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State Negative Affect in Relation to Loss-of-Control Eating Among Children and Adolescents in the Natural Environment

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Abstract

Affect regulation theory proposes that loss-of-control (LOC)-eating is preceded by increases and followed by decreases in negative affect (NA), but empirical tests of this theory among pediatric samples in the natural environment are needed. Using an ecological momentary assessment approach, we conducted post-hoc analyses to examine LOC-eating severity reported during post-meal surveys in relation to the intensity of composite NA and NA components (anger, anxiety, depression, guilt) throughout the day for two weeks in a cohort of healthy children and adolescents. Multilevel models tested the associations among LOC-eating severity and NA components reported at pre-meal surveys (t-1), post-meal surveys (t), and lagged post-meal surveys (t+1). Models were adjusted for sex, age, race/ethnicity, height, fat mass, socioeconomic status, and time between the occurrence and report of eating episodes; post-meal analyses were

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also adjusted for pre-meal NA. Participants age 8–17 (*N*=100; 55% female; 45% male; 12.83 ± 2.73y; 24% with overweight/obesity) recorded 2,410 eating episodes. Pre-meal composite NA and NA components were not associated with LOC-eating severity at the subsequent meal. LOC-eating severity was positively associated with post-meal depression (ß = 0.042, 95% CI = 0.007, 0.076) and guilt (ß = 0.056, 95% CI = 0.017, 0.095), but not composite negative affect, anger, or anxiety. The positive association among LOC-eating severity and guilt persisted in lagged post-meal analyses (ß = 0.075, 95% CI = 0.021, 0.128). Contrary to affect regulation theory and laboratory data, but consistent with prior ecological momentary assessment data in children and adolescents, pre-meal NA was not linked to subsequent LOC-eating. Increased guilt following meals may be a mechanism for the development of exacerbated disordered eating. Longitudinal studies may elucidate how NA is implicated in the etiology of pediatric eating disorders.

Keywords

negative affect; children; adolescents; loss-of-control-eating; ecological momentary assessment

1. Introduction

Loss-of-control (LOC)-eating (i.e., feeling out-of-control while eating regardless of the amount of food consumed; American Psychiatric Association, 2013), is reported by approximately 23% of children and adolescents across the weight spectrum (Schlüter et al., 2016). LOC-eating is prospectively predictive of excess weight gain (Sonneville et al., 2013; Tanofsky-Kraff, Yanovski, et al., 2009), increases in metabolic syndrome components (Tanofsky-Kraff et al., 2012), and worsening of anxiety and depressive symptoms, as well as development of partial or full syndrome binge-eating disorder (Hilbert et al., 2013; Tanofsky-Kraff et al., 2011). Despite these concerning outcomes, the factors that promote LOC-eating in children and adolescents are not well understood.

Affect regulation theory posits that LOC-eating functions as a form of emotion regulation (Hawkins & Clement, 1984). Affect regulation theory does not speculate about affect during an eating episode, but rather focuses on the affective antecedents and consequences of LOC-eating. Specifically, negative affective states are hypothesized to trigger episodes of uncontrolled eating as an attempt to alleviate distressing emotions. Engagement in LOC-eating is then reinforced by a post-eating reduction in negative affect (NA). However, eating-induced decreases in distress are only temporary. Over time, a reliance on food consumption to modulate emotional states theoretically results in a maladaptive cycle of using LOC-eating to regulate affect. Generally, pre-meal affective components consistent with the affect regulation theory are observed among adults who report LOC-eating, including adults with anorexia nervosa, and bulimia nervosa and binge-eating spectrum disorders (Mikhail, 2021). However, support for the post-meal component is inconsistent. Moreover, the relevance of affect regulation theory for LOC-eating among children and adolescents is unclear.

Support for the pre-meal pathway of affect regulation theory of LOC-eating among children and adolescents varies by how affect is measured and study setting. Research among community samples of children and adolescents assessing composite measures of NA in the laboratory tend to report increases in NA prior to consuming a meal designed to model an episode of LOC-eating. Laboratory LOC-eating paradigms typically assess energy intake and report of LOC-eating during a snack or meal. During the meal, the participant is often presented with an array of foods, provided with instructions like “eat as much as you want”, and is then left alone to eat. One study among a sample of adolescent girls participating in an adult obesity prevention trial, all of whom had high weight and reported LOC-eating in the past month, found increases in NA prior to completion of a LOC-eating paradigm (Ranzenhofer et al., 2013). Links between pre-meal negative affect and LOC-eating also differ across studies that employed mood-induction paradigms. For example, greater pre-meal NA was linked to greater risk for reporting LOC-eating following a sad mood induction in a small community sample of girls age 6–12 years with overweight (Goldschmidt et al., 2011). However, Hilbert et al. (2010) did not find an effect of negative affect on energy intake or LOC-eating among a community sample of children following a parent-based negative mood induction.

Contrary to laboratory paradigms, studies utilizing ecological momentary assessment (EMA) to measure NA and LOC-eating among community samples of children and adolescents in their natural environment have failed to detect a relationship between composite pre-meal NA and LOC-eating (Goldschmidt, Smith, Crosby, Boyd, Dougherty, Engel, & Haedt-Matt, 2018; Hilbert et al., 2009; Ranzenhofer et al., 2014). However, past EMA studies have not investigated whether there are associations between LOC-eating and specific NA states. It is possible that, similar to past laboratory meal (Shank et al., 2017) and self-reported (Tanofsky-Kraff, Goossens, et al., 2007) studies of children and adolescents participating in nonintervention studies, obesity prevention, or weight loss treatment studies, associations will emerge when examining the relationship between LOC-eating and specific components of NA prior to eating. Moreover, such an examination may help explain the lack of findings between NA and LOC-eating in EMA studies.

Fewer studies have investigated post-meal NA among children and adolescents, and findings are mixed. Consistent with affect regulation theory, adult obesity prevention seeking adolescent girls with above average weight and LOC-eating in the past month reported decreases in a composite measure of NA following a laboratory LOC-eating paradigm (Ranzenhofer et al., 2013). However, contrary to affect regulation theory, a study examining specific components of NA following a laboratory-based LOC-eating episode in a nonintervention sample found increases in anxiety, confusion and fatigue, and no change in anger, depression, or tension following the meal in both girls and boys (Tanofsky-Kraff, McDuffie, et al., 2009). Therefore, additional study of post-meal NA in children and adolescents is needed.

No study has tested the associations among LOC-eating and post-meal NA among children and adolescents in their natural environment. Some EMA studies investigating NA in relation to binge-eating episodes (i.e., experiencing LOC-eating while consuming an unambiguously large amount of food) in adults have reported decreases in NA following binge-eating episodes in adults with obesity (Berg et al., 2013) and binge-eating disorder (Schaefer et al., 2020; Wonderlich et al., 2021). Of note, significant decreases in negative affect were observed across the 1–4 hours following binge-eating episodes (Berg et al., 2017; Schaefer et al., 2020; Wonderlich et al., 2021), but in all studies levels of negative affect remained elevated compared to pre-eating episodes. Moreover, EMA studies of adults have provided varying support for the hypothesized link between LOC-eating and post-meal affect. For example, among adults with obesity, Berg and colleagues (2015) found no changes in trajectories of guilt, fear, hostility or sadness following LOC-eating episodes, whereas Goldschmidt et al. (2012) observed increased composite NA following LOC-eating episodes in a small sample of adults with binge-eating disorder. Disparate findings may also be related to different statistical approaches (Berg et al., 2017). Alternatively, the post-meal pathway of affect regulation theory may be linked to other components of binge eating (e.g., perceiving oneself as having overeaten and/or the consumption of large amounts of food) but not LOC-eating (which may not include consuming a large amount of food) as suggested by Berg et al. (2015). Nevertheless, empirical investigation of post-meal NA in the natural environment is needed to determine whether specific components of NA are relevant for pediatric LOC-eating.

The current study conducted post-hoc analyses to determine whether composite NA and specific types of pre- and post-meal NA (anger, anxiety, depression, guilt) are linked to LOC-eating among girls and boys in the natural environment during a two-week EMA period. These four affective states were chosen because they have been commonly studied and demonstrate relationships with LOC-eating in prior studies (e.g., Mikhail, 2021; Tanofsky-Kraff, Goossens, et al., 2007; Tanofsky-Kraff, McDuffie, et al., 2009). Evidence for associations among pre-meal affect and LOC-eating has differed based on study methodology (e.g., EMA, laboratory settings), and no pediatric EMA study has tested the post-LOC-eating component of affect regulation theory, so we based our hypotheses on the affect regulation model. In concert with the affect regulation theory of disordered eating, we hypothesized that greater pre-meal (t-1) composite NA and each component of NA would be associated with greater LOC-eating severity during the subsequent meal. We also expected that greater LOC-eating severity during a meal would be associated with lower intensity of post-meal (at t and t+1) composite NA and each post-meal negative affective state.

2. Methods

2.1 Participants

We analyzed data from a convenience sample of children and adolescents participating in an ongoing longitudinal, non-treatment study that aims to understand how eating behaviors impact weight gain over time (ClinicalTrials.gov ID# NCT02390765). Consistent with prior studies, girls and boys, age 8–17 years old at the time of enrollment, were recruited. Exclusionary criteria for the parent study includes 1) current or past major or mental illness (including anorexia nervosa and bulimia nervosa but not binge-eating disorder), brain injury, or pregnancy, 2) current use of medication known to affect body weight and food intake, 3) weight loss >5% in the prior 3 months, 4) body mass index (BMI, kg/m^2) <5th percentile for age and sex, 5) current and regular use of tobacco products, illicit substances, or alcohol, and 6) a full-scale intelligence quotient score <70. The larger study protocol from which these data were collected aims to identify how eating behavior changes and contributes to excess weight gain. Therefore, children/adolescents who have a medical related need to gain weight are excluded from the longitudinal parent study. No additional inclusion/exclusion criteria were applied for the present analysis. Flyers and mailings recruited children and adolescents from the metro D.C. area. All study procedures were approved by the National Institutes of Health (NIH) Institutional Review Board and were conducted at the outpatient Pediatric Clinic of the NIH Hatfield Clinical Research Center (Bethesda, MD). Prior to data collection, parents/guardians and children/adolescents provided written consent and assent, respectively. Participants who enrolled in the parent study were given the opportunity to complete a two-week long EMA protocol for additional compensation of up to $100 (25/week and a $50 bonus for ≥80% adherence). Interested participants received training on how to complete the EMA protocol and were temporarily provided with a smartphone for data collection. Some aspects of the EMA data (e.g., associations among LOC-eating and food cravings and sleep, respectively) have been previously reported from this cohort (Parker, LeMay-Russell, et al., 2021; Parker, Tanofsky-Kraff, et al., 2021). NA data from this cohort have not been reported.

2.2 Measures

2.2.1 Demographics—Parents reported their child's sex assigned at birth, race and ethnicity. Socioeconomic status was determined by parents' reported education and employment status via the Hollingshead Two Factor Index of Socioeconomic Status. Scaled scores range from 1 to 5, with lower scores indicating a higher social class (Hollingshead, 1957).

2.2.2 Body Composition—Height (cm) was measured by a calibrated stadiometer in triplicate. Fasting weight (kg) was measured by a calibrated scale and used to calculate body mass index (BMI: height in meters/weight^2). For descriptive purposes, standardized deviation BMI scores (BMIz) were calculated from participants' BMI, following Center of Disease Control and Prevention growth standards for age and sex (Kuczmarski et al., 2002). Total body fat mass (kg) was measured by dual-energy x-ray absorptiometry using an iDXA system (GE Healthcare, Madison WI).

2.2.3 State Negative Affect—To assess the intensity of negative affective states, participants were asked to rate "how you feel right now" on a Likert-type scale from 1 (Not at all) to 5 (Extremely). Depressed mood (depressed, downhearted, miserable, unhappy), anxiety (anxious, nervous, panicky, worried), and anger (angry, annoyed, bad tempered, bitter) were assessed using items from the reliable and valid Brunel Mood Scale (Terry et al., 2003; Terry et al., 1999). Guilt was assessed using four items from the Guilt subscale of the PANAS-X: guilty, ashamed, angry at self, disgusted with self (Watson & Clark, 1994). The Guilt subscale has demonstrated acceptable reliability and validity and has been shown to be differentiable from other components of negative affect (Watson & Clark, 1992). Composite NA was computed by averaging all items from the Brunel Mood Scale and PANAS-X. Internal consistency for the composite score and each negative affective state was good to excellent (Cronbach's αs = .87 – .95).

2.2.4 Eating Episodes—

Participants self-reported the amount of time between the occurrence of an eating episode and their report of the episode on a 1–5 Likert-type scale: 1 ‘<15 minutes’, 2 ‘15 – 30 minutes’, 3 ‘30 – 60 minutes’, 4 ‘60 – 90 minutes’, 5 ‘> 90 minutes’. LOC-eating severity during eating episodes was assessed using six items adapted from the LOC-eating questions in the Eating Disorder Examination (EDE; Fairburn & Cooper, 1993). Items included: “How much did you lose control during this eating episode?”, “Did you feel that you could not keep yourself from eating?”, “Did you feel that you could not stop eating once you started?”, and “During the eating episode you just finished, how much did you feel a sense of loss of control?”, “How upset or distressed are you about how much you just ate?” and “How much did you feel driven to eat?”. All items were rated on a 1 (Not at all) to 5 (Extremely) Likert-type scale. Items within each eating event were averaged to create a composite LOC-eating severity score. Internal reliability was very good (Cronbach’s α = .91). These items are also consistent with other pediatric EMA protocols (Goldschmidt, Smith, Crosby, Boyd, Dougherty, Engel, & Haedt-Matt, 2018; Ranzenhofer et al., 2014).

2.3 EMA Procedures

The EMA protocol entailed completing multiple surveys on a smartphone (provided by the study team) in the natural environment for approximately 14 days. Participants received signaled surveys (i.e., responding to a notification instructing them to complete a survey) at semi-random times (approximately 11:10am, 1:50pm, 3:30pm, 5:40pm, and 8:20pm). The timing of the first and last surveys of each day were set based on the participant’s reported typical wake and bed times. On weekend days, five signals were delivered between 11am and 9pm. On weekdays, so as to not interfere with school, three signals were delivered between 3pm and 9pm. Interval surveys (i.e., surveys completed at the same time each day) were completed before bed (everyday) and after school (weekdays). Completion of eating event surveys (i.e., surveys completed immediately following consumption of a meal or snack) were not prompted by signals. Eating event surveys were optional, but encouraged. These surveys were not used to calculate compliance and compensation. The present study examined items that assessed intensity of affective states (reported during all surveys) and severity of LOC-eating during all reported eating episodes.

2.4 Data Analytic Plan

Analyses were conducted in SPSS version 25 (IBM Corp., 2017). To obtain sample average ratings of negative affective states and LOC-eating, surveys were averaged within-person and within-day. To test the associations among between- and within-subject negative affective states (t-1) and LOC-eating severity during the subsequent meal (t), we ran five multilevel models (composite NA, anger, anxiety, depression, guilt). Ratings of pre-meal NA were lagged within-person and within-day. Surveys in which eating episodes were not reported were then removed. Between-person NA was grand-mean centered (i.e., an individual’s average level of NA over the course of the two weeks compared to the full sample’s average level of NA over the course of the two weeks) and within-person NA was person-mean centered (i.e., the difference between a person’s momentary NA rating and the person’s average level of NA over the course of the two weeks) prior to analyses.

To test if LOC-eating severity predicted post-meal (t) and lagged post-meal (t+1) NA while adjusting for pre-meal NA, we ran ten additional multilevel models. Between-person LOC-eating severity (i.e., an individual's average level of LOC-eating severity compared to the full sample's average level of LOC-eating severity) was grand-mean centered and within-person LOC-eating severity (i.e., the difference between LOC-eating severity during a specific eating episode and the person's average level of LOC-eating severity over the course of the two weeks) was person-mean centered. Both were included as independent variables. Five models examined the associations among LOC-eating severity and post-meal negative affective states by testing ratings of LOC-eating severity and NA provided in the same survey. Then lagged post-meal associations were assessed by lagging LOC-eating ratings within person and day.

All multilevel models assumed a gamma distribution and a logit link function due to the positive skew of dependent variables: LOC-eating severity in pre-meal analyses, and intensity of negative affective states in post-meal analyses. Surveys were nested within persons. An AR1 covariance structure was used to account for the relatedness of surveys completed by each participant. Models included a random intercept. Random slopes included the appropriate within-subject negative affective state for pre-meal analyses and within-subject LOC-severity for post meal analyses. An unstructured covariance structure was assumed for random intercepts and slopes. All models were adjusted for sex assigned at birth (Field et al., 1999; Salk et al., 2017), age (Field et al., 1999; Salk et al., 2017), race/ethnicity (Anderson & Mayes, 2010), height, fat mass (Byrne et al., 2019), socioeconomic status (Lemstra et al., 2008), and time between occurrence of the eating episode and report of the eating episode. Non-adjusted models are presented in Supplemental Tables 1–3. Post-meal NA models also adjusted for pre-meal levels of NA. Given that the analyses were not specified a-priori and the EMA protocol was not designed to specifically test the current hypotheses, the interpretation is focused on 95% confidence intervals (CI), rather than p values.

3. Results

3.1 Missing Data

Of the 260 participants enrolled in the parent study, 138 completed the EMA protocol. There were no significant differences in age ($t = -132$, $p = .895$), sex assigned at birth (= .010, $p = .922$), race/ethnicity (= .656, $p = .418$), or socioeconomic status ($t = .843$, $p = .400$) between participants who elected to participate in the EMA protocol and those who did not. Consistent with prior studies, participants who did not provide sufficient data were removed prior to analyses (Egbert et al., 2020; Ranzenhofer et al., 2014). Specifically, participants who completed the EMA protocol but had compliance below 29% ($n = 9$) or reported fewer than 2 eating episodes ($n = 23$) were removed from analyses. Six participants did not provide data for all covariates. Therefore, of the 138 participants who completed the EMA protocol, 100 participants provided usable data including all covariates. Among those who completed the EMA protocol with usable data, compared to those whose data were not included in analyses, there were no significant differences in age ($t = -.115$, $p = .909$), sex assigned at birth (= 0.644, *p* = .422), race/ethnicity (= .002, *p* = .969), or socioeconomic status (*t* = .739, *p* = .466). Participant characteristics and EMA demographic data are reported in Table 1.

Only 83 participants provided usable data for the lagged post-meal analyses. Participants not included in lagged post-meal analyses did not differ from participants who provided data with regard to age (*t* = −0.269, *p* = .788), race/ethnicity (χ^2 = 2.544, *p* = .111), or socioeconomic status (*t* = 0.739, *p* = .462). Compared to individuals who provided data for lagged analyses, participants not included in lagged post-meal analyses were more likely to be assigned male sex at birth (χ^2 = 5.418, *p* = .020). Average amount of time between lagged surveys was 3.4 hours (*SD* = 1.4, range 0.13 – 10.75).

3.2 Pre-Meal Negative affect

Results from pre-meal models are presented in Table 2. Between-subject composite NA (ß = 0.567, 95% CI = 0.427, 0.707), anger (ß = 0.346, 95% CI = 0212, 0.481), anxiety(ß = 0.510, 95% CI = 0.412, 0.608), depression (ß = 0.457, 95% CI = 0.282, 0.632), and guilt (ß = 0.670, 95% CI = 0.533, 0.807) were all positively associated with LOC-eating severity. However, neither within-subject composite NA (ß = 0.057, 95% CI = −0.039, 0.155), anger (ß = 0.046, 95% CI = −0.013, 0.106), anxiety (ß = 0.030, 95% CI = −0.037, 0.097), depression (ß = 0.007, 95% CI = −0.062, 0.077), or guilt (ß = 0.047, 95% CI = −0.095, 0.188) were associated with LOC-eating severity at the subsequently reported eating episode.

3.3 Post-Meal Negative affect

Results from post-meal models are presented in Table 3. Between-subject LOC-eating severity was associated with greater between-subject composite NA (ß = 0.191, 95% CI = 0.160, 0.222), anger (ß = 0.098, 95% CI = 0.066, 0.130), anxiety (ß = 0.247, 95% CI = 0.208, 0.287), depression (ß = 0.158, 95% CI = 0.127, 0.190), and guilt (ß = 0.234, 95% CI = 0.201, 0.267). When adjusting for pre-meal affect, within-subject LOC-eating severity during an eating episode was not associated with post-meal composite NA (ß = 0.027, 95% CI = −0.001, 0.055), anger (ß = 0.015, 95% CI = −0.019, 0.049), or anxiety (ß = 0.007, 95% CI = −0.015, 0.028), after the meal. Within-subject LOC-eating severity was positively associated with depression (ß = 0.042, 95% CI = 0.007, 0.076) and guilt (ß = 0.056, 95% CI = 0.017, 0.095) following the meal, when adjusting for pre-meal depression and guilt, respectively.

Results from lagged post-meal models are presented in Table 4. Greater between-subject LOC-eating severity was associated with greater time lagged, between-subject composite NA (ß = 0.176, 95% CI = 0.137, 0.215), anger (ß = 0.102, 95% CI = 0.060, 0.144), anxiety (ß = 0.262, 95% CI = 0.212, 0.312), depression (ß = 0.174, 95% CI = 0.129, 0.218), and guilt (ß = 0.279, 95% CI = 0.241, 0.317). Within-subject LOC-eating severity during an eating episode was not associated with lagged post-meal composite NA (ß = 0.014, 95% CI = −0.036, 0.065), anger (ß = 0.007, 95% CI = −0.057, 0.071), anxiety (ß = −0.011, 95% CI = −0.058, 0.035), depression (ß = 0.024, 95% CI = −0.041, 0.089). There was a positive association between within-subject LOC-eating severity and lagged post-meal guilt, when adjusting for pre-meal guilt (ß = 0.075, 95% CI = 0.021, 0.128).

Discussion

Among girls and boys of a broad age and BMI range, LOC-eating ratings were higher among children and adolescents with generally greater levels of pre-meal NA. However, no pre-meal negative affective state, including composite NA, was associated with subsequent LOC-eating. All post-meal and lagged post-meal negative affective states were higher among children and adolescents who reported generally greater LOC-eating. We also observed increases in depression and guilt following eating episodes during which participants reported greater LOC-eating severity. The positive relationship between LOC-eating severity and post-meal guilt, but not depression, persisted in lagged post-meal analyses. By contrast, LOC-eating severity during a meal was not associated with levels of composite NA, anger, or anxiety following the meal. Overall, results from our post-hoc analyses do not support the affect regulation theory of LOC-eating in a community sample of children and adolescents.

Consistent with prior pediatric studies, we did not observe relationships between pre-meal NA and LOC-eating severity in the natural environment. These findings complement data showing that pre-meal NA does not predict subsequent LOC-eating in the natural environment among girls participating in excess weight gain prevention trial, had high weight, and endorsed LOC-eating in the prior month (Ranzenhofer et al., 2014), girls and boys who reported LOC-eating in the prior three months (Hilbert et al., 2009), and girls and boys with overweight/obesity (Goldschmidt, Smith, Crosby, Boyd, Dougherty, Engel, & Haedt-Matt, 2018). Prior EMA research among children and adolescents suggest that other factors such as food cravings (Goldschmidt, Smith, Crosby, Boyd, Dougherty, Engel, & Haedt-Matt, 2018; Parker, Tanofsky-Kraff, et al., 2021), positive affect (Egbert et al., 2020), or interpersonal distress (Ranzenhofer et al., 2014) may be more salient predictors of LOC-eating among children and adolescents in the natural environment. Although NA does not appear to have a direct role in pediatric LOC-eating in the natural environment, it is possible that NA moderates or mediates the relationships between these factors and LOC-eating. It is also possible that alexithymia, the inability to feel or identify emotional states, made it difficult for some participants, especially those with LOC-eating (Shank et al., 2019), to report accurately about their mood. Future studies should investigate these possibilities.

Laboratory-based studies of NA and LOC-eating in pediatric samples have identified associations among pre-meal affect and eating behavior, for example, composite NA (Ranzenhofer et al., 2013) and anxiety (Shank et al., 2017). Differences in the amount of time between provided ratings of NA and LOC-eating in laboratory and naturalistic studies may explain these differences. In our study, LOC-eating severity was reported less than 30 minutes after the eating episode for approximately half of the reported eating episodes. However, about 25% of ratings were reported more than an hour after the eating episode occurred, so analyses were adjusted for time between occurrence and report of an eating episode to account for the potential influence of time. Research should refine theories implicating affect surrounding disordered eating episodes by defining relevant time periods of hypothesized affective change.

Our findings that greater LOC-eating was not associated with changes in post-meal composite NA, anger, anxiety, and depression; and was possibly linked to *increased* post-meal depression and guilt in children may provide important information for the refinement of affect regulation theory in children and adolescents. Our results are somewhat consistent with a previous laboratory study in children and adolescents that observed increased anxiety, confusion, and fatigue following a laboratory LOC-eating paradigm (Tanofsky-Kraff, McDuffie, et al., 2009), and an EMA study among a small sample of adults with overweight/obesity and binge-eating disorder that found increased NA following LOC-eating episodes (Goldschmidt et al., 2012). While it may be that most of our post-meal ratings were too close in proximity (< 30 minutes) to the eating event to observe decreases in depression and guilt, increases in guilt persisted in our lagged post-meal analyses. Some studies have suggested that 1.5 hours following eating episodes provides sufficient time to observe decreases in guilt (Berg et al., 2017; Wonderlich et al., 2021). Arguably, a behavior that typically requires 1.5 hours or more to transpire for heightened NA to subside is unlikely to constitute a behavior that functions to alleviate NA. Rather, the pattern observed in the current study suggests that among children and adolescents LOC-eating might be a catalyst for increased depression and guilt. Data from adult samples have led to speculation that certain affective states are amplified while others are reduced by LOC-eating (Mikhail, 2021). Despite limited evidence for this among children and adolescents, this hypothesis might be worth exploring in future studies. Ultimately, the post-meal component of affect regulation theory likely requires refinement, especially when applying it to pediatric LOC-eating.

The post-LOC-eating amplification of guilt, specifically, may be a pathway for the exacerbation of eating disordered behaviors and attitudes in children. Increased guilt, but not other affective components, prior to and during LOC-eating episodes has been repeatedly observed among clinical and community samples of adults with LOC-eating (Mikhail, 2021; Schaefer et al., 2020) and post LOC-eating increases in guilt have also been reported among female college students (Craven & Fekete, 2019). Although we did not observe increases in guilt prior to LOC-eating in our sample, the link between guilt and LOC-eating may develop in childhood and promote exacerbated disordered eating behavior in adulthood. For example, increased guilt following LOC-eating in childhood may contribute to increases in trait NA in adolescence (e.g., depression and anxiety), which is robustly linked to the development of eating disorders (Pearson et al., 2015; Stein et al., 2007). As has been suggested previously, additional contextual information is needed to better understand how feelings of guilt relate to, and stem from, eating disordered behaviors in daily life (Berg et al., 2015). More studies are needed to clarify why children, but not adolescents, experienced associations among guilt and LOC-eating in the present study. Future longitudinal studies aiming to understand whether momentary guilt promotes trait NA and thereby pediatric LOC-eating might utilize multi-method approaches to probe this risk pathway for the development of eating disorders.

Disparate findings among studies of children and adolescents versus adults with eating disorders suggest that there may be a differential role of state affect in disordered eating behaviors among children, adolescents, and adults. Contrary to our findings, and other pediatric data (Goldschmidt, Smith, Crosby, Boyd, Dougherty, Engel, & Haedt-Matt, 2018;

Hilbert et al., 2009; Ranzenhofer et al., 2014), studies examining daily reports of binge eating in adults with binge eating have generally observed increases in NA preceding binge-eating episodes ((Mikhail, 2021). Although the data are mixed in regards to post-meal affect following binge-eating episodes in adults, some studies have found post-meal decreases in NA (e.g., De Young et al., 2013; Haedt-Matt & Keel, 2011; Schaefer et al., 2020; Wonderlich et al., 2021). Eating disorder diagnosis (Wonderlich et al., 2021), type of disordered eating episode assessed (Berg et al., 2015), and statistical approach (Berg et al., 2017) have been identified as sources of discrepant findings among studies of adults. Although these factors may also explain the differing results between adult and pediatric samples, the role of NA in disordered eating may also differ across the lifespan. Mechanisms underlying these differences are not well understood and warrant targeted investigation. Studies comparing the associations among affect and LOC-eating between children, adolescents, and adults could help to elucidate why pre-meal negative affective states are not robustly linked to LOC-eating among children or adolescents in their daily lives but have been consistently linked to LOC-eating in adults with eating disorders.

Our findings are consistent with a growing body of literature that has largely failed to support key components of the affect regulation theory in pediatric samples, particularly in the natural environment. Given that affect regulation theory may not capture etiological pathways for eating disorders in children and adolescents, the theory may need to be modified to better explain the experiences of pediatric populations. Alternatively, theories that provide additional mechanisms for negative affect's impact on eating behavior, such as interpersonal theory (Tanofsky-Kraff, Wilfley, et al., 2007), escape theory (Heatherton & Baumeister, 1991), restraint theory (Herman & Polivy, 1988; Polivy et al., 1984), and expectancy theory (Hohlstein et al., 1998) may provide necessary context for understanding how specific negative affective states contribute to the development of disordered eating. Interpersonal theory posits that distressing interpersonal events cause rises in NA which then trigger LOC-eating. Tests of the interpersonal theory of LOC-eating in the natural environment (Ranzenhofer et al., 2014), laboratory (Shank et al., 2017), and via self report data (Elliott et al., 2010) have provided empirical evidence for NA and anxiety, respectively, as indirect mechanisms linking interpersonal distress to LOC-eating in children and adolescents. Escape theory suggests individuals experience increased NA before LOC-eating and decreased NA during a LOC-eating episode, due to reduced aversive self-awareness while eating. Following eating, when self-awareness returns, increased distress is expected. Although our pre-meal findings are inconsistent with escape theory, post-meal guilt findings are somewhat consistent with the post-eating component of this model. Restraint theory (Herman & Polivy, 1988; Polivy et al., 1984) posits that attempts at dietary restraint are abandoned when experiencing NA, due to diminished cognitive capacity to regulate eating. Thus, the model rests on the notion that increases in NA and concurrent decreases in cognitive restraint occur prior to LOC-eating. It does not propose changes in post-meal trajectories of negative affect. Although our findings do not appear to support this proposal, dietary restraint was not assessed, therefore comprehensive tests of this theory among children and adolescents in the natural environment are required. Expectancy theory (Hohlstein et al., 1998) posits that overtime, individuals acquire expectations about the outcomes of specific behaviors (for example, that LOC-eating reduces NA). These

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expected outcomes promote subsequent LOC-eating, particularly when one is experiencing heightened NA. Preliminary tests of this theory among adults using EMA have supported this theory (Fischer et al., 2018; Howard et al., 2021; Smith et al., 2020). However, studies among children and adolescents are needed to determine its relevance as a momentary pathway promoting pediatric LOC-eating. Generally, identification of relevant affective states and timeframes for affective change need to be determined, even within these alternative theoretical frameworks. Conduct of comprehensive, theory driven, naturalistic studies could help to identify pertinent affective pathways for the development of pediatric eating disorders.

When considered in conjunction with prior research, several clinical implications may be drawn from this study's findings. First, NA may not be the most relevant trigger for LOC-eating episodes among children and adolescents. Therefore, pediatric LOC-eating prevention programs should target multiple momentary triggers of LOC-eating, such as food cravings or interpersonal distress. Second, feelings of guilt and depression should be directly addressed in treatments for LOC-eating to prevent development of more severe eating and mood disturbances among those who report LOC-eating. Encouraging children and adolescents to use affect regulation strategies following LOC-eating episodes may also be beneficial. Ultimately, clarifying the role of NA states, particularly guilt, in alternative theoretical contexts could provide important insight to programs aimed at reducing pediatric LOC-eating and preventing eating disorders.

Study strengths include the use of EMA, which allows for examination of relationships in the natural environment, increases external validity, and provides data pertaining to a large number of eating episodes. Additionally, we investigated several different negative affective states, rather than a composite score only. This allowed for identification of which negative affective states may be most salient to children and adolescents' experiences of LOC-eating. Limitations include the conduct of post-hoc analyses, the sample size, use of ordinal-level measures, and the healthy nature of the sample which may have contributed to low average reported intensity of NA and severity of LOC-eating. Our relatively small sample may have reduced our ability to detect small effects. Additionally, our small sample size prevented investigation of these associations within different age or pubertal development groups. Reactivity to EMA surveys may have affected results. Completing surveys brings one's awareness to a present emotional state about which they otherwise may not have been aware. Therefore, participants may have reported different levels of NA or LOC-eating than they typically experience when they are not reporting on these phenomena. Infrequent surveys throughout the day prohibited examination of changes in trajectories of NA in the hours prior to and following eating episodes. More frequent measurement and growth curve modeling approaches can provide additional context for how negative affective states relate to disordered eating behaviors (Berg et al., 2017). Lastly, LOC-eating severity was self-reported on a continuous scale. This is consistent with methodology used in previous pediatric EMA studies (Goldschmidt, Smith, Crosby, Boyd, Dougherty, Engel, & Haedt-Matt, 2018; Ranzenhofer et al., 2014); however, self-report measures of LOC-eating have tended to demonstrate lower specificity compared to clinician rated interviews when assessing for the presence of LOC-eating in children and adolescents (Altman et al., 2020; Tanofsky-Kraff et al., 2003). To better understand the utility of EMA studies in this population, clinically relevant cutoffs of LOC-eating severity in pediatric samples should be determined.

4.1 Conclusions

There is some evidence for the affect regulation theory of LOC-eating among children and adolescents in the laboratory, but these relationships have not been replicated in the natural environment. Theoretically driven, intensive, and precise measurement of affective states surrounding key time periods prior to and following eating episodes in children and adolescents' natural environments is needed to clarify whether the affect regulation theory of LOC-eating is an accurate etiological theory of pediatric eating disorders.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

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CONFLICT OF INTEREST:

Dr. Crosby is a paid statistical consultant for Health Outcomes Solutions, Winter Park, Florida, USA. Dr. Yanovski is the Principal Investigator of unrelated pharmacotherapy trials for obesity from Soleno Therapeutics, Hikma Pharmaceuticals, and Rhythm Pharmaceuticals for which his institution receives grant support.

DATA STATEMENT:

The data that support the findings of this study are available from the corresponding author upon request.

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Table 1.

Participant and EMA Demographic data

Participant Demographics	**n (N = 100)**	**%**
Sex at birth (Female)	55	55
Race/Ethnicity		
non-Hispanic Asian American	19	19
non-Hispanic Black	16	16
non-Hispanic Mixed race	11	11
non-Hispanic White	47	47
Hispanic Mixed race	1	1
Hispanic White	5	5
Hispanic with an unreported race	1	1
overweight or obesity	24	24
	M	**SD**
Age (year)	12.8	2.7
BMIz	0.50	1.05
EMA descriptive statistics	**M**	**SD**
composite negative affect	1.11	0.27
anger	1.14	**0.31**
anxiety	1.11	0.37
depression	1.10	0.26
guilt	1.06	0.24
LOC-eating severity	1.23	0.44
	n (N = 2,410)	**%**
Time between onset and report of eating episodes		
< 15 minutes	896	37.2%
15–30 minutes	471	19.5%
30–60 minutes	371	15.4%
60–90 minutes	198	8.2%
> 90 minutes	474	19.7%

The 100 youths with usable data reported a total of 2,410 eating episodes.

Table 2.

Models Examining if Pre-Meal NA Predicts Subsequent LOC-Eating

Composite negative affect	**ß**	**SE**	**p**	**95% CI**
Intercept	−0.106	0.285	.710	−0.664 – 0.453
Sex	0.002	0.046	.960	−0.088 – 0.093
Age	0.008	0.014	.542	−0.018 – 0.035
Race/Ethnicity	0.051	0.044	.253	−0.036 – 0.138
Height (cm)	0.002	0.003	.518	−0.003 – 0.007
Fat mass (kg)	0.001	0.002	.779	−0.004 – 0.005
SES	−0.046	0.025	.060	−0.094 – 0.002
Time since eating episode	−0.002	0.004	.676	−0.010 – 0.007
Between subject affect	**0.567**	**0.071**	**< .001**	**0.427 – 0.707**
Within subject affect	0.058	0.049	.239	−0.039 – 0.155
Anger	**ß**	***SE***	***p***	**95% CI**
Intercept	0.067	0.324	.836	−0.569 – 0.703
Sex	0.010	0.053	.843	−0.093 – 0.114
Age	0.008	0.016	.599	−0.022 – 0.039
Race/Ethnicity	0.059	0.051	.246	−0.041 – 0.159
Height (cm)	0.001	0.003	.812	−0.005 – 0.007
Fat mass (kg)	0.001	0.003	.660	−0.004 – 0.006
SES	−0.068	0.028	.016	−0.123 – −0.013
Time since eating episode	−0.001	0.004	.799	−0.009 – 0.007
Between subject anger	**0.346**	**0.069**	**< .001**	**0.212 – 0.481**
Within subject anger	0.046	0.030	.127	−0.013 – 0.106
Anxiety	**ß**	**SE**	**p**	**95% CI**
Intercept	−0.207	0.255	.418	−0.707 – 0.294
Sex	0.018	0.041	.655	−0.062 – 0.099
Age	0.007	0.012	.582	−0.017 – 0.030
Race/Ethnicity	0.05	0.039	.201	−0.027 – 0.128
Height (cm)	0.002	0.002	.336	−0.002 – 0.007
Fat mass (kg)	< 0.001	0.002	.866	−0.004 – 0.004
SES	−0.021	0.022	.353	−0.064 – 0.023
Time since eating episode	−0.002	0.004	.654	−0.010 – 0.006
Between subject anxiety	**0.510**	**0.050**	**< .001**	**0.412 – 0.608**
Within subject anxiety	0.030	0.034	.379	−0.037 – 0.097
Depression	**ß**	**SE**	**p**	**95% CI**
Intercept	−0.015	0.325	.963	−0.653 – 0.623
Sex	< 0.001	0.053	.997	−0.104 – 0.104
Age	0.005	0.015	.750	−0.025 – 0.035
Race/Ethnicity	0.076	0.051	.133	−0.023 – 0.175
Height (cm)	0.001	0.003	.653	−0.004 – 0.007
Fat mass (kg)	0.002	0.003	.475	−0.003 – 0.007

SES	−0.063	0.028	.025	−0.118 – −0.008
Time since eating episode	−0.001	0.004	.794	−0.010 – 0.007
Between subject depression	**0.457**	**0.089**	**< .001**	**0.282 – 0.632**
Within subject depression	0.007	0.036	.835	−0.062 – 0.077
Guilt	**ß**	**SE**	**p**	**95% CI**
Intercept	−0.115	0.262	0.66	−0.629 – 0.399
Sex	< 0.001	0.042	0.995	−0.083 – 0.083
Age	0.011	0.012	0.397	−0.014 – 0.035
Race/Ethnicity	0.044	0.041	0.28	−0.036 – 0.124
Height (cm)	0.002	0.002	0.526	−0.003 – 0.006
Fat mass (kg)	< 0.001	0.002	0.961	−0.004 – 0.004
SES	−0.032	0.023	0.158	−0.077 – 0.012
Time since eating episode	−0.002	0.004	0.687	−0.010 – 0.007
Between subject guilt	**0.670**	**0.070**	**< .001**	**0.533 – 0.807**
Within subject guilt	0.047	0.072	0.518	−0.095 – 0.188

Note: LOC; loss-of-control eating, NA; negative affect, SES; social economic status. Females were set as the reference sex assigned at birth. Race/Ethnicity was coded with non-Hispanic White set as the reference group. Time since eating episode refers to the amount of time between the occurrence and report of the eating episode. 95% confidence intervals that do not contain zero are in bold.

Table 3.

Models Examining if LOC-Eating Severity Predicts Post-Meal NA

Composite negative affect	**ß**	**SE**	**p**	**95% CI**
Intercept	−0.035	0.096	.716	−0.223 – 0.153
Sex	−0.009	0.015	.570	−0.038 – 0.021
Age	−0.001	0.004	.878	−0.009 – 0.008
Race/Ethnicity	−0.002	0.014	.915	−0.030 – 0.027
Height (cm)	−0.001	0.001	.241	−0.003 – 0.001
Fat mass (kg)	0.001	0.001	.512	−0.001 – 0.002
SES	0.008	0.008	.332	−0.008 – 0.024
Time since eating episode	**0.007**	**0.003**	**.005**	**0.002 – 0.012**
Pre-meal negative affect	**0.233**	**0.013**	**< .001**	**0.207 – 0.259**
Between subject LOC	**0.191**	**0.016**	**< .001**	**0.160 – 0.222**
Within subject LOC	0.027	0.014	.057	−0.001 – 0.055
Anger	**ß**	**SE**	**p**	**95% CI**
Intercept	−0.201	0.115	.080	−0.427 – 0.024
Sex	−0.009	0.018	.635	−0.044 – 0.027
Age	−0.001	0.005	.814	−0.012 – 0.009
Race	0.004	0.017	.833	−0.030 – 0.037
Height (cm)	< 0.001	0.001	.665	−0.002 – 0.002
Fat Mass (kg)	0.001	0.001	.274	−0.001 – 0.003
SES	0.013	0.010	.182	−0.006 – 0.033
Time since eating episode	**0.010**	**0.004**	**.017**	**0.002 – 0.018**
Pre-meal anger	**0.286**	**0.012**	**< .001**	**0.262 – 0.309**
Between subject LOC	**0.098**	**0.016**	**< .001**	**0.066 – 0.130**
Within subject LOC	0.015	0.017	.384	−0.019 – 0.049
Anxiety	**ß**	**SE**	**p**	**95% CI**
Intercept	0.144	0.117	.217	−0.085 – 0.373
Sex	−0.016	0.019	.385	−0.053 – 0.021
Age	0.004	0.006	.419	−0.006 – 0.015
Race	−0.004	0.018	.832	−0.039 – 0.031
Height (cm)	**−0.002**	**0.001**	**.039**	**−0.004 – < −0.001**
Fat mass (kg)	< 0.001	0.001	.774	−0.002 – 0.002
SES	0.006	0.010	.575	−0.014 – 0.026
Time since eating episode	0.005	0.003	.093	−0.001 – 0.011
Pre-meal anxiety	**0.212**	**0.011**	**< .001**	**0.191 – 0.232**
Between subject LOC	**0.247**	**0.020**	**< .001**	**0.208 – 0.287**
Within subject LOC	0.007	0.011	.540	−0.015 – 0.028
Depression	**ß**	**SE**	**p**	**95% CI**
Intercept	−0.072	0.121	.553	−0.309 – 0.165
Sex	0.007	0.019	.710	−0.030 – 0.044
Age	−0.001	0.006	.832	−0.012 – 0.010

Race/Ethnicity	< 0.001	0.018	.987	−0.035 – 0.035
Height (cm)	−0.001	0.001	.432	−0.003 – 0.001
Fat mass (kg)	< 0.001	0.001	.895	−0.002 – 0.002
SES	0.015	0.010	.153	−0.006 – 0.035
Time since eating episode	**0.010**	**0.004**	**.016**	**0.002 – 0.017**
Pre-meal depression	**0.224**	**0.016**	**< .001**	**0.193 – 0.255**
Between subject LOC	**0.158**	**0.016**	**< .001**	**0.127 – 0.190**
Within subject LOC	**0.042**	**0.018**	**.019**	**0.007 – 0.076**
Guilt	**ß**	**SE**	**p**	**95% CI**
Intercept	0.037	0.099	.704	−0.156 – 0.231
Sex	0.005	0.016	.741	−0.026 – 0.036
Age	−0.001	0.005	0.78	−0.010 – 0.008
Race/Ethnicity	0.007	0.015	.617	−0.022 – 0.037
Height (cm)	−0.001	0.001	.367	−0.003 – 0.001
Fat mass (kg)	0.001	0.001	.418	−0.001 – 0.002
SES	−0.007	0.009	.390	−0.024 – 0.009
Time since eating episode	**0.006**	**0.003**	**.010**	**0.001 – 0.011**
Pre-meal guilt	**0.147**	**0.012**	**< .001**	**0.123 – 0.171**
Between subject LOC	**0.234**	**0.017**	**< .001**	**0.201 – 0.267**
Within subject LOC	**0.056**	**0.020**	**.005**	**0.017 – 0.095**

Note: LOC; loss-of-control eating, NA; negative affect, SES; social economic status. Females were set as the reference sex assigned at birth. Race/Ethnicity was coded with non-Hispanic White set as the reference group. Time since eating episode refers to the amount of time between the occurrence and report of the eating episode. 95% confidence intervals that do not contain zero are in bold.

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Table 4.

Models Examining if LOC-Eating Severity Predicts Lagged Post-Meal NA

Composite negative affect	**ß**	**SE**	**p**	**95% CI**
Intercept	−0.102	0.121	.400	−0.340 – 0.136
Sex	0.001	0.018	.973	−0.035 – 0.037
Age	−0.004	0.005	.429	−0.015 – 0.006
Race/Ethnicity	0.017	0.017	.334	−0.017 – 0.051
Height (cm)	−0.001	0.001	.572	−0.003 – 0.001
Fat mass (kg)	< 0.001	0.001	.805	−0.002 – 0.002
SES	−0.006	0.010	.575	−0.026 – 0.014
Time since eating episode	**0.011**	**0.004**	**.004**	**0.003 – 0.018**
Pre-meal negative affect	**0.299**	**0.021**	**< .001**	**0.258 – 0.340**
Between subject LOC	**0.176**	**0.020**	**< .001**	**0.137 – 0.215**
Within subject LOC	0.014	0.026	.578	−0.036 – 0.065
Anger	**ß**	**SE**	**p**	**95% CI**
Intercept	−0.144	0.156	0.358	−0.450 – 0.163
Sex	< 0.001	0.024	0.993	−0.047 – 0.047
Age	−0.004	0.007	0.588	−0.017 – 0.010
Race/Ethnicity	0.021	0.022	0.348	−0.023 – 0.065
Height (cm)	−0.001	0.001	0.597	−0.003 – 0.002
Fat Mass (kg)	< 0.001	0.001	0.738	−0.002 – 0.003
SES	< 0.001	0.014	0.988	−0.027 – 0.027
Time since eating episode	**0.017**	**0.006**	**0.006**	**0.005 – 0.029**
Pre-meal anger	**0.321**	**0.019**	**< .001**	**0.283 – 0.359**
Between subject LOC	**0.102**	**0.022**	**< .001**	**0.060 – 0.144**
Within subject LOC	0.007	0.033	0.830	−0.057 – 0.071
Anxiety	**ß**	**SE**	**p**	**95% CI**
Intercept	0.080	0.155	.608	−0.225 – 0.384
Sex	−0.021	0.024	.371	−0.068 – 0.025
Age	−0.001	0.007	.835	−0.015 – 0.012
Race/Ethnicity	0.038	0.022	.091	−0.006 – 0.082
Height (cm)	−0.001	0.001	.438	−0.004 – 0.002
Fat mass (kg)	< 0.001	0.001	.960	−0.002 – 0.002
SES	−0.018	0.013	.185	−0.044 – 0.008
Time since eating episode	0.006	0.004	.173	−0.003 – 0.014
Pre-meal anxiety	**0.217**	**0.015**	**< .001**	**0.187 – 0.247**
Between subject LOC	**0.262**	**0.025**	**< .001**	**0.212 – 0.312**
Within subject LOC	−0.011	0.024	.636	−0.058 – 0.035
Depression	**ß**	**SE**	**p**	**95% CI**
Intercept	−0.067	0.182	.714	−0.425 – 0.291
Sex	0.030	0.028	.271	−0.024 – 0.084
Age	−0.008	0.008	.328	−0.024 – 0.008

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Race/Ethnicity	0.012	0.026	.641	−0.039 – 0.063
Height (cm)	< 0.001	0.002	.764	−0.004 – 0.003
Fat mass (kg)	< 0.001	0.001	.998	−0.003 – 0.003
SES	0.003	0.016	.849	−0.028 – 0.034
Time since eating episode	**0.016**	**0.006**	**.011**	**0.004 – 0.027**
Pre-meal depression	**0.256**	**0.025**	**< .001**	**0.207 – 0.306**
Between subject LOC	**0.174**	**0.023**	**< .001**	**0.129 – 0.218**
Within subject LOC	0.024	0.033	.470	−0.041 – 0.089
Guilt	**ß**	**SE**	**p**	**95% CI**
Intercept	0.097	0.129	.450	−0.155 – 0.350
Sex	0.012	0.019	.533	−0.026 – 0.050
Age	−0.005	0.006	.419	−0.016 – 0.007
Race/Ethnicity	0.027	0.018	.134	−0.008 – 0.063
Height (cm)	−0.001	0.001	.460	−0.003 – 0.001
Fat mass (kg)	< 0.001	0.001	.995	−0.002 – 0.002
SES	−0.010	0.011	.336	−0.031 – 0.011
Time since eating episode	**0.010**	**0.003**	**.002**	**0.004 – 0.017**
Pre-meal guilt	**0.152**	**0.018**	**< .001**	**0.118 – 0.187**
Between subject LOC	**0.279**	**0.020**	**< .001**	**0.241 – 0.317**
Within subject LOC	**0.075**	**0.027**	**.006**	**0.021 – 0.128**

Note: LOC; loss-of-control eating, NA; negative affect, SES; social economic status. Females were set as the reference sex assigned at birth. Race/Ethnicity was coded with non-Hispanic White set as the reference group. Time since eating episode refers to the amount of time between the occurrence and report of the eating episode. 95% confidence intervals that do not contain zero are in bold.