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Discordance between assessments of food cue responsiveness: Implications for assessment in youth with overweight/obesity

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ABSTRACT

Food cue responsiveness (FCR), broadly defined as behavioral, cognitive, emotional and/or physiological responses to external appetitive cues outside of physiological need, contributes to overeating and obesity among youth and adults. A variety of measures purportedly assess this construct, ranging from youth- or parent-report surveys to objective eating tasks. However, little research has assessed their convergence. It is especially important to evaluate this in children with overweight/obesity (OW/OB), as reliable and valid assessments of FCR are essential to better understand the role of this critical mechanism in behavioral interventions. The present study examined the relationship between five measures of FCR in a sample of 111 children with OW/OB (mean age = 10.6, mean BMI percentile = 96.4; 70% female; 68% white; 23% Latinx). Assessments included: objectively measured eating in the absence of hunger (EAH), parasympathetic activity when exposed to food, parent reported food responsiveness subscale from the Child Eating Behavior Questionnaire (CEBQ-FR), child self-reported Power of Food total score (C-PFS), and child self-reported Food Cravings Questionnaire total score (FCQ-T). Statistically significant spearman correlations were found between EAH and CEBQ-FR ($\rho = 0.19$, $p < 0.05$) and parasympathetic reactivity to food cues with both C-PFS ($\rho = -0.32$, $p = 0.002$) and FCQ-T ($\rho = -0.34$, $p < 0.001$). No other associations were statistically significant. These relationships remained significant in subsequent linear regression models controlling for child age and gender. The lack of concordance between measures assessing highly conceptually related constructs is of concern. Future studies should seek to elucidate a clear operationalization of FCR, examine the associations between FCR assessments in children and adolescents with a range of weight statuses, and evaluate how to best revise these measures to accurately reflect the latent construct being assessed.

1. Introduction

The ubiquity of highly palatable, energy-dense foods in today's food environment is a driver of current epidemic rates of obesity (Lakerveld et al., 2018; Townshend & Lake, 2017). Indeed, while ambiguity regarding the extent to which genetic and other biological mechanisms influence eating behaviors remains, the role of excessive eating in the development of obesity is undisputed. (Begg & Woods, 2013; Russo et al., 2010; Santos & Cortés, 2020). Moreover, given that differences in appetitive traits and overeating behaviors are known to emerge early in the life course (Birch & Fisher, 1998), better understanding of these phenomena and their relationship to obesity in youth is critical. One important facet of eating in today's environment is responsiveness to appetitive cues, both internal and external. Internal appetitive cues include gastrointestinal and endocrine signals of physiological hunger that initiate consumption, such as cholecystokinin, glucagon-like peptide 1, ghrelin, leptin, and peptide YY, which were traditionally studied as the main drivers of appetite regulation (D'Agostino et al., 2016; Anderberg et al., 2017; Al Massadi et al., 2017; Barrios-Correa et al., 2018; Manning & Batterham, 2014; Delzenne et al., 2010). External appetitive cues include environmental signals that can influence eating, such as the presence and palatability of food as well as increased attention to food and food cues (Brignell et al., 2009; Herman & Polivy, 2008).

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While a variety of terms are in use to characterize the phenomenon of eating in response to external appetitive cues, food cue responsiveness (FCR) is used for the present investigation as FCR is considered a conceptual and pragmatic term that can encompass other related terms (Mela, 2006; Price et al., 2015). The Behavioral Susceptibility Theory of obesity posits FCR as a central appetitive mechanism which is highly genetically determined and can lead to increased risk for the development and maintenance of obesity (Carnell & Wardle, 2007; Boutelle et al., 2020; van den Akker et al., 2014). Heightened FCR has been found in young children and is stable throughout childhood (Carnell & Wardle, 2008; Northstone & Emmett, 2008). Indeed, FCR is known to emerge as early as infancy, with maternal-reported measures of FCR in infants as young as 3-months being predictive of subsequent weight gain (Llewellyn et al., 2011; van Jaarsveld et al., 2011). It is also associated with an increased preference for food versus non-food stimuli (Buvinger et al., 2017). Moreover, heightened FCR is posited as a moderating factor which interacts with the modern "obesogenic" environment leading to excess caloric consumption in youth (Carnell & Wardle, 2008; Sadler et al., 2021).

Furthermore, while genetic predispositions greatly influence an individuals' risk for engaging in overeating behaviors, responsiveness to food cues is learned and develops through Pavlovian and operant conditioning. The presence of food, memories of foods, advertisements, or even situational factors such as time of day or location can become conditioned stimuli that elicit physiological, psychological, and neurological changes that promote increased food intake (Belfort-DeAguiar & Seo, 2018; Boutelle & Bouton, 2015; Jansen et al., 2003). Research has linked FCR to increased cephalic phase responses and neural activation of motivation and reward circuitry (Bruce et al., 2010; Ferriday & Brunstrom, 2011). Taken together, understanding this multifaceted appetitive construct is vital to elucidating mechanisms that lead to and maintain excessive weight gain, with investigation in children being particularly salient given that individual differences emerge early in the life course.

For the present investigation, FCR is defined as cognitive, emotional, and/or physiological changes that result from exposure to food cues and lead to overeating (Kanoski & Boutelle, 2022). Over the past three decades, a variety of assessments using a myriad of methodologies were developed that were said to assess FCR, including: the eating in the absence of hunger ad libitum eating paradigm, parasympathetic activity during a food exposure paradigm, Child Eating Behavior Questionnaire, Child Power of Food Scale, and Food Craving Questionnaire. Of note, this includes two behavioral paradigms, two child-report questionnaires, and one parent-report questionnaire. These measures capture a variety of FCR antecedents in addition to objective overeating, all of which are important facets of FCR.

One of the earliest assessments of FCR was the eating in the absence of hunger (EAH) ad libitum eating paradigm (Faith et al., 2006; Fisher & Birch, 2002; Shomaker et al., 2010). While methodologies differ slightly, the task is generally set up as a pseudo taste test task where children are initially provided a meal, told to eat until comfortably full, and are then given free access to several highly palatable foods. The EAH task allowed for an ecologically valid understanding of overeating beyond physiological needs; however, given the outcome of this behavioral measure is simply calories consumed while overeating, it is unclear whether the EAH task is assessing FCR specifically or overeating more broadly. Additionally, the EAH task is typically administered once and is influenced by mood, so its utility for measuring overeating as a trait is in question (Lansigan et al., 2015). Thus, while informative, the time and resources required to administer the EAH task restricts its use to predominantly academic research laboratories, limiting the dissemination of this measure to assess this important construct.

Another assessment of FCR is a food exposure paradigm that measures cephalic phase responses to the presentation of highly palatable foods (Boutelle et al., 2015; Nederkoorn et al., 2000). This task assesses FCR more directly. Physiological changes are measured when food is present or absent, and differences in physiological metrics between the non-food and food presentation periods can be used as an indicator of physiological FCR. Of note, since actual food consumption is prevented in this paradigm, only physiologic responsiveness and resulting self-reported craving responses are assessed. Like the EAH task, the time and resources needed to administer and score this psychophysiological assessment have made the assessment tool informative but limited in use.

