Selective eating behaviors in children: An observational validation of parental report measures

By: Carmen Fernandez, Jasmine M. DeJesus, Alison L. Miller, Danielle P. Appugliese, Katherine L. Rosenblum, Julie C. Lumeng, and Megan H. Pesch

Fernandez, C., DeJesus, J. M., Lumeng, J. C., Miller, A., Rosenblum, K. L., Appugliese, D., P., & Pesch, M. H. (2018). Selective eating behaviors in children: An observational validation of parental report measures. *Appetite, 127,* 163-170. doi: 10.1016/j.appet.2018.04.028

Abstract:

Selective eating in children is commonly measured by parental report questionnaires, yet it is unknown if parents accurately estimate their child's selective eating behavior. The objectives of this study were to test the validity and stability of two measures of selective eating using observed child behavior. Low-income mother-child dyads participated in a videotaped laboratory eating protocol at two time points (baseline: mean child age = 5.9 years; follow-up: mean child age = 8.6 years), during which they were presented with a familiar and an unfamiliar vegetable. Videos were reliably coded for child selective eating behaviors: amount consumed, child hedonic rating of vegetables, child compliance with maternal prompts to eat, latency to first bite, number of bites, and negative utterances. Mothers completed the Child Eating Behavior Questionnaire Food Fussiness (CEBQ FF) scale and the Food Neophobia Scale (FNS) at both time points. Questionnaire validity, stability of measured behaviors, and discriminant validity of questionnaires were examined in the full sample. CEBQ FF scores and FNS scores were both inversely correlated with the quantity consumed, child hedonic rating, and compliance with prompts to eat for both familiar and unfamiliar vegetables at baseline and at follow up. CEBQ FF and FNS scores were inversely correlated with number of bites (for both foods), positively correlated with latency to first bite (for both foods), and inversely correlated with child negative utterances (for the familiar food only). Notably, FNS scores correlated with observed behavior for both familiar and unfamiliar foods, rather than demonstrating a specific association with unfamiliar foods only. This study supports the validity of the CEBQ FF and FNS in low-income early school-aged children.

Keywords: Picky eating | Neophobia | Children | Mothers | Observation | Behavior

Article:

Abbreviations
CEBQ FF, Child Eating Behavior Questionnaire Food Fussiness scale; FNS, Food Neophobia Scale; SEP, Standardized Eating Protocol

1. Introduction

Selective eating is characterized by consumption of an inadequate variety of foods via their rejection (Dovey, Staples, Gibson, & Halford, 2007), and is common during childhood (Brown, Vander Schaaf, Cohen, Irby, & Skelton, 2016; Cardona Cano et al., 2015; Carruth, Ziegler, Gordon, & Barr, 2004; Taylor, Wernimont, Northstone, & Emmett, 2015). This pattern of eating is considered problematic because it is associated with consumption of a lower variety of vegetables (Cooke et al., 2004), nutrient deficiencies (Galloway, Fiorito, Lee, & Birch, 2005; Volger et al., 2013), and parental concern (Brown, Pesch, et al., 2016). Estimates of the prevalence of selective eating vary widely, and depend on the measurement instruments used, age of the child, and study population (Carruth et al., 2004; Taylor et al., 2015). The use of different definitions complicates the study of this behavior (Taylor et al., 2015). Selective eating has been conceptualized as two separate constructs, based on the familiarity of the food: Picky eating and food neophobia. While children who are picky eaters reject both novel and familiar foods, food neophobic children are thought to reject unfamiliar foods specifically (Dovey et al., 2007).

These two constructs (picky eating and food neophobia) have most commonly been measured using parental reports. Two of the most common questionnaires used are the Child Eating Behavior Questionnaire Food Fussiness subscale (CEBQ FF) (Carnell & Wardle, 2007) and the Food Neophobia Scale (FNS) (Pliner & Hobden, 1992). These questionnaires have been validated against child body mass index z-score (BMIz) (Domoff, Miller, Kaciroti, & Lumeng, 2015; Sleddens, Kremers, & Thijs, 2008) or weight-for-age z-score (Mallan et al., 2013) with more selective eating behavior being negatively correlated with BMIz or weight-for-age z-score. Critics of these scales question whether parent report of picky eating behavior is biased, positing that parents may not be able to accurately estimate how much their child's eating behavior deviates from typical child eating behavior or that their perception of their child's eating behavior is biased by their own concerns about eating and feeding behaviors (Werthmann et al., 2015).

For these reasons, it is important to validate picky eating questionnaires against observational measures, which few prior studies have done. One study by Werthmann et al. examined sensory components of yogurt, measuring acceptance of the yogurt when different sensory components (taste, texture, color) were altered, finding that acceptance of yogurt did not correlate with CEBQ FF subscale scores (Werthmann et al., 2015). Another study (Jacobi, Agras, Bryson, & Hammer, 2003) examined children's estimated caloric intakeand variety of foods consumed in a standardized home feeding setting in which parents were provided with a cooler of food and drinks and instructed to feed their child with only foods from that cooler over a 24-hour period. They found that parent-reported picky eating, as reported in 6 items from the Stanford Feeding Questionnaire (Jacobi et al., 2003), was associated with a lower total intake of food and a lower

variety of foods consumed. A study by Fries et al. using video recorded home dinners found that parental report of picky eating was not associated with greater child food refusal, but that parental report of food neophobia was associated with greater food refusals (crying, pushing plate away, verbal refusing to eat) (Fries, Martin, & van der Horst, 2017). Lastly, a study by Surette et al. examined children's picky eating or food reluctance by measuring plate waste after a meal served at daycare (Surette, Ward, Morin, Vatanparast, & Bélanger, 2017) and examining the correlations between plate waste and subscales of the CEBQ. Food reluctance was not correlated with CEBQ FF, but was positively correlated with CEBQ Slowness in Eating, negatively correlated with age-adjusted child body mass index (Surette et al., 2017).

