Eating behavior and familial interactions of children with loss of control eating: a laboratory test meal study\textsuperscript{1–3}

Anja Hilbert, Brunna Tuschen-Caffier, and Julia Czaja

ABSTRACT
Background: Loss of control (LOC) eating in children leads to excessive weight gain. However, few studies have investigated the eating behavior of children with LOC eating and psychological and familial factors that maintain the eating behavior.

Objective: This study sought to measure food intake in children with LOC eating and to examine maintenance through negative mood and parent-child mealtime interactions.

Design: Children with or without LOC eating (n = 120, aged 8–13 y) consumed a parent-child test meal and a child-only meal, consisting of snack food, after the induction of negative mood. Food intake, mood, sense of LOC, hunger, satiety, and mealtime interactions were assessed.

Results: Regardless of mood induction, children with LOC eating showed a greater intake of energy, fat, and protein and a greater sense of LOC than did those without LOC in the child-only snack group, which was accounted for by greater baseline hunger and satiety. Independently, children with high recurrent LOC eating had a greater food intake at both test meals than did those with low recurrent LOC eating. Overall, mealtime interactions did not differ between groups, but parents of children with LOC eating expressed more weight-related critique than did parents of children without LOC eating outside negative mood induction. Predictors of food intake were greater antecedent hunger or less satiety, stronger antecedent sense of LOC, and more weight-related critique.

Conclusions: The results showed objective abnormalities in the eating behavior of children with LOC eating that were mostly unrelated to negative mood or dysfunctional mealtime interactions. Further research is required to specify factors maintaining LOC eating. Am J Clin Nutr 2010;91:510–8.

INTRODUCTION

Binge eating is defined as eating an objectively large amount of food accompanied by a sense of loss of control (LOC) over eating (1) and occurs in 6.2\% of 6–12-y-old normal- and overweight children (2). LOC eating, which involves consumption of a subjectively or objectively large amount of food and a sense of LOC over eating, affects even more youth, especially when they seek treatment of overeating (3–7). Although only a minority of youth, predominantly adolescents, fulfill the diagnostic criteria of binge eating disorder (BED) (8, 9), subsyndromal LOC eating is associated with eating disorder and general psychopathology in childhood (2, 4, 6, 7, 10–12) and predicts greater weight gain over time (13).

One test meal study showed a greater ingestion of carbohydrates and a smaller ingestion of protein in youth (8–18 y) with LOC eating than in those without LOC eating, but found no differences in energy consumption (14). Greater consumption of energy was observed in overweight girls with LOC eating only, which also was found in a pilot test meal study in obese treatment-seeking children (6–12 y) with self-reported binge eating (15). It thus remains unclear whether middle childhood samples of LOC eating show abnormal eating behavior if they are not seeking treatment of overweight. In self-monitoring studies, non-treatment-seeking children with LOC eating reported increased energy consumption, especially during LOC episodes (16, 17). However, self-monitoring is considered less accurate in the assessment of food intake than are laboratory test meals (18).

As posited by maintenance theories developed for adults (19–21) and adapted for children (22), antecedent negative mood and dietary restriction are among the most pertinent factors responsible for the maintenance of binge eating. Concerning negative affect, youth retrospectively reported emotional eating and LOC eating under negative mood (23–26), and emotional-external eating has been found to predict snack food intake in the absence of hunger in children (27). However, evidence from ecologic momentary assessment provided limited support for negative affect as an immediate antecedent of LOC eating in children (16). Because most self-reported LOC episodes in youth occur during dinner with the family around (25), an additional question is the contribution of parent-child mealtime interactions to negative affect or aberrant eating. In overweight and obese children, mealtime interactions were more negative and char-

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acterized by greater feeding control (28–30). Restrictive feeding practices have proven relevant for overeating tendencies in preschoolers (31, 32). However, in middle childhood, results are inconsistent (27, 33) and LOC eating has not been assessed.

The present test meal study examined food intake in relation to negative mood and parent-child interactions. We hypothesized that children with LOC eating would, first, have greater intakes of food, energy, and carbohydrates than would children without LOC eating and, second, show a greater sense of LOC over eating, especially after a negative interaction. We also hypothesized that, third, their parent-child interactions would be characterized by more restrictive feeding behaviors, more negative behaviors, and more parental critique about weight, shape, or eating (34, 35). Fourth, we sought to determine antecedents of food intake and LOC over eating.

**SUBJECTS AND METHODS**

**Recruitment and sample**

Children aged 8–13 y were recruited from the community either through schools (grades 3–7) or through an advertising campaign consisting of the use of posters, newspaper advertisements, and flyers about this study. For both recruitment avenues, eligibility regarding inclusion and exclusion criteria was determined in a telephone interview. Eligible children and their parents were invited to attend a diagnostic session that included diagnostic interviews, self-reported questionnaires, and a measurement of body weight and height. The Eating Disorder Examination adapted for Children (ChEDE) (36, 37) was used to ascertain diagnostic status (see Measures). Ethical approval for the conduct of this study was granted through the German Psychological Society’s Ethics Committee. Informed assent and consent were obtained from the child and the participating parent before the diagnostic session. Recruitment took place between April 2006 and October 2007.

The main inclusion criterion for children with LOC eating (LOC+) was that, at least, one episode of LOC eating during the past 3 mo. Further inclusion criteria were age 8–13 y and sufficient German language skills of the child and participating parent. Exclusion criteria were as follows: compensatory behaviors (more than one episode over the past 3 mo), psychotic disorders in child or parent; medical conditions with an enduring effect on eating behavior; current treatment of overweight, special education, a planned move, or commuting time of >30 min to the laboratory site. Children without LOC eating (LOC−) were individually matched to the LOC+ children on age, sex, percentile of body mass index (BMI), education (school type and grade), and the mother’s education (y). Inclusion criteria for LOC− children were absence of past or present LOC eating, compensatory behaviors, or an eating disorder.

A total of 751 children were contacted for the purpose of this study (for recruitment detail, see reference 16). After the telephone screening, 624 of these children were excluded according to the criteria specified above. After the diagnostic visit, 7 additional children were excluded, which left a total of 60 LOC+ children and 60 matched LOC− children to participate in the study. Sociodemographic and anthropometric characteristics did not differ by study group (all $P > 0.01$). The overall study sample consisted of 68 girls and 52 boys with a mean (±SD) age of 10.77 ± 1.46 y and a mean (±SD) duration of education of 4.77 ± 1.44 y. BMI (in kg/m²) was calculated from weight, measured to the nearest 0.1 kg with a calibrated balance scale, and height was measured to the nearest centimeter with a rigid stadiometer. The mean (±SD) BMI was 23.02 ± 5.03, and the mean (±SD) BMI-SD score (BMI-SDS) was 1.31 ± 1.06. According to the definition of overweight and obesity by the International Task Force of Obesity, 40.0% of the children were normal weight (48/120; 10th–90th BMI percentile), 29.2% of the children were classified as overweight (35/120; 90th–97th BMI percentile), and 30.8% were classified as obese (37/120; BMI >97th percentile). There were no group differences in the BMI of the participating parent, calculated from measured height and weight (27.58 ± 6.36).

**Procedures**

All experimental sessions took place between 1800 and 1900 in a light- and temperature-controlled laboratory adjacent to a connecting control room. On arrival, the child and participating parent were familiarized with the laboratory suite, and the experimental procedure was explained. To control for pre-experimental hunger and satiety and to increase the likelihood of food intake during the test meal, participants were instructed not to eat anything after 1400 in the afternoon.

At the outset of the experiment, a semistructured interview was performed to identify relevant conversation themes for the interaction task described below. All parents and children were asked to describe recent conversation topics: neutral topics that provoked neither negative nor positive feelings, and conflictual topics that provoked strong negative feelings during the 2 wk before the investigation. For each topic, parents and children were asked to provide detail on the duration, context, and content of the discussion to facilitate their recall of the interaction. Neutral and conflictual topics were ranked by the child and the parent according to their frequency. Frequency was used as a selection criterion rather than severity because frequency can be determined more reliably and may lead to a selection of topics that is more representative of the daily conversation, although it is possible that low-frequency, high-severity conflict themes may have been missed. In the current sample, neutral topics were, for example, concerned with leisure-time activities, weather, animals, and appointments, whereas conflictual topics concerned homework assignments, school, or conduct problems.

The experimental protocol is depicted in Figure 1 and included the following trials: a neutral interaction task (baseline) (a), a negative compared with neutral interaction task (experimental variation) (b), a parent-child test meal (c), and child-only snack eating (d). All trials were videotaped.

The interaction task was modeled after a discussion task developed to study interactive behavior between depressed mothers and their children (38). Discussion tasks are common approaches to study interaction behavior in diverse forms of pediatric psychopathology and health conditions (eg, anxiety and diabetes) (39, 40) and are suited to elicit negative emotions (41). Idiosyncratically relevant conversation topics were selected for the interaction task as described above. For the baseline assessment, a neutral interaction task was performed by using the neutral interaction topic with the second highest rank (5 min). Dyads were asked to discuss this topic as they would do at home. For the negative compared with neutral interaction task, dyads were...
randomly assigned to discuss either the highest-ranking negative or the highest-ranking neutral topic as they would do at home (5 min). Methodologically, a neutral, and not a positive interaction served as the control condition for the induction of negative mood because LOC episodes have been found to occur under positive affective states (25).

After the interaction task to induce negative affect, a buffet-style parent-child test meal was performed. The child and the parent were instructed to eat as much as desired (20 min). The test meal was developed from a pilot study of typical dinner food in an independent school-based sample of 112 children at ages 8–13 y. The test meal used the most frequently reported dinner foods, for example, a selection of bread and rolls, diverse cold cuts and cheese, meat salad, meatballs, chocolate spread, hot pizza sandwich, gherkin, tomato, apples, yogurt, chocolate cream, and a selection of drinks (juice, soda, water, milk, tea, and chocolate drink). The test meal was composed of 8373 g food and drinks (15575 kcal; 372 g protein, 1564 g carbohydrates, and 775 g fat). To separately assess food intake in the child and parent, food was served on 2 identical trolley tables.

After the test meal, the parent was asked to leave the laboratory under the pretext of meeting with the research assistant. During this child-only snack eating period, the child was offered snack food ad libitum while watching a sequence of popular age-appropriate videos (10 min). In addition, the child was given access to toys and games. Snack food consisted of potato chips, salted peanuts, candy, ice cream, chocolate bars, fruit gums, and chocolate cookies. A total of 870 g snack food (3975 kcal; 83 g protein, 450 g carbohydrate, and 201 g fat) was offered.

Finally, a semistructured postexperimental interview was conducted with the child and parent to provide counseling for any acute stress responses the study may have caused (42). In addition, the children were asked to rate the representativeness of experimental procedures (see Control variables).

Measures

Food intake

The dependent variables of food intake included the amount (g), energy content (kcal), and macronutrient composition (g of fat, carbohydrate, and protein) of the foods consumed by the child during the test meal and snack eating. All foods were weighed before and after the trials by using a calibrated table top scale (NWT-3K; Jadever Ltd, Sinjuhuang, Taiwan). The amount of food intake was calculated and converted into energy and macronutrient intakes by using the nutritional information of the food producer.

Sense of LOC over eating

Children were asked to self-rate the degree of LOC over eating after each experimental trial (1 = very slightly or not at all to 5 = extremely).

Mealtime interactions

Mealtime interactions were quantified through behavioral observation by using digital video recordings of the parent-child test meal. Overall negative behavior of parent to child and child to parent was counted, as defined according to the behavioral coding system Family Problem Solving Code (43), established to analyze parent-child discussions of problems. Negative behavior refers to overt (direct) and covert (indirect) forms of definite criticism, anger, disagreement, complaining, rejection, etc, of the parent or child. Negative behaviors of parent to child and child to parent were counted and, because of positive skewness, dichotomized for further analysis to 0 = 0 or once and 1 = repeated. Furthermore, a variable of critical comments by the parent about the child’s shape, weight, or eating was defined. For this variable, overt and covert signs of parental critique regarding the child’s shape, weight, or eating, such as “Do you want to grow bigger?” were counted and dichotomized as described above. In addition, a variable of parental restrictive feeding behavior was defined on the basis of the respective scale of the Child Feeding Questionnaire (44). Restrictive feeding behavior included overt and covert parental attempts to limit the child’s consumption of the amount or certain types of food and was counted and dichotomized as described above.

Coding of mealtime interaction variables was based on a 10-min sequence of the parent-child test meal (5th to 15th min) during which all dyads were eating. Interrater reliability of coding of the mealtime interaction variables was determined for the entire sample between independent ratings of 2 raters blind to group assignment and hypotheses; $\kappa$ coefficients were substantial or almost perfect ($0.63 \leq \kappa \leq 0.83$; all $P < 0.001$) (45).

Classificatory variable for secondary analyses: LOC+ children with high compared with low recurrent LOC eating

To determine differences between LOC+ children with clinical compared with subthreshold levels of LOC eating, all dependent variables were compared by clusters of high compared with low recurrent LOC eating in secondary analyses. These clusters had been derived by hierarchical cluster analysis by using the DSM-IV diagnostic criteria of BED as cluster variables on the sample of the current research project (11). The
cluster of high recurrent LOC eating consisted of 11 children (out of 60, 18.3%), and the cluster of low recurrent LOC eating consisted of 36 children (out of 60, 60.0%). The remainder of the LOC+ children had been grouped into a cluster of no or sporadic LOC eating. Children with high recurrent LOC eating had clinical levels of eating disorder and a general psychopathology that was significantly greater than that of children with low recurrent LOC eating.

**Descriptive and control variables**

Preexperimental descriptive assessments related to the study purpose included the following validated trait measures: child-reported depressiveness (Children’s Depression Inventory (CDI; 46); 26 items; analysis: sum scores, converted to T scores) and restraint [5-item subscale from the ChEDE (36); 0 = not present to 6 = present every day; analysis: mean subscale score] and parent-reported restrictive feeding practices [8-item subscale from the Child-Feeding Questionnaire (47); 1 = never to 5 = always; analysis: mean subscale score] and family climate [Skala zur Selbsteinschätzung des Familienlebens (SEF; 48); 53 items; 1 = strongly agree to 5 = strongly disagree, with lower scores indicating greater dysfunction; analysis: mean score].

During the experiment, the control variables of mood, hunger, and satiety were assessed after each experimental trial. For assessment of mood, the general mood item of happiness was selected from the Positive and Negative Affect Schedule for Children (49, 50) (1 = very slightly or not at all to 5 = extremely). A difference score of mood at neutral interaction (baseline) minus mood at negative compared with neutral interaction (experimental variation) served to quantify the effects of the mood induction for an experimental check. In addition, children were also asked about feelings of hunger and satiety (ie, “full”; 1 = very slightly or not at all to 5 = extremely) (51).

At the postexperimental interview, children were asked to rate the representativeness of the test meal, the selection of foods, and the parent-child interactions to assess the ecological validity of the experimental procedures (1 = very slightly or not at all to 5 = extremely). In addition, children were asked to rate the tastiness of the foods offered at the test meal (1 = good to 5 = bad).

**Group differences in descriptive variables and experimental check**

Two-factor repeated-measures analyses of group (LOC+, LOC−; within-subjects factor) × condition (neutral, negative interaction; between-subjects factor) were conducted on the descriptive and control variables and on age and BMI-SDS [analysis of sex by generalized estimating equation (GEE) logistic regression by using a logit link function and a binomial error distribution]. Descriptively, LOC+ children reported greater depressiveness and restraint than did LOC− children (50.53 ± 9.71 compared with 44.57 ± 9.74 and 0.58 ± 0.66 compared with 0.27 ± 0.51, respectively; P < 0.05). Of the control variables, baseline hunger and satiety were significantly greater in LOC+ children than in LOC− children (3.12 ± 1.24 compared with 2.52 ± 1.32; P < 0.05). Thus, for the main analyses, it was indicated to control for baseline levels of hunger and satiety. Mood showed a deterioration between baseline and experimental variation in the negative interaction condition (effect of condition: P < 0.05), which indicated a successful induction of negative mood in this experimental condition (η² = 0.17, large effect), whereas in the neutral interaction condition, mood did not change between the baseline and interaction task as expected (P > 0.05, η² = 0.01). Concerning ecological validity, children reported a high representativeness of the test meal and a medium representativeness of the food selection (3.78 ± 1.06 and 3.28 ± 1.21, respectively). Both groups of children evaluated the taste of the foods at the test meal as good, but LOC+ children liked the taste better than did the LOC− children (1.22 ± 0.50 compared with 1.55 ± 0.68; P < 0.05). Children perceived a high level of representativeness of the interaction task for their daily conversation (3.69 ± 1.02). However, children in the negative interaction condition perceived a lower level of representativeness of the interaction task than did children in the neutral interaction condition [3.45 ± 1.11 compared with 3.93 ± 0.93; group × condition, Tukey honestly significant difference (HSD) test, P < 0.05]. Only significant effects were reported.

**Data analytic plan**

The data analysis was based on a 2-factor repeated-measures design of group (LOC+, LOC−; within-subjects factor) × condition (neutral, negative interaction; between-subjects factor). For continuous variables, univariate general linear model (GLM) analyses for repeated measures were conducted (hypotheses 1 and 2). Data were checked for normal distribution and homogeneity of error distributions. Partial η² describing the proportion of total variability attributable to a factor was displayed for estimation of effect sizes when appropriate (small: η² < 0.01; medium: η² < 0.06; large: η² < 0.14) (52). Binary data were analyzed by using the generalized estimating equation (GEE) logistic regression approach (logit link function, binomial error distribution), allowing for repeated-measures analysis of categorical data (hypothesis 3). All analyses were adjusted for baseline hunger and satiety in an additional step. For post hoc comparisons, pairwise GLM, logistic regression analyses, or Tukey HSD tests were used. Hierarchical linear regression analyses were conducted to predict food intake (g, kcal) and sense of LOC at the test meal and snack eating (research question 4). In these analyses, momentary experimental variables (mood, mood induction, hunger, satiety, and LOC before test meal or snack eating, respectively, and the test meal interaction variables) were entered in step 1, and the trait variables of child depressiveness and restraint, restricting feeding practices, and family climate were entered in step 2, after correction for age, sex, BMI-SDS, group, and parental BMI (step 0). Effect size of prediction was evaluated according to Cohen (small: R² ≥ 0.02; medium: R² ≥ 0.15; large: R² ≥ 0.35) (52). Secondary analyses served to compare within the LOC+ children those of a high compared with a low recurrent LOC cluster (classificatory variable) [one-way GLM or generalized linear model analyses of cluster (high, low recurrent LOC eating; between-subjects factor) for continuous or binary variables, respectively]. A factor of condition was not included in these analyses, because of insufficient n and absence of between-cluster differences in mood induction (see below). An overall 2-tailed α of 0.05 was applied to statistical testing. All analyses were performed with SPSS 17.0 (SPSS Inc, Chicago, IL).
RESULTS

Food intake

The results of food intake variables are presented in Table 1 and Figure 2. During the parent-child test meal, there were no significant effects on either food intake variable (all $P > 0.05$). In contrast, during the child-only snack eating, LOC+ children had a significantly greater intake of energy than did LOC$^-$ children, a greater consumption of protein and fat (all $P < 0.05$, $\eta^2 = 0.09$), and a tendency of greater carbohydrate intake ($P = 0.064$, $\eta^2 = 0.06$; medium-size effect). Group differences were accounted for by baseline hunger and satiety when included as covariates in an additional step ($P < 0.05$).

Sense of LOC over eating

As presented in Table 2, LOC+ children reported a marginally significant greater sense of LOC over eating during the test meal than did LOC$^-$ children ($P = 0.056$, $\eta^2 = 0.06$) and a significantly greater sense of LOC at snack eating ($P < 0.05$, $\eta^2 = 0.11$; both medium-size effects), independent of mood induction ($P < 0.05$). The group effect was accounted for by baseline hunger and satiety included as covariates in an additional step in the analyses ($P < 0.05$).

Mealtime interactions

Both LOC+ and LOC$^-$ children showed more negative behavior toward their parents during the test meal in the negative interaction condition than in the neutral interaction condition ($P < 0.05$; Table 3). There was no difference in overall negative behavior of parents toward children and vice versa ($P > 0.05$). However, parents of LOC+ children expressed more critical comments about their child’s shape, weight, or eating in the neutral interaction condition than did parents of LOC$^-$ children (group × condition, post hoc tests; $P < 0.05$), whereas there were no differences in the negative interaction condition ($P > 0.05$). Inclusion of baseline hunger and satiety as covariates did not modify the results ($P > 0.05$).

Prediction of food intake and sense of LOC over eating at test meal and snack eating

For the prediction of food intake (g) and energy intake (kcal) during the test meal, hierarchical linear regression analyses resulted in models that each accounted for 23.0% of the

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**Table 1**

Food intake at a test meal and snack eating in children with and without loss of control (LOC) eating by a neutral compared with a negative interaction condition$^d$

<table>
<thead>
<tr>
<th></th>
<th>LOC+ ($n = 60$)</th>
<th>LOC$^-$ ($n = 60$)</th>
<th>Group</th>
<th>Condition</th>
<th>Group × condition</th>
</tr>
</thead>
<tbody>
<tr>
<td>Parent-child test meal</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Energy (kcal)</td>
<td>$802 \pm 280^d$</td>
<td>$744 \pm 321$</td>
<td>0.281</td>
<td>0.991</td>
<td>0.957</td>
</tr>
<tr>
<td>Amount of food (g)</td>
<td>$362 \pm 127$</td>
<td>$340 \pm 136$</td>
<td>0.339</td>
<td>0.516</td>
<td>0.430</td>
</tr>
<tr>
<td>Carbohydrate (g)</td>
<td>$86 \pm 29$</td>
<td>$78 \pm 38$</td>
<td>0.201</td>
<td>0.385</td>
<td>0.830</td>
</tr>
<tr>
<td>Protein (g)</td>
<td>$26 \pm 12$</td>
<td>$23 \pm 10$</td>
<td>0.256</td>
<td>0.886</td>
<td>0.999</td>
</tr>
<tr>
<td>Fat (g)</td>
<td>$39 \pm 16$</td>
<td>$38 \pm 18$</td>
<td>0.586</td>
<td>0.419</td>
<td>0.999</td>
</tr>
<tr>
<td>Child-only snack eating</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Energy (kcal)</td>
<td>$245 \pm 179$</td>
<td>$176 \pm 175$</td>
<td>0.019$^d$</td>
<td>0.643</td>
<td>0.720</td>
</tr>
<tr>
<td>Amount of food (g)</td>
<td>$364 \pm 126$</td>
<td>$340 \pm 136$</td>
<td>0.340</td>
<td>0.436</td>
<td>0.495</td>
</tr>
<tr>
<td>Carbohydrate (g)</td>
<td>$33 \pm 23$</td>
<td>$26 \pm 24$</td>
<td>0.064</td>
<td>0.524</td>
<td>0.535</td>
</tr>
<tr>
<td>Protein (g)</td>
<td>$3 \pm 3$</td>
<td>$2 \pm 2$</td>
<td>0.013$^d$</td>
<td>0.831</td>
<td>0.917</td>
</tr>
<tr>
<td>Fat (g)</td>
<td>$11 \pm 11$</td>
<td>$7 \pm 9$</td>
<td>0.018$^d$</td>
<td>0.818</td>
<td>0.933</td>
</tr>
</tbody>
</table>

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$^d$ LOC+, children with LOC eating; LOC$^-$, children without LOC eating.

Two-factor repeated measures of group (LOC+, LOC$^-$; within-subjects factor) × condition (neutral, negative interaction; between-subjects factor).

Mean ± SD (all such values).

$^d$ $P < 0.05$. 

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**Figure 2.** Ad libitum energy intake in children with and without loss of control (LOC) eating and in children with low compared with high recurrent LOC eating. LOC+, children with LOC eating; LOC$^-$, children without LOC eating. One-factor general linear model of group (LOC+, LOC$^-$) or of cluster (high, low recurrent LOC). *$P < 0.05$, **$P < 0.01$. 

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variance, which indicated medium-size prediction effects ($P < 0.001$; Table 4). In both models, greater hunger before the test meal predicted greater test meal intake of food and energy (all $P < 0.05$) after sociodemographic characteristics were controlled for. Food intake during snack eating was predicted through a model that explained 21.0% of the variance, which indicated a medium-size prediction effect ($P < 0.001$). In this model, food intake was predicted by less satiety and a greater sense of LOC experienced after the test meal ($P < 0.05$), after sociodemographic characteristics were adjusted for. The regression analysis of energy intake during the snack eating trial resulted in a model yielding a small prediction effect (7.0% of explained variance). More critical comments about the child’s shape, weight, or eating by the parent at the test meal predicted a greater sense of LOC over eating during the test meal ($P < 0.05$) after sociodemographic characteristics were controlled for. Sense of LOC over eating at the test meal and snack eating were both best predicted by antecedent sense of LOC (both $P < 0.001$).

**Secondary analyses: comparison of LOC+ children with high or low recurrent LOC eating**

A comparison of LOC+ children with a high compared with a low frequency of LOC eating (see Classificatory variable, Table 2) showed that children with high recurrent LOC eating consumed a greater amount of food during the test meal and during snack eating as well as a greater amount of energy and of all macronutrients during snack eating than did those with low recurrent LOC eating (all $P < 0.05$). Children with high recurrent LOC eating showed a trend-wise greater sense of LOC over eating during the test meal ($P = 0.064$) and a significantly greater sense of LOC during snack eating than those with low recurrent LOC eating ($P < 0.05$). There were no between-cluster differences in mealtime interactions and mood induction (both $P > 0.05$). The results were not modified by baseline hunger and satiety.

**Post hoc comparison by sex**

Because of sex-by-LOC status differences in food intake reported in the literature, post hoc analyses of food intake, sense of LOC over eating, and mealtime interactions were conducted [GLM or generalized linear model of sex (female, male) × group (LOC+, LOC−) × condition (neutral, negative interaction)]. Boys showed a greater intake of energy, carbohydrates, and protein during the test meal than did girls, whereas girls reported a greater sense of LOC over eating at snack eating (group effects, $P < 0.05$). No further significant group or interaction effects emerged ($P > 0.05$).

**TABLE 2**

<table>
<thead>
<tr>
<th>LOCEating</th>
<th>LOCEating (n = 60) Mean ± SD</th>
<th>LOCEating (n = 60) Mean ± SD</th>
<th>Group</th>
<th>Condition</th>
<th>Group × condition</th>
</tr>
</thead>
<tbody>
<tr>
<td>LOC+</td>
<td>1.80 ± 1.33</td>
<td>1.40 ± 1.01</td>
<td>0.056</td>
<td>1.000</td>
<td>1.000</td>
</tr>
<tr>
<td>LOC−</td>
<td>1.74 ± 1.25</td>
<td>1.18 ± 0.70</td>
<td>0.010</td>
<td>0.240</td>
<td>0.895</td>
</tr>
</tbody>
</table>

1. LOC+, children with LOC eating; LOC−, children without LOC eating.

2. Two-factor repeated measures of group (LOC+, LOC−) × condition (neutral, negative interaction; between-subjects factor).

3. Mean ± SD (all such values).

4. $P < 0.05$.

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**TABLE 3**

Parent-child interactions at a parent-child test meal in children with and without loss of control (LOC) over eating by a neutral compared with a negative interaction condition

<table>
<thead>
<tr>
<th>Interaction</th>
<th>LOCEating (n = 60)</th>
<th>LOCEating (n = 60)</th>
<th>Group</th>
<th>Condition</th>
<th>Group × condition</th>
</tr>
</thead>
<tbody>
<tr>
<td>Negative behavior child</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Neutral interaction</td>
<td>8</td>
<td>30.8</td>
<td>5</td>
<td>19.2</td>
<td>0.240</td>
</tr>
<tr>
<td>Negative interaction</td>
<td>13</td>
<td>52.0</td>
<td>12</td>
<td>41.4</td>
<td></td>
</tr>
<tr>
<td>Negative behavior parent</td>
<td></td>
<td></td>
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1. LOC+, children with LOC eating; LOC−, children without LOC eating.

2. Generalized estimating equation logistic regression of group (LOC+, LOC−); within-subjects factor) × condition (neutral, negative interaction; between-subjects factor).

3. $P < 0.05$. 

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**EATING BEHAVIOR IN CHILDREN WITH LOC EATING**

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Hierarchical linear regression analysis with age (y), sex (female, male), BMI–SD score (BMI-SDS), group (children with LOC eating, children without LOC eating), and parental BMI entered in step 0; antecedent mood, hunger, satiety, and sense of LOC over eating entered in step 1 (all scaled as 1 = very slightly or not at all to 5 = extremely); and depressiveness (T scores), restraint (0 = not present to 6 = present every day), restricting feeding practices (1 = never to 5 = always), and family climate (1 = strongly agree to 5 = strongly disagree) entered in step 3. B, unstandardized regression coefficient; β, standardized regression coefficient; \( R^2 \), adjusted multiple \( R^2 \) (cumulative); \( R^2 \) change, adjusted multiple \( R^2 \) (by predictor). All final models were significant at \( P < 0.01 \).

### DISCUSSION

By conducting a child-only snack eating after a test meal with the parent, this laboratory feeding study documented objective abnormalities in eating behavior of children with LOC eating. Children with LOC eating showed greater consumption of energy, fat, protein, and a tendency toward greater carbohydrate intake than did children without LOC eating while on their own and provided with snack food. They also reported a greater momentary sense of LOC over eating. Within the group of children with LOC eating, those with high recurrent LOC eating also showed a greater amount of food intake at both test meal and snack eating than those with low recurrent LOC eating. These results extend previous evidence (14, 15) by showing that 8–13-y-old children from the community experience overeating and a sense of LOC, particularly related to a preference of snack food (53). Consistent with retrospective studies, overeating and LOC over eating were more likely to occur when children were on their own (25). Boys showed a greater intake of energy, carbohydrates, and protein during the test meal than did girls, which reflects overall sex differences in food intake at that age (54). However, girls reported a greater sense of LOC during snack eating than did boys, which is consistent with previous findings in youth (2, 3, 14) and adults (55).

In contrast with retrospective self-reports of children with LOC eating (23–26), but consistent with results from an ecologic momentary assessment study in the same sample (16), there was no indication that negative affect functioned as an immediate antecedent of food intake. Neither momentary negative affect nor trait depressiveness emerged as predictors of food intake, although children with LOC eating had higher levels of depressiveness than did those without LOC eating. Several methodological and developmental explanations are plausible to explain the inconsistency between momentary and retrospective results: methodologically, the ecologically valid mood induction paradigm decreased mood to a large extent and was related to more negative child behavior during the test meal. However, it is unclear whether this mood induction was intense enough to provoke greater eating, as could be expected from an interpersonal threat or rejection in the natural environment (56). Developmentally, we may not have found an association between momentary negative affect and overeating because restrictive feeding behavior or practices and the child’s own restraint only yielded low scores. In adults with BED, restraint was found to be a mediator between negative affect and increased food intake (57).

Overall, there was little support for greater dysfunctional mealtime interactions in children with LOC eating than in those without LOC eating. Parents of children with LOC eating expressed more critical comments about the child’s shape, weight, or eating when asked to discuss a neutral topic. The negative interaction condition likely increased the expression of
critical comments in parents of children without LOC eating and may have shifted the focus away from shape, weight, or eating in parents of children with LOC eating. Indeed, critical comments about shape, weight, or eating are known risk factors for eating pathology in adolescence (58) and retrospective correlates of risk of BED in adults (35, 59). Consistent with these findings, critical comments were identified as a weak antecedent of greater ad libitum energy intake in the current study. In contrast, there was no indication of greater overall negative test meal behavior between parents and children with LOC eating. These results contrast with those from samples with overweight or obese children (28–30), presumably because the study sample was not entirely overweight. That only a few parents showed restrictive feeding behavior could reflect a decreased parental influence on the child’s eating behavior in middle childhood (27).

The results provided further insight into antecedents of food intake. Greater hunger and less satiety were the most salient psychological predictors of food intake during the test meal and snack eating. These results are consistent with those of Mirch et al. (15), who found a briefer satiety duration in overweight girls with binge eating than in those without binge eating, and evidence suggests a psychobiological disturbance in the regulation of hunger and satiety in adults with BED (60–62). To interpret the current results, it is noteworthy that children with LOC eating were more hungry at baseline than were children without LOC eating, despite both groups reporting abstinence from eating 4 h before the experiment, as instructed. Further research should elucidate the psychobiological aspects of hunger and satiety regulation in children with LOC eating, taking into account hedonics of eating; similar to results in adults with BED (63, 64), children with LOC eating showed a greater tendency toward hedonic eating in the current study.

The results need to be interpreted with regard to the strengths and limitations of the present study. Strengths include the use of a comparatively large and well-characterized community-based sample with and without LOC eating. Individuals were matched for potential group differences related to anthropometric and sociodemographic differences. Food intake, subjective ratings, and mealtime interactions were assessed by using established procedures, except for the mealtime interaction variables of critical comments and restrictive feeding behavior, which was due to the lack of available measures. Nevertheless, high interrater reliability was established for all behavioral observation measures. Concerning the generalization of results, multiple efforts were aimed at ensuring ecological validity by conducting a typical dinner test meal with a parent present and mood induction through an established interaction task involving discussion of idiosyncratically relevant topics (38), which produced mostly a high representativeness of experimental procedures. Although the study design was similar to designs assessing eating in the absence of hunger (31, 32), it is of note that the test meal procedure was not aimed at ensuring satiety or absence of hunger but rather to investigate eating behavior in response to negative mood and mealtime interactions. Therefore, ad libitum snack food intake in the current study is not equivalent to eating in the absence of hunger, which has been discussed as a representation of binge eating in children (65, 66). Furthermore, the results for snack food intake can be generalized to episodes of snack eating that occur after family mealtimes, but cannot be generalized as well to snack eating that occurs when mealtimes are absent or irregular.

Overall, the study results contribute to the construct validity of LOC eating in middle childhood, while further questioning the role of antecedent negative affect for food intake in this age group. For clinical implications, the results emphasize the need to develop early interventions, especially for those children who present with high levels of LOC eating (11) because of the risk of weight gain (13). On the basis of the current results, interventions may not only focus on the normalization of food intake, but also on the perception of hunger and satiety and the prevention or coping with critical comments about weight, shape, or eating. Future research needs to elucidate the effectiveness of these interventions at decreasing LOC eating in children and preventing obesity and related medical and psychosocial sequelae.

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REFERENCES