In addition to more objective measures, a variety of questionnaires have been developed to assess FCR. The Child Eating Behavior Questionnaire (CEBQ) (Carnell & Wardle, 2007; Wardle et al., 2001) measures a parent's report of their child's eating behaviors across eight domains. One of the most prominent and widely investigated is a 4-item food responsiveness scale (CEBQ-FR). Although touted to evaluate food responsiveness, the CEBQ-FR items refer more to overeating behaviors than cue responsiveness (*i.e.,* "My child is always asking for food," "If allowed to, my child would eat too much," "Given the choice, my child would eat most of the time," and "Even if my child is full up s/he finds room to eat his/her favorite food"). The Power of Food Scale is a 15-item self-report measure of hedonic eating and is designed to assess anticipation of cognitive expectations of the reward value of food prior to consumption (Lowe et al., 2009). A child specific adaptation (C-PFS) was later developed which utilizes more developmentally appropriate language (Laurent, 2015a) including questions such as "If I see or smell a food I like, I get a very strong desire to have some," "When I know a delicious food is available, I keep thinking about having some," and "It seems like I have food on my mind a lot." The Food Craving Questionnaire-Trait (FCQ-T) is a 39-item self-report measure which assesses a related construct, cravings. (Cepeda-Benito et al., 2000). Food cravings are broadly characterized as wanting to eat a specific food or food type that is difficult to resist (Meule, 2020). This measure includes questions such as "Eating what I crave makes me feel better," "If I get what I am craving I cannot stop myself from eating it," and "It is hard for me to resist eating yummy foods that are right in front of me." These questionnaires are more feasible to administer than behavioral paradigms, yet research on their validity in measuring their hypothesized latent constructs has yet to empirically support such claims.

While the EAH task, psychophysiological responses to food, CEBQ-FR, C-PFS, and FCQ-T are all posited to assess some aspect of FCR, to our knowledge, no studies have tested the convergence of all of these assessments. The present study investigated the concordance among these five FCR assessments, including behavioral tasks and questionnaires, to better understand how they relate to each other in children with overweight/obesity. Of note, some assessments capture antecedents of food cue-based eating (psychophysiological responses, C-PFS, FCQ-T) and others assess resulting overeating behaviors (EAH and CEBQ-FR). This is of particular importance given that children are still early in their development when overeating behaviors are malleable and cognitive functions, particularly related to self-awareness, are not as advanced to be able to accurately answer self-assessment questions. Despite these potential differences, given that all are posited as measures of FCR, we hypothesized that all measures should be at least moderately associated.

2. Methods

2.1. Participants

Children with overweight or obesity (OW/OB) were recruited as part of the Intervention on the Regulation of Cues (iROC) study (Boutelle et al., 2015). One hundred and eleven children and their parent completed the baseline measures and were included in the present investigation. To be eligible, children needed to meet the following criteria: 8–12 years of age, age and sex adjusted BMI greater than or equal to the 85th percentile and below the 99.9th percentile, free from psychiatric, medical, or behavioral conditions that would interfere with treatment, able to read at the third-grade level, and consumed at least 5% of their daily caloric needs during the EAH task. Parents needed to meet the following inclusion criteria: free from psychiatric, medical, or behavioral conditions that would interfere with treatment, and available one weekday afternoon or evening for treatment with their child. Parents signed written consent and children signed written assent to participate. The Institutional Review Boards of both the University of California, San Diego and Rady Children's Hospital approved the study.

2.2. Measures

2.2.1. Eating in the absence of hunger paradigm (EAH)

The Eating in the Absence of Hunger (EAH) paradigm is a pseudo taste-test designed to assess children's consumption after they report being sated (Birch et al., 2003; Fisher & Birch, 2002). Children consumed pizza, carrots, and water until they were comfortably full (mean kilocalories consumed: 760.2; range: 272–1632), as assessed by rating of at least a 3 on a 5-point Likert-type scale of hunger. After 30 min, children were presented with 8 pre-weighed highly palatable snack foods (gummy bears, chocolate chip cookies, Oreo® cookies, M & M's®, Skittles®, Doritos®, popcorn, and Cheetos®) and a variety of games and toys. The assessor left the room for 10 min and were given the following prompt: "Your parent is still finishing up their dinner and I have a few things I need to clean up in the other room so I can set up the next activity. So please wait here until I return. Feel free to help yourself to the rest of any of the foods here. We won't be using them anymore, so you can have as much as you want before we throw it away. You can also play with any of the games here on table. I'll be gone for maybe 5 or 10 min or maybe a little longer, but I will be back to get you for the next activity." The foods consumed during that period were weighed and calories eaten were calculated. The primary outcome of the EAH task is total calories consumed, with more calories consumed being indicative of greater FCR.

2.2.2. Psychophysiological food exposure paradigm

Electrocardiogram recordings (ECG) were measured during a food exposure paradigm that consisted of three 6-min phases (baseline, food exposure, recovery) using a BIOPAC MP150 (Nederkoorn et al., 2000). Participants identified their highly craved foods prior to the task. Heart rate and heart rate variability were measured using two Ag ± AgCl electrodes, one attached on the left side of the subject, the other attached under the right collarbone. During the baseline phase, children were told to sit quietly and limit movement. During the food exposure phase, children were presented with their highly craved food and were given standardized prompts to notice the desirable look and smell of the food at 30 s intervals. During the recovery phase the food was removed, and the children were told to remain quiet and still. R-waves were detected off-line using a template matching procedure and inter-beat intervals were calculated. Interbeat intervals extracted from ECG recordings during these phases were used to derive the root mean square of successive differences (RMSSD), which is posited as a measure of parasympathetic activation (Laborde et al., 2017; Stein et al., 1994). Parasympathetic activity indices were used as they are more sensitive to acute changes and dysregulated states that can be assessed over the course of as little as a few minutes, in contrast to other indices driven by sympathetic changes (Bertsch et al., 2012; Koenig et al., 2014). Differences between RMSSD measured in the baseline phase and the food exposure phase were calculated to quantify changes in parasympathetic activity. Change in RMSSD is used as a proxy for FCR, with *decreases* being indicative of *increased* FCR.

2.2.3. Child Eating Behavior Questionnaire (CEBQ)

The Child Eating Behavior Questionnaire (CEBQ) is 35-item parent report measure of children's eating behaviors across eight conceptual domains (*i.e.*, food responsiveness, enjoyment of food, desire to drink, emotional overeating, satiety responsiveness, food fussiness, slowness of eating, and emotional undereating), utilizing a 5-point Likert type scale that assesses frequency of behaviors, not agreement with certain traits (Wardle et al., 2001). The CEBQ has demonstrated adequate reliability and validity in pediatric samples (Carnell & Wardle, 2007). Scores are calculated by taking the average of all items within each subscale. Only the food responsiveness subscale was used for the present analyses (CEBQ-FR). Higher food responsiveness scores reflect greater FCR and strong reliability ($\alpha = 0.85$; $\omega = 0.85$) was found in the present sample.

2.2.4. Child Power of Food Scale questionnaire (C-PFS)

The Child Power of Food Scale (C-PFS) is a 15-item self-report measure assessing the cognitions around motivation, wanting and desire to eat foods outside of physiological hunger (Laurent, 2015b; Lowe et al., 2009). The C-PFS assesses three levels of proximity to food including, food available, food present, and food tasted but not eaten. A total score is calculated by averaging across all 15 items. Higher C-PFS scores reflect greater FCR. The C-PFS has demonstrated strong reliability and validity in diverse pediatric samples (Laurent, 2015a; Mitchell et al., 2016) and strong reliability was found in the present sample ($\alpha = 0.93$; $\omega = 0.93$).

2.2.5. Food Craving Questionnaire- trait (FCQ-T)

The Food Cravings Questionnaire-Trait (FCQ-T) is a 39-item measure that assesses typical situations that generate food cravings (Cepeda-Benito et al., 2000). The FCQ-T contains the following 8 subscales: intentions/plans to consume food, anticipation of positive reinforcement from eating, anticipation of relief from negative states around eating, lack of control over-eating, thoughts/preoccupation with food, craving as a physiological state, emotions around food cravings or eating, environmental cues that may trigger food cravings, and guilt from cravings. A child version of the FCQ-T had not been validated at the time of this study, so the measure was adapted by removing two items that were identified as less developmentally appropriate for children by the study team, resulting in a 37-item abridged version. The two items removed were: 'when I'm stressed out, I crave food' and 'I crave foods when I'm upset'. A total score representing the variety of contexts in which food cues elicit craving responses is calculated by averaging responses across all 37 items. Higher FCQ-T scores reflect greater FCR and strong reliability ($\alpha = 0.96$; $\omega = 0.96$) was found in the present sample.

2.3. Statistical analysis

Initial spearman correlations were used to investigate the observed bivariate associations between all five food responsiveness assessments (*e.g.,* EAH, RMSSD, CEBQ-FR, C-PFS and FCQ-T). Spearman correlations were utilized rather than Pearson correlations due to the latter being restricted to characterizing only linear relationships, while the former can be used to characterize any monotonic relationship (Puth et al., 2015). Subsequently, linear regression models were run for assessments with statistically significant bivariate associations at the $p < 0.05$ level, controlling for age and gender, to account for the influence of demographic characteristics on assessments.

Post-hoc exploratory hierarchical bifactor modeling was used to elucidate potential clusters of assessments. Hierarchical bifactor models simultaneously account for variance in assessment scores attributable to the overall latent construct (*i.e.,* FCR) and the variance accounted for by the subdomain (Reise, 2012). Bifactor models, including items from all five measures, were iteratively conducted to explore which number of subfactors demonstrated optimal model fit. Two model fit parameters were used to guide model selection. First, Bayesian information criteria (BIC) was used as a metric of relative fit, with lower values indicating better model fit. Second, root mean square error of approximation (RMSEA) was used a metric of absolute model fit, which accounts for model complexity (Hu & Bentler, 1999). Additionally, explained common variance (ECV) was used to assess the proportion of variance in scores that is attributed to the overall FCR factor, with higher values indicating more variance is attributable to the overall latent construct.

3. Results

The sample of 111 children had a mean age of 10.6 years, were 70% female, 23% Latino/a, and 62% of families reporting an income of over $100,000 a year (see Table 1). Correlational analysis revealed significant associations between only a subset of assessments (see Table 2). The strongest association was found between the C-PFS and FCQ-T ($\rho = 0.87$, $p < 0.001$), which remained statistically significant in regression models including demographic covariates ($\beta = 0.89$, $p < 0.001$) (see Table 3). The C-PFS and FCQ-T scores were also both moderately related to RMSSD (PFS: $\rho =$ -0.32, p = 0.002; FCQ: $\rho =$ -0.34, $p < 0.001$), which remained statistically significant in regression models including covariates (PFS: $\beta =$ -0.25, p = 0.015; FCQ: $\beta =$ -0.26, p = 0.008).

The CEBQ-FR demonstrated a small but statistically significant association with the EAH paradigm ($\rho = 0.19$, p = 0.047; see Table 2), which was maintained in subsequent regression models controlling for child age and gender (FCR: $\beta = 0.24$, p = 0.008; see Table 3). Of note, in this regression model, age was statistically significantly associated with EAH ($\beta = 0.23$, $p < 0.001$). No other associations between assessments were found to be statistically significant.

Exploratory post-hoc analyses revealed hierarchical bifactor models with 2-, 3- or 4-subdomains all had poor fit and accounted for little common variance (See Table 4). Only the 2-subdomain model was interpretable. In this model, C-PFS, FCQ-T, and RMSSD assessments clustered together well to form one factor, with the last loading negatively. The EAH and CEBQ assessments clustered somewhat, with the CEBQ explaining much of the variance in this exploratory factor. The little common variance demonstrated suggests EAH and CEBQ-FR may not measure FCR in the same way as the C-PFS, FCQ-T, and RMSSD assessments.

4. Discussion

The present study sought to investigate the convergence of numerous FCR measures in children with OW/OB, however, it yielded mixed results. Overall, there was little to moderate convergence between most assessments, with many relationships among measures not reaching statistical significance. This contrasts with findings in adult samples where strong correlations have consistently been demonstrated among measures of overeating behaviors in individuals of varying weight statuses (Mason et al., 2017; Price et al., 2015; Vainik et al., 2015).

In this study, we found significant associations between the C-PFS, FCQ-T and RMSSD. The C-PFS and the FCQ-T are thought to measure the cognitive and physiological cravings in response to food cues respectively, while RMSSD measures the parasympathetic physiological reactivity. Not surprisingly, the two questionnaires were significantly associated in our data. These three concepts (*i.e.,* cognitions, cravings, and physiological responsivity) could be thought of as antecedents to food-cue based eating. There is some support for this relationship in the adult literature. As part of the initial validation of the PFS, total PFS scores were demonstrated to predict chocolate cravings (Lowe et al., 2009). Moreover, an fMRI study found that PFS scores moderated the relationship between food cravings and neural changes in the basal ganglia and sensorimotor regions that are implicated in addiction processes (Rejeski et al., 2012). Additionally, a pilot study demonstrated that heart rate variability (HRV) biofeedback sessions successfully reduced food cravings (Meule et al., 2012). Lastly, given the C-PFS and FCQ-T were child-report measures, it follows that subjective awareness of food cognitions and cravings would align with objectively assessed internal psychophysiological reactivity more so than parent-report measures. Thus, the C-PFS, FCQ-T, and psychophysiological changes may represent changes that occur prior to food cue-based eating and are representative of various facets of FCR among children with OW/OB.

While the measures above represent antecedents to food cue-based eating, both the CEBQ-FR subscale and the EAH paradigm seemed to measure actual overeating. Neither of these measures was associated with the three above, suggesting they could be measuring a different aspect of FCR, if not an entirely distinct construct. The statistically significant relationship between CEBQ-FR and EAH is not surprising, as the initial validation of the CEBQ included an adapted EAH paradigm for concurrent validity (Carnell & Wardle, 2007). Moreover, EAH has consistency been operationalized as an assessment of responsiveness to external, palatable food cues (Fogel et al., 2018; Hill et al., 2008). Furthermore, research suggests a heightened behavioral responsiveness

Table 1
Child and parent demographics (% or mean (SD)).

	Child	Parent
Age (years); Mean (SD)	10.61 (1.62)	43.79 (5.89)
Sex (female)	70%	88%
Ethnicity		
Latino/a	23%	18%
Race		
Asian	5%	11%
Black	5%	3%
White	68%	68%
Hawaiian/Pacific Islander	–	1%
Multiple	12%	2%
Not reported	10%	15%
Anthropometrics); Mean (SD)		
BMI	25.93 (3.62)	28.98 (5.99)
%BMI	96.40 (3.31)	–
zBMI	1.93 (0.37)	–
Household Income		
<$50,000/year	–	12%
$50,000-$99,999/year	–	26%
>$100,000/year	–	62%

Table 2
Spearman correlations between food cue responsiveness measures and related descriptive statistics.

	1	2	3	4	5
1. EAH	–	–	–	–	–
2. RMSSD	.02	–	–	–	–
3. CEBQ-FR	.19*	.03	–	–	–
4. C-PFS	−.13	−.32*	−.02	–	–
5. FCQ-T	−.01	−.34*	−.02	0.87***	–
Mean	424.5	−4.61	4.03	2.47	2.60
SD	193.0	18.84	0.76	0.95	0.93

*p < 0.05 **p < 0.01 ***p < 0.001.

Table 3
Associations between food cue responsiveness measures, adjusting for covariates.

RMSSD (outcome)			
Predictor	*β*	SE	*p*
C-PFS	−0.25	0.10	0.015*
FCQ-T	−0.26	0.10	0.008**
EAH (outcome)			
Predictor	*β*	SE	*p*
CEBQ-FR	0.24	0.09	0.008**

*p < 0.05 **p < 0.01 ***p < 0.001.

Table 4
Exploratory bifactor models fit parameters and explained common variance.

# Sub Factors	BIC	RMSEA	ECV
2	153.96	0.58	0.01
3	154.75	0.58	0.05
4	131.11	0.54	0.17

to food cues to be both a risk and maintaining factor for the development of overeating behaviors and obesity (Carnell & Wardle, 2008; Masterson et al., 2019; Paquet et al., 2017). Lastly, both the CEBQ-FR and EAH assess observable behaviors, which could partially explain why these assessments converged. Taken together, these measures are of great importance and future research should seek to clarify whether these behaviors are a behavioral aspect of FCR or are representative of more general overeating.

While the differing aspects of FCR measures make sense conceptually, the lack of consistent associations between assessments in these two potential clusters is notable. These clusters highlight the need for future work to better operationalize what is meant by FCR and how it leads to overeating and obesity. For example, recent work investigating hedonic eating in youth has operationalized hedonic eating as an "extreme" form of FCR (Mason et al., 2020), while a recent meta-analysis included "cravings" as a common example of FCR (Boswell & Kober, 2016). Whether these measures are assessing FCR, antecedents to FCR, or are so "extreme" that they represent a related but entirely distinct construct remains to be empirically evaluated. Furthermore, the External Food Cue Responsiveness scale was recently developed for use among preschool aged children which utilizes items that parallel the C-PFS, including specific types of food cues that prompt overeating as opposed to the more general overeating items of the CEBQ-FR (Masterson et al., 2019). Future work should explore the mechanisms driving overeating behaviors and determine at what point related constructs can be appropriately differentiated.

The present study has several strengths. First, this is the first study to evaluate the convergence of FCR assessments utilizing a multimodal assessment battery. Second, the sample was somewhat ethnically diverse (23% Latino), and despite including only children with OW/OB, all assessments demonstrated heterogeneity in responses. Third, the investigation of assessment convergence is of critical importance to the replication of findings and accurate operationalization of assessments.

Nevertheless, as in all studies, there are a number of limitations that need to be noted. First, while investigating children at the higher end of the weight spectrum is of great importance, having children with a variety of weight statuses could bolster the generalizability of the current findings to youth of all weight statuses. Furthermore, while FCR is found in children of all body sizes, it does tend to be more prevalent in children with OW/OB (Belfort-DeAguiar & Seo, 2018; Bohon, 2017). Thus, the decreased variance of FCR in children with OW/OB may have influenced the present results. Additionally, the present sample was comprised of treatment-seeking children with OW/OB who may have limited insight into their own motivations and cognitions around food, as well the potential for social desirability to influence reporting on parent- and self-reported measures (McKee et al., 2016; Miller et al., 2014). Thus, these findings cannot generalize to non-treatment seeking children with OW/OB, children of lower weight statuses, or older children. Furthermore, it is possible that varying methodologies (*e.g.,* child self-report, parent self-report, physiological assessment and EAH) contributed to the unexplained variance in the present analyses. Subjective reports of eating behaviors notoriously differ from results of objective assessments (Dhurandhar et al., 2015), and child and parents likely have differing insights into the frequency or severity of observable behaviors. Lastly, post-hoc analyses were underpowered, so future studies should ensure adequately powered, diverse samples are used to further investigate the varying aspects of FCR.

FCR is an important construct to assess, particularly as it relates to overeating behaviors and weight status (Boswell & Kober, 2016; Boutelle et al., 2020). Of equal importance is confidence that assessments purported to assess this construct are indeed doing so. The present study provides some evidence that FCR may be differentially assessed via varying assessment measures and approaches. Moreover, as presently defined, FCR is characterized by anticipatory changes elicited by food and food cues while overeating is the resulting behavior. Moving forward, the C-PFS and FCQ-T appear to be the most valid questionnaires in assessing the anticipatory cognitive, affective, and psychophysiological changes that occur when exposed to food cues. A clear operationalization of FCR is critical in advancing our understanding of this important eating phenomenon. Future research should investigate the associative strength between FCR measures in individuals across the spectrums of age and weights, include assessments of appetite hormones such as ghrelin and leptin which are known to influence FCR and related neural processes (Wever et al., 2021), and assess the predictive validity of these measures to inform measure selection in intervention trials.

Author contributions

KB was the principal investigator responsible for the original study and data collection. MM and KB conceptualized the present study. MM conducted statistical analyses, prepared all figures and tables, and wrote the majority of the manuscript. DS aided in interpreting analyses. All authors provided critical revision of the manuscript for important intellectual content.

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Data sharing

The full data set is available to the lead author. Data can be shared upon request and approval of principal and co-investigators.

Financial disclosure

The others have no financial relationships to disclose.

Declaration of competing interest

The authors declare no conflicts of interest.

Data availability

Data will be made available on request.

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