These studies have several limitations. First, prior work has been in predominantly Caucasian, college-educated populations with young children (birth to five years-old) (Fries et al., 2017; Jacobi et al., 2003; Jacobi, Schmitz, & Agras, 2008; Surette et al., 2017; Werthmann et al., 2015). These studies may not be applicable to other populations, including low-income populations. Second, these studies did not differentiate between familiar and unfamiliar vegetables. Since picky eating and food neophobia are posited to be two separate constructs differentiated by the level of familiarity of the food, it is important to consider or manipulate this variable.

We have been unable to identify any studies that observationally validated the CEBQ FF and FNS in a low-income population of United States early school-aged children.

We propose that it is important to investigate the validity of parental self-report measures of selective eating in a low-income school-aged population for several reasons. First, prior work (Tharner et al., 2014) has found selective eating to be more common in children of lower-socioeconomic status (SES). Second, other work (Pesch, Harrell, Kaciroti, Rosenblum, & Lumeng, 2011) has shown that mothers of lower SES may conceptualize child feeding and eating behaviors differently than their middle-to-upper SES counterparts. Third, although it is often believed that children with selective eating behaviors will “just grow out of it” (American Academy of Pediatrics, 2015), this notion is not widely supported in the literature. Although there is no consensus in the literature with regard to the prevalence or trajectory of selective eating behaviors over time in childhood, several studies have found these behaviors to plateau or peak in the early school years (Mascola, Bryson, & Agras, 2010), or remain stable over childhood (Dubois, Farmer, Girard, Peterson, & Tatone-Tokuda, 2007; Marchi & Cohen, 1990). Therefore, for many children and families, selective eating remains a problem in the early school years that may manifest differently with regard to children's behaviors and parental perceptions than in the toddler years. Therefore, examining the validity of parental report questionnaires of child selective eating behaviors and observationally captured child eating behaviors specifically in a low-income school-age cohort may reveal insights unique to this group.

Therefore, the objectives of this study were threefold: 1) To examine the correlations of observationally captured child selective eating behaviors with maternal reported picky eating and food neophobic behavior as measured by the CEBQ FF and FNS at two time points, 2) to examine the stability of the observational and maternal report measures of selective eating across each measure, and 3) to examine discriminant validity of the CEBQ FF and FNS with regard to observationally captured child eating behavior with familiar and unfamiliar vegetables. Prior

research (Werthmann et al., 2015) has called for the validation of these measures to disentangle concerns for biased parental reporting of selective eating and to better characterize selective eating behaviors.

2. Materials and methods

2.1. Study design

This was an observational longitudinal study. All measures were obtained at baseline (mean child age = 5.9 years) and at follow-up (mean child age = 8.6 years), on average 2.6 years (SD ± 0.6, range 1.5–4.0) later. Mothers completed demographic and child selective eating questionnaires without the child present. At a subsequent visit, mother-child dyads participated in the Structured Eating Protocol (SEP) and child and mother anthropometrics were measured. The University of Michigan Institutional Review Board approved the study protocol. Mothers provided written informed consent and were each compensated $60 for their participation at each time point.

2.2. Participants

Participants were a convenience sample of female primary caregiver-child dyads from South-central Michigan who enrolled in a longitudinal study examining psychosocial and behavioral contributors to low-income children's obesity risk in 2009–2011 (Fig. 1). Participants in the original study ($N = 380$) were invited to participate in a study about children's eating behaviors through their child's Head Start program (free, federally subsidized preschool programs for low-income children). Participants were followed longitudinally, and invited to participate in a follow-up study explained as seeking to "understand how mothers and caregivers feed their children." Eligible caregivers were fluent in English and had less than a four-year college degree. Exclusion criteria for the original study included the child having a gestational age less than 35 weeks, significant perinatal or neonatal complications, serious medical problems or food allergies, or foster care. As all child participants were originally recruited from Head Start, they were aged three-to four-years and living in low-income families at the time of recruitment into the original study. Of the female primary caregivers, 95% were biological mothers (the remaining 5% were adoptive mothers, stepmothers, etc.). Henceforth we refer to the entire group as "mothers."

2.3. Maternal report of child selective eating

Mothers completed the 35-item Child Eating Behavior Questionnaire (CEBQ). For this analysis, child picky eating was measured using the six-item Food Fussiness subscale (CEBQ FF) (Wardle, Guthrie, Sanderson, & Rapoport, 2001) (baseline Cronbach's $\alpha = 0.91$, follow-up Cronbach's $\alpha = 0.87$). Of note, the CEBQ FF includes items that conceptually map onto both picky eating (e.g., *"My child is difficult to please with meals."*) and food neophobia (e.g., *"My child refuses new foods at first."*). Items were answered on a Likert scale(range = 1–5 and averaged such that a higher score indicates greater picky eating. Child food neophobia was measured using the 10-item Child Food Neophobia Scale (Pliner & Hobden, 1992) (baseline

Cronbach's $\alpha = 0.92$, follow-up Cronbach's $\alpha = 0.88$). Items were answered on a Likert scale (range = 1–7) and summed such that a higher score indicates greater food neophobia.

2.4. Structured Eating Protocol (SEP)

The SEP (Goulding et al., 2014; Lumeng & Burke, 2006; Mosli et al., 2015; Pesch, Miller, Appugliese, Rosenblum, & Lumeng, 2017) examines the mother's and child's responses to different types of foods and serves to reduce the broad variability that occurs during home mealtimes (e.g., the quantity and type of food served, distractions of other family members or television, mothers attending to food preparation, other children). The mother and child were asked to fast for two hours prior to the protocol. While seated at a table alone in a quiet room, they were videotaped while they were presented with individual portions of four different types of foods, sequentially in a randomized order by a research assistant. For each food, dyads were told, "These are [name of food]. Have you, [mother's name] ever had [name of food] before? Has [child's name] ever had [name of food] before?" Responses were recorded. The research assistant then said, "Give it a try if you'd like and tell me what you think of it when I come back in a couple of minutes." They were then left alone for four minutes with each food. The four foods were chosen such that they differed in familiarity (familiar or unfamiliar) and vegetable vs. dessert.

At baseline, the food items served to each participant were one cup of green beans (Del Monte, Cut Green Beans, No Salt Added, 123.7 ± 0.5 g), one cup of artichoke hearts (Reese Quartered, Artichoke Hearts, 123.7 ± 0.5 g), two cupcakes (Hostess Chocolate Cupcakes, 104.9 ± 0.5 g), and one-quarter container of halva (Ziyad, Halva with Vanilla, 76.0 ± 0.5 g). At follow-up, the food items served to each participant were one cup of green peas (Del Monte, sweet peas, No Salt Added, 123.7 ± 0.5 g), one cup of palm cabbage (also known as hearts of palm) (Reese Palm Cabbage, 123.7 ± 0.5 g), two brownies (Little Debbie Cosmic Brownies, $\sim 125.0 \pm 0.5$ g), and three cubes of Turkish delight (Sultan Turkish Delight, rose flavor, 123.7 ± 0.5 g).

The portion sizes were identical for both child and mother. Foods were prepared and portioned outside the room and served in plastic containers free of brand packaging. This study focuses on the vegetables only, since it was hypothesized that vegetables (vs. desserts) would elicit selective eating. Both unfamiliar and familiar vegetables were included because it was hypothesized that unfamiliar (vs. familiar) vegetables would elicit food neophobia. In summary, the foods that are the focus of this analysis are green beans (familiar vegetable) and artichoke (unfamiliar vegetable) at baseline, and peas (familiar vegetable) and palm cabbage (unfamiliar vegetable) at follow-up.

2.5. Observed child selective eating behaviors

The following observed selective eating behaviors were measured or coded in the entire sample: Amount consumed, hedonic rating of vegetable, and child compliance with maternal encouragement. In a subset ($N = 90$), three additional behaviors were coded: Latency to first bite, number of bites, and number of negative utterances.

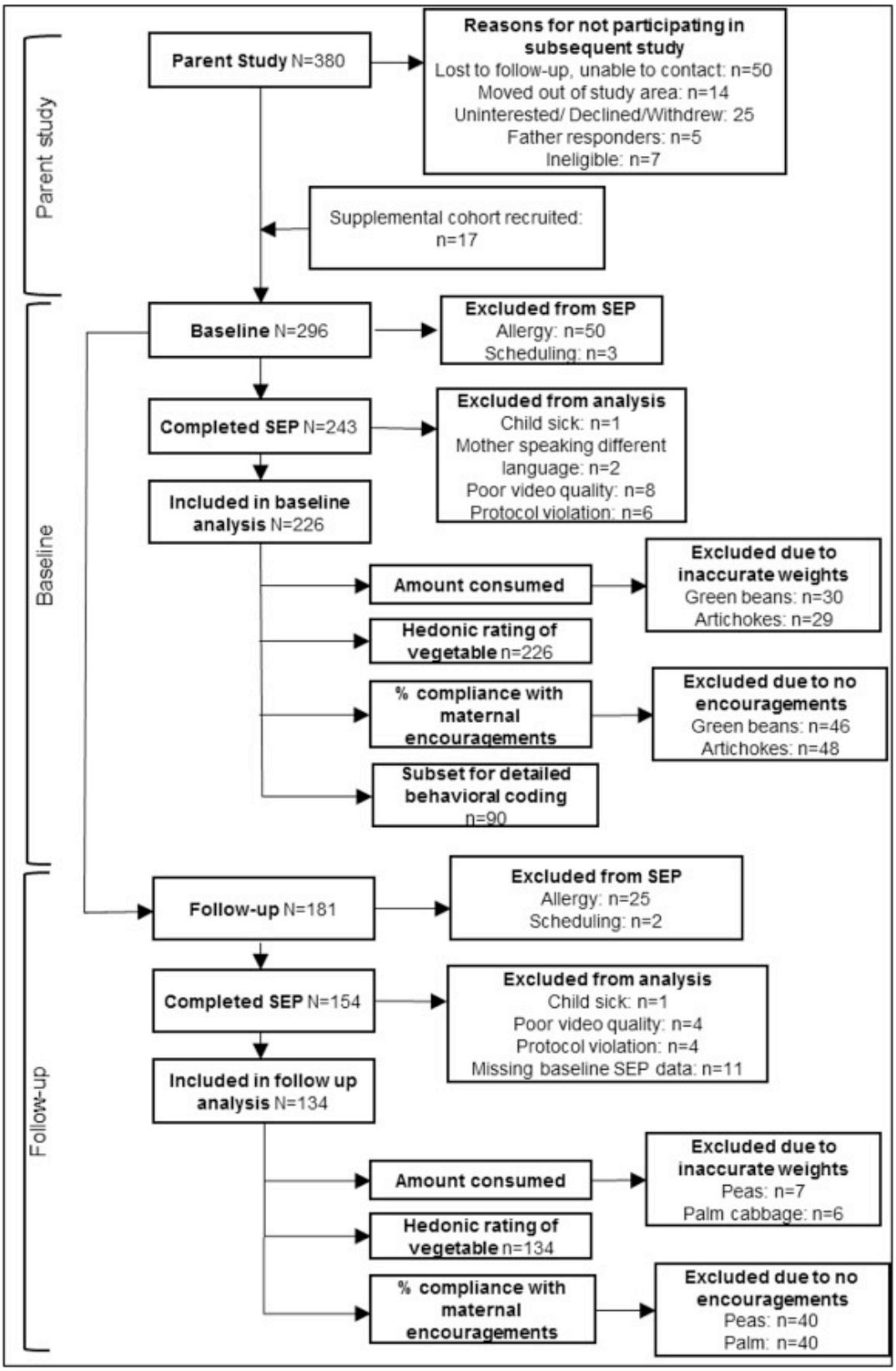

Fig. 1. Flowchart of participants from parent study to baseline and follow-up of the present study.

The amount of vegetable consumed by the child was calculated by subtracting the post-weight of the food from the pre-weight of the food, measured in grams using a Scout®*Pro*Balance scale (±0.01g). Videos were reviewed for instances in which the weight of food may not reliably capture the amount of vegetable consumed (e.g., the mother places a scoop of green beans in the child's bowl, or the child takes a bite of the mother's palm cabbage, or the child spits artichoke into a napkin) and these children were removed from the analysis for that particular food, but remained in the sample for all other measures. In summary, the number of children excluded from analyses regarding the amount consumed for each food was 30 for green beans, 29 for artichokes, nine for peas, and six for palm cabbage.

The child's hedonic rating of each vegetable was obtained immediately after the end of each vegetable segment. The research assistant presented the child with a scale with five faces and corresponding numbers, pointed at each number with corresponding face and said: *"One is really yucky, gross, bleah!; two is kinda yucky, you don't like it; three is OK, you don't really think it's yummy, but you don't think it's yucky; four is kinda yummy, you like it; five is really yummy, one of your favorite foods."* The child's response was recorded.

Additional selective eating behaviors were coded from the video recording, with inter-rater reliability established. Specifically, for each behavior, two raters coded the same 20% of the video segments, and once reliability was established, the remainder of the videos were coded. All coding schemes are available from the authors upon request. All coding schemes were applied to each individual four-minute food segment.

Maternal encouragement and child compliance with maternal encouragement were coded using the Bob and Tom's Method of Assessing Nutrition (BATMAN) (Klesges et al., 1983) coding scheme. Maternal encouragements to eat were defined as suggesting, commanding, directing, or making positive statements about the food or pushing or moving the plate of food towards the child. Inter-rater reliability was ≥0.78 for maternal encouragements at both time points. Child compliance with maternal encouragement was defined as the child biting, chewing, or placing food in the mouth within five seconds following the maternal encouragement. Inter-rater reliability was ≥0.83 for child compliance at both time points. The percentage of child compliance with maternal encouragements was calculated as the count of instances of child compliance divided by the count of maternal encouragements. For dyads in which no maternal encouragements occurred during the segment, this variable could not be calculated and dyads were therefore eliminated from the portion of the analysis involving the percentage of child compliance with maternal encouragements for that particular vegetable. This occurred for 46 dyads with green beans, 48 dyads with artichokes, 40 dyads with peas, and 40 dyads with palm cabbage. Of these, 31 mothers did not encourage their child to eat for any vegetable.

For a subset of baseline videos ($N = 90$), three additional behaviors were coded: Latency to first bite, number of bites, and number of negative utterances. Latency to first bite was calculated by subtracting the start time of the video segment from the lower limit of the 10-second interval in which the first bite occurred. The number of bites, defined as the food touching any part of the child's mouth, including lips and tongue, were coded with regard to whether a bite was present vs. not present in each 10-second interval and summed to indicate the total number of bites. If

the child did not take any bites during the four-minute segment, a score of 240 s was assigned. Inter-rater reliability exceeded kappa of 0.92. Food intake measured in bites was highly correlated with the amount consumed measured in grams for each food (green beans: r (79) = 0.52, $p < .001$; artichoke: r (77) = 0.73, $p < .001$).

The number of negative utterances made by the child about the food was coded from transcripts of the videos so that coders could be blind to the weight status and amount consumed. A negative utterance was defined as negatively valenced talk about food (e.g., "Yuck", "These are gross!", "I hate green beans!"). Inter-rater reliability was kappa = 0.88.

2.6. Sample characteristics

Heights and weights of mothers and children were measured according to standardized procedures (Shorr, 1986). Body Mass Index (BMI) was calculated as weight in kilograms divided by height in meters squared. For mothers who were pregnant or had recently given birth, self-reported pre-pregnancy weight was used instead of measured weight. BMI could not be calculated for two mothers who had given birth within three months of the study visit and did not know their pre-pregnancy weight. Children were categorized as being underweight (defined as BMI ≤ 5th percentile for age and sex), normal weight (defined as a BMI > 5th to < 85th percentile for age and sex), overweight (defined as a BMI ≥ 85th to < 95th percentile for age and sex) or obese (BMI ≥ 95th percentile for age and sex) based on the United States Center for Disease Control and Prevention growth charts.

Mothers reported their own age, education level, and race/ethnicity, as well as the child's age and sex. Household food security was categorized as food secure versus food insecure as reported by the mother on the United States Department of Agriculture Household Food Security Scale (11 items) (Bickel, Nord, Price, Hamilton, & Cook, 2000). Mothers were asked to rate statements on a 3-point scale as either Often True, Sometimes True, Never True about their household food situation over the last 12 months (e.g., "*We worried whether our food would run out before we got money to buy more.*" and "*The food that we bought just didn't last, and we didn't have money to get more*."). Items answered in the affirmative (Often True or Sometimes True) were given a score of one, and summed. Scores greater than three were considered food insecure, whereas scores less than or equal to three were considered food secure.

2.7. Analysis

Of the 296 dyads who participated in the parent study at baseline, the sample was limited to those 244 dyads who completed the SEP. Fifty dyads were excluded from completing the SEP because of food allergy or intolerance (in the mother, or a new food allergy in the child that had developed since recruitment into the original study) and three dyads were not able to complete the SEP due to scheduling. Of the 243 completed SEPs, 17 additional dyads were excluded from this analysis for the following reasons: The child becoming sick during the protocol ($N = 1$), the mother speaking language other than English during the SEP ($N = 2$), having an uncodeable video (due to noise or video recording malfunction, $N = 8$), and study protocol violation ($N = 6$). The sample was further limited to those with complete data for maternal report of child selective eating ($N = 17$). This resulted in a final sample size of 226 dyads at baseline.

The subset of 90 participants selected for more detailed baseline behavioral coding were selected to equally sample from the three most frequent parent-child weight status combinations in this sample (30 dyads were both normal weight, 30 dyads were both obese, 30 dyads had an obese mother and a normal weight child) and (to the extent possible) to have equal numbers of boys and girls in each group. We did not include a group of normal weight mother and obese child in this analysis as this combination of weight statuses was infrequent in our sample ($N = 8$). There was no difference between this subset and the remainder of the sample with regard to race/ethnicity, maternal education, maternal BMI, child sex, child BMI, amount of green beans and artichokes eaten by the child, CEBQ FF and FNS scores (data not shown, available from the authors upon request).

A total of 181 dyads participated in the follow-up. Of those, 154 completed the SEP, with 25 dyads excluded for food allergies in the mother or child that were not present at recruitment into the original study and two excluded for scheduling difficulties. An additional 20 dyads who completed the SEP were excluded from the analysis for following reasons: The child being sick ($N = 1$), poor video quality ($N = 4$), protocol violation ($N = 4$), and not completing the SEP at baseline ($N = 11$).

This resulted in a sample of 134 dyads at follow-up, which included 67 from the original subset of 90 at baseline. Those who participated in the follow-up, as compared to those who did not, were not significantly different with regard to maternal race/ethnicity, maternal BMI, child sex, child BMI, and the amount of green beans and artichokes consumed by the child (data not shown, available from the authors upon request). However, those who participated in the follow-up had higher CEBQ FF and FNS scores (i.e., higher rates of selective eating) than those who did not (CEBQ FF: 2.83 versus 2.56, $p = .01$; FNS: 37.95 versus 34.17, $p = .03$) and had higher maternal education at baseline (72.7% versus 62.3% with highest level of educational attainment greater than a high school diploma, $p = .049$).

Univariate statistics were performed using SAS 9.4 (SAS Institute, Cary, NC). Pearson's correlations were performed for maternal report of child picky eating and food neophobia with each of the SEP outcome variables, for each vegetable (green beans, artichokes, peas, palm cabbage) separately at baseline (including the full sample and subset) and follow-up (full sample only). To assess stability, Pearson's correlations were performed for behaviors measured at baseline compared to follow-up.

3. Results

Characteristics of the sample are presented in Table 1. Mothers, on average, were obese, with a mean BMI of 33.1 at baseline, and 34.0 at follow-up. Of the children, with regard to child weight status, 21.3% of children had overweight weight status and 20.4% had obese weight status at baseline. At follow-up, the percentage of children with overweight weight status was stable at 20.2%, however the percentage of children with obese weight status rose to 27.6%.

Table 1. Participant characteristics at baseline and follow-up.

Participant characteristics	Baseline (N = 226)	Follow-up (N = 134)
Mother characteristics		
Maternal age (years); mean (SD)	31.2 (7.0)	34.5 (7.9)
Maternal race/ethnicity:		
White non-Hispanic; n (%)	162 (71.7)	95 (70.9)
Hispanic or Not White; n (%)	64 (28.2)	39 (29.1)
Maternal level of education:		
High school diploma or less; n (%)	105 (46.5)	55 (41.0)
Greater than high school diploma; n (%)	121 (53.5)	79 (59.0)
Maternal BMI; mean (SD)	33.0 (9.3)	34.2 (10.1)
Child characteristics		
Child age (months); mean (SD)	70.9 (8.5)	101.9 (11.2)
Child is male; n (%)	109 (48.2)	56 (48.5)
Child weight status:		
Underweight (BMI < 5th % for age/sex); n (%)	1 (0.1)	0 (0.0)
Normal weight (BMI 5th to < 85th % for age/sex); n (%)	131 (58.2)	70 (52.2)
Overweight (BMI ≥ 85th to < 95th % for age/sex); n (%)	48 (21.3)	27 (20.2)
Obese (BMI ≥ 95th % for age/sex); n (%)	46 (20.4)	37 (27.6)
BMI z-score	0.8 (1.0)	0.97 (1.0)
Household Food Security:		
Food secure; n (%)	154 (68.1)	87 (64.9)
Food insecure; n (%)	72 (31.9)	47 (35.1)
Maternal reported child selective eating behaviors		
Picky Eating (CEBQ FF); mean (SD)	2.7 (0.7)	2.7 (0.9)
Food Neophobia (FNS); mean (SD)	36.4 (12.8)	36.9 (12.6)

CEBQ FF denotes Child Eating Behavior Questionnaire Food Fussiness scale (scored on a 1–5 scale), FNS denotes Food Neophobia Scale (scored on a 7–70 scale).

Table 2. Univariate data of observed child selective eating behavior at baseline and follow-up as measured from the Structured Eating Protocol.

Observed child selective eating behaviors	Baseline		Follow-up	
	Green beans (Familiar vegetable) Mean (SD)	Artichokes (Unfamiliar vegetable) Mean (SD)	Peas (Familiar vegetable) Mean (SD)	Palm (Unfamiliar vegetable) Mean (SD)
Amount consumed (g)	25.76 (28.55)	4.91 (7.53)	20.07 (30.11)	5.19 (7.81)
Hedonic rating of vegetable[a]	3.51 (1.72)	1.98 (1.52)	2.83 (1.62)	1.88 (1.14)
% compliance with maternal encouragements (%)	0.37 (0.37)	0.27 (0.31)	0.27 (0.34)	0.18 (0.30)
Number of bites (count)	7.01 (6.12)	2.64 (2.99)		
Latency to first bite (s)	24.28 (55.23)	55.03 (74.54)		

Observed child selective eating behaviors	Baseline		Follow-up	
	Green beans (Familiar vegetable) Mean (SD)	Artichokes (Unfamiliar vegetable) Mean (SD)	Peas (Familiar vegetable) Mean (SD)	Palm (Unfamiliar vegetable) Mean (SD)
Negative utterances (count)	1.35 (1.76)	3.25 (3.00)		

[a] Hedonic rating of vegetable was rated on a Likert-type scale from1-5, with lower scores indicating less hedonic liking of the vegetable.

Table 3. Pearson correlations between maternal reported and observationally captured child selective eating behaviors at two time points.

Observed child selective eating behaviors	Maternal reported child selective eating behaviors							
	CEBQ FF Baseline (*N* = 226)		FNS Baseline (*N* = 226)		CEBQ FF Follow-up (*N* = 134)		FNS Follow-up (*N* = 134)	
	Green beans	Artichokes	Green beans	Artichokes	Peas	Palm	Peas	Palm
Amount consumed (g)	-.30**	-.17*	-.29**	-.18**	-.24**	-.27**	−0.22*	-.27**
Hedonic rating of vegetable	-.24**	-.19**	-.27**	-.15*	-.18*	-.22*	-.23*	-.24**
% compliance with maternal encouragements (%)	-.25**	.20**	-.30**	-.26**	-.31**	-.03	-.26*	-.04
Number of bites (count)	.38**	.40**	.41**	.37**				
Latency to first bite (s)	-.39**	-.25*	-.36**	-.24*				
Negative utterances (count)	.30**	-.12	.35**	-.11				

*p < .05, **≤0.01.
CEBQ FF denotes the Child Eating Behavior Questionnaire Food Fussiness subscale, FNS denotes the Food Neophobia Scale.
Number of bites (count), latency to first bite (in seconds), and negative utterances (count) were collected on a subset of 90 dyads.

With regard to maternal reported child selective eating behavior, the mean CEBQ FF scores were 2.7 (SD ± 0.7, range = 1.0–4.5) and 2.7 (SD ± 0.9, range = 1.0–5.0) at baseline and follow-up respectively. For the FNS, the mean scores were 36.4 (SD ± 12.8, range = 10.0–66.0) and 36.9 (SD ± 12.6, range = 11.0–70.0) at baseline and follow-up respectively.

As expected, in the SEP most children were familiar with the familiar vegetables (green beans: $N = 215$, 98.0%; peas: $N = 124$, 92.5%), and were unfamiliar with the unfamiliar vegetables (artichokes: $N = 187$, 87.0%; palm cabbage: $N = 131$, 98.5%). Descriptive statistics of child selective eating behaviors are presented in Table 2.

Correlations between maternal reported and observed child selective eating behaviors are presented in Table 3.

CEBQ FF score was inversely correlated with the amount of green beans and artichokes consumed (r (196) = −0.30, r (197) = -0.17, respectively), child's hedonic rating of green beans and artichokes (r (226) = −0.24, r (226) = −0.19), and with child compliance with maternal encouragement for green beans and artichokes (r (180) = −0.25, r (178) = −0.20) at baseline. Similar results were observed at follow-up, with the exception that no correlation was observed between the percent of maternal encouragements with which the child complied for palm cabbage and either the CEBQ FF or FNS.

In the subset, CEBQ FF was positively correlated with latency to first bite (r (87) = 0.38, r(87) = 0.40), and inversely correlated with number of bites for green beans and artichokes (r(84) = −0.39, r (84) = −0.25, respectively). FNS was also positively correlated with latency to first bite (r (87) = 0.41, r (87) = 0.37), and inversely correlated with number of bites for green beans and artichokes (r (84) = −0.36, r (84) = −0.24, respectively). CEBQ FF and FNS score positively correlated with child negative utterances for green beans (r (84) = 0.30, r(84) = 0.35). There was no correlation between CEBQ FF or FNS and child negative utterances for artichokes.

Correlations between observed behaviors measured at baseline and follow-up are presented in Table 4. The amount of familiar vegetable consumed moderately correlated between baseline and follow-up (r (110) = 0.32), as did the amount of unfamiliar vegetable consumed (r (112) = 0.22). The child's hedonic rating of familiar vegetable at baseline correlated with the rating at follow-up (r (134) = 0.27). There was no correlation between the child's hedonic rating of unfamiliar vegetables across time points. The percent of child compliance with mother's encouragements to eat did not correlate across time points for either familiar or unfamiliar vegetables.

Table 4. Pearson correlations between observed child selective eating behaviors at baseline and follow-up.

	Observed child selective eating behaviors	**12**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**
1	Amount of green beans consumed (baseline)	–.44**	.38**	.11	.12	-.05	.32**	.25**	.15	.17	-.08	.18
2	Hedonic rating of green beans (baseline)	–	.35**	-.09	.08	.15	.15	.27**	.01	.02	-.10	-.006
3	Child compliance with maternal encouragement to eat green beans (baseline)		–	.000	3.13	.24*	.15	.15	.04	.26**	.08	.03
4	Amount of artichokes consumed (baseline)			–	.42**	.09	.02	.03	.06	.22*	.12	.09
5	Hedonic rating of artichokes (baseline)				–	.15	.02	.11	.05	.20*	.18	.02
6	Child compliance with maternal encouragement to eat artichokes (baseline)					–	-.14	-.05	-.17	.29 *	.15	-.09

	Observed child selective eating behaviors	12	3	4	5	6	7	8	9	10	11	12
7	Amount of peas consumed (follow-up)						–	.61**	.31*	.09	-.17	.06
8	Hedonic rating of peas (follow-up)							–	.32*	.10	.05	-.06
9	Child compliance with maternal encouragement to eat peas (follow-up)								–	.27*	.17	. 05
10	Amount of palm consumed (follow-up)									–	.60**	-.02
11	Hedonic rating of palm (follow-up)										–	-.11
12	Child compliance with maternal encouragement to eat palm (follow-up)											–

*p < .05, **≤0.01.

Correlations between maternal reports of selective eating at baseline and at follow-up are presented in Table 5. CEBQ FF scores at baseline correlated with CEBQ FF scores at follow-up (r (134) = 0.58). FNS scores at baseline and at follow-up were also moderately correlated (r (134) = 0.54). CEBQ FF and FNS scores were highly correlated with each other both at baseline (r (134) = 0.79) and at follow-up (r (134) = 0.87).

Table 5. Pearson correlations between Child Eating Behavior Questionnaire Food Fussiness scale and the Food Neophobia Scale at baseline and follow-up.

		1	2	3	4
1	CEBQ FF baseline	–	.79**	.58**	.58**
2	FNS baseline		–	.46**	.54**
3	CEBQ FF follow-up			–	.87**
4	FNS follow-up				–

*p < .05, **≤0.01.

CEBQ FF denotes the Child Eating Behavior Questionnaire Food Fussiness subscale, FNS denotes the Food Neophobia Scale.

4. Discussion

This study expands prior research on child selective eating, and presents several new findings. This study is the first, to our knowledge, to validate the most common parental report measures of child selective eating with observational data in a population of low-income early school-aged children. This study found that maternal-reported child selective eating was associated with the following observed child selective behaviors in an experimental laboratory protocol with both familiar and unfamiliar vegetables: Fewer grams consumed, lower hedonic ratings, less compliance with maternal encouragements to eat, fewer bites, longer observed latency to the first bite, and more negative utterances about the food by the child. Of the observed child selective eating behaviors measured again on average two years later with different vegetables, there was low to moderate stability for amount consumed and hedonic rating for familiar and unfamiliar vegetables, whereas the maternal reports of selective eating showed stronger stability based on the magnitude of correlation.

Of note, the average scores on the maternal report measures of selective eating in this cohort were similar to those found in prior work with the CEBQ FF (Ashcroft, Semmler, Carnell, Van

Jaarsveld, & Wardle, 2008; Sleddens et al., 2008), and the FNS (Falciglia, Couch, Gribble, Pabst, & Frank, 2000; Pliner, 1994) in other populations of children and parents.

Prior work (Surette et al., 2017; Werthmann et al., 2015) has questioned whether maternal report of child selective eating behaviors are valid measurements of child behavior, given the subjective nature of a mother's interpretation of her child's eating behavior. This study, however, supports the validity of maternal report of child selective eating behaviors, which correlate with observed child behaviors. It is notable, however, that although statistically significant, maternal reported and observed child selective eating behaviors were only weakly to moderately correlated.

While coding of observational child selective eating behaviors can provide “in vivo” insights into child behaviors, it is a time and resource intensive endeavor, that is not without limitations (Pesch & Lumeng, 2017). The SEP is one such observational protocol that has been used in many prior studies (Pesch, Appugliese, et al., 2016; Pesch, Miller, Appugliese, Rosenblum, & Lumeng, 2016; Radesky et al., 2015) to measure maternal feeding behaviorsand child eating behaviors with familiar and unfamiliar foods. Observational protocols such as the SEP may be capturing unique aspects of child eating behavior that may not be captured by mothers’ reports, and vice versa. Another explanation for the weak-to-moderate correlation between parental report and observational selective eating behaviors is that parental report may be based on behaviors observed in the home, whereas the observational selective eating behaviors captured in the SEP were all from a laboratory setting. It should be considered that the SEP protocol, which only presents two vegetables, may limit the opportunities to observe child selective eating. Future studies observationally investigating child selective eating behaviors may benefit from presenting several vegetables, and may even vary their properties (texture, smell, color as well as familiarity), which may enhance the observation of selective eating and increase the correlation between observation and parent report. Future studies investigating child selective eating behavior may benefit from utilizing both observational and parental self-report methods of measurement.

This study investigated maternal report of child picky eating as well as food neophobia. These are often considered as two separate eating behaviors, which fall under the umbrella of selective eating (Dovey et al., 2007). In this study, however, observationally measured child eating behaviors with familiar and unfamiliar vegetables did not differentiate maternal reported picky eating from food neophobia. The authors had hypothesized that children with higher FNS scores would exhibit greater selective eating behaviors with the unfamiliar vegetables than with the familiar vegetables. However, this was not the case, as observed behaviors for both familiar and unfamiliar vegetables were similarly correlated. This finding may be interpreted in several ways. First, given the high degree of correlation between CEBQ FF and FNS, it is possible the differentiation between the concepts of picky eating and food neophobia is more theoretical than practical, as these behaviors have a high rate of co-occurrence. This is supported by the recent work by Smith et al., which found that picky eating and food neophobia are strongly correlated and may share similar etiologies (Smith et al., 2017). Furthermore, although the CEBQ FF is an accepted measure of picky eating, it does contain items that conceptually map onto food neophobia. Second, it is possible that low-income United States mothers do not conceptually distinguish food neophobia and picky eating from each other as two separate constructs. Further research is needed to determine whether or not the CEBQ FF and FNS discriminate between

picky eating and food neophobic behaviors broadly and in specific populations. Third, it may also be that the foods presented in the SEP were not unfamiliar enough to elicit a more robust neophobic response from the child. Alternatively, the child's eating behaviors may have been influenced by the laboratory environment and may be different in the home setting, which may be the major contributor to a mother's perception of these behaviors. Future studies should investigate children's eating behaviors with familiar and unfamiliar foods in other settings such as the home environment.

Strengths of this study include a relatively large, racially/ethnically diverse low-income United States sample, in addition to the observational methodology. While a strength of this study is that the SEP was conducted in a laboratory setting, which is free from distraction thereby allowing for the examination of the dyadic interaction in isolation, this is also a limitation as these observational results may not reflect the typical eating behaviors of the home environment (Faith, Scanlon, Birch, Francis, & Sherry, 2004), and children may have been more willing to accept vegetables had they been prepared in a more familiar manner. Children may also be more inclined to accept a vegetable when different types of maternal encouragement are used (autonomy-supportive vs. coercive-controlling) (Blissett, 2011; Edelson, Mokdad, & Martin, 2016; Fries et al., 2017). Future work should investigate the effects of maternal prompt types on child vegetable acceptance in selective eaters. In addition, only two vegetables were presented at each time point in the SEP, which provided limited opportunities to observe selective eating behavior. Although vegetables were matched as familiar or unfamiliar across time points, the foods did differ which may have led to variability in behaviors. Children may have also modified their eating behaviors based on social desirability bias. Findings may not be generalizable to other populations. Finally, there was missing data, as is common in longitudinal studies with high-risk and child samples.

5. Conclusions

This study supports the validity of the CEBQ FF and FNS in measuring selective eating behaviors in low-income early school-aged children at two time points. We observed moderate stability for these questionnaires. Future work should seek to validate these measures in naturalistic settings and to better understand low-income mothers' conceptualization of the constructs of picky eating and food neophobia.

Funding

This work was funded by a Summer Biomedical Research Program training grant from the University of Michigan to Ms. Fernandez, R01 HD061356 to Dr. Lumeng, and an American Heart Association Fellow-to-Faculty Transition Award (17FTF33630183) to Dr. Pesch.

References

American Academy of Pediatrics (2015). Picky eaters. Toddler Nutrition. https://www.healthychildren.org/English/ages-stages/toddler/nutrition/Pages/Picky-Eaters.aspx, Accessed date: 2 January 2018.

Ashcroft, J., Semmler, C., Carnell, S., Van Jaarsveld, C., & Wardle, J. (2008). Continuity and stability of eating behaviour traits in children. European Journal of Clinical Nutrition, 62, 985.

Bickel, G., Nord, M., Price, C., Hamilton, W., & Cook, J. (2000). Guide to Measuring Household Food Security, Revised 2000, 1–76. US Department of Agriculture, Food, and Nutrition Service, Office of Analysis, Nutrition, and Evaluation. Retrieved May 2, 2018, from https://www.fns.usda.gov/guide-measuring-household-food-securityrevised.

Blissett, J. (2011). Relationships between parenting style, feeding style and feeding practices and fruit and vegetable consumption in early childhood. Appetite, 57, 826–831.

Brown, C. L., Pesch, M. H., Perrin, E. M., Appugliese, D. P., Miller, A. L., Rosenblum, K., et al. (2016). Maternal concern for child undereating. Academic Pediatrics, 16, 777–782.

Brown, C. L., Vander Schaaf, E. B., Cohen, G. M., Irby, M. B., & Skelton, J. A. (2016). Association of picky eating and food neophobia with weight: A systematic review. Childhood Obesity, 12, 247–262.

Cardona Cano, S., Tiemeier, H., Van Hoeken, D., Tharner, A., Jaddoe, V. W., Hofman, A., et al. (2015). Trajectories of picky eating during childhood: A general population study. International Journal of Eating Disorders, 48, 570–579.

Carnell, S., & Wardle, J. (2007). Measuring behavioural susceptibility to obesity: Validation of the child eating behaviour questionnaire. Appetite, 48, 104–113.

Carruth, B. R., Ziegler, P. J., Gordon, A., & Barr, S. I. (2004). Prevalence of picky eaters among infants and toddlers and their caregivers' decisions about offering a new food. Journal of the American Dietetic Association, 104, 57–64.

Cooke, L., Wardle, J., Gibson, E., Sapochnik, M., Sheiham, A., & Lawson, M. (2004). Demographic, familial and trait predictors of fruit and vegetable consumption by preschool children. Public Health Nutrition, 7, 295–302 .

Domoff, S. E., Miller, A. L., Kaciroti, N., & Lumeng, J. C. (2015). Validation of the Children's eating behaviour questionnaire in a low-income preschool-aged sample in the United States. Appetite, 95, 415–420.

Dovey, T. M., Staples, P. A., Gibson, E. L., & Halford, J. C. (2007). Food neophobia and ‘picky/fussy’ eating in children: A review. Appetite, 50, 181 –193.

Dubois, L., Farmer, A., Girard, M., Peterson, K., & Tatone-Tokuda, F. (2007). Problem eating behaviors related to social factors and body weight in preschool children: A longitudinal study. International Journal of Behavioral Nutrition and Physical Activity, 4, 9.

Edelson, L. R., Mokdad, C., & Martin, N. (2016). Prompts to eat novel and familiar fruits and vegetables in families with 1–3 year-old children: Relationships with food acceptance and intake. Appetite, 99, 138–148.

Faith, M. S., Scanlon, K. S., Birch, L. L., Francis, L. A., & Sherry, B. (2004). Parent-child feeding strategies and their relationships to child eating and weight status. Obesity Research, 12, 1711–1722.

Falciglia, G. A., Couch, S. C., Gribble, L. S., Pabst, S. M., & Frank, R. (2000). Food neophobia in childhood affects dietary variety. Journal of the American Dietetic Association, 100, 1474–1481.

Fries, L. R., Martin, N., & van der Horst, K. (2017). Parent-child mealtime interactions associated with toddlers' refusals of novel and familiar foods. Physiology & Behavior, 176, 93–100.

Galloway, A. T., Fiorito, L., Lee, Y., & Birch, L. L. (2005). Parental pressure, dietary patterns, and weight status among girls who are “picky eaters”. Journal of the American Dietetic Association, 105, 541–548.

Goulding, A. N., Rosenblum, K. L., Miller, A. L., Peterson, K. E., Chen, Y.-P., Kaciroti, N., et al. (2014). Associations between maternal depressive symptoms and child feeding practices in a cross-sectional study of low-income mothers and their young children. International Journal of Behavioral Nutrition and Physical Activity, 11, 75.

Jacobi, C., Agras, W. S., Bryson, S., & Hammer, L. D. (2003). Behavioral validation, precursors, and concomitants of picky eating in childhood. Journal of the American Academy of Child & Adolