; obesity refers to a BMI ≥ 95th percentile for age and sex.

[e] EAH = eating in the absence of hunger.

** $p < .01$;

* $p < .05$

Table 2

Multiple hierarchical regressions predicting adolescents' eating in the absence of hunger (EAH)

Level	Variable Entered	β [a]	*SE*	*b* [b]	R^2 [c]	ΔR^2
Level 1					.16**	.16**
	Age	−7.70	6.46	−.07		
	Sex	−27.94	32.86	−.09		
	Race	−55.40	24.94	−.18*		
	Pubertal status	−8.90	30.77	−.02		
	Fat-free mass	4.21	2.04	.28*		
	Fat mass	108.40	84.24	.12		
	Height	−2.36	2.17	−.13		
	Buffet lunch meal intake	.07	.03	.23**		
Level 2					.17**	.01
	Film clip	24.92	22.21	.08		
Level 3					.18**	.01
	Depressive symptoms	−.56	2.34	−.02		
	Dietary restraint	24.84	17.43	.12		
Level 4					.24**	.06
	Restraint × depression	3.18	3.20	.08		
	Restraint × film clip	58.07	33.04	.20		
	Restraint × sex	73.67	31.31	.28*		
	Film Clip × sex	27.93	48.65	.09		
	Depression × sex	−6.34	5.72	−.19		
	Depression × film clip	1.27	4.59	.03		
Level 5					.25**	.01
	Depression × film clip × sex	7.96	13.51	.16		
	Restraint × film clip × sex	−72.24	63.71	−.20		

[a] β = unstandardized regression coefficient at each step;

[b] b = standardized regression coefficient at each step;

[c] R^2 = proportion of variability in the dependent variable accounted for by model;

** $p < .01$;

* $p < .05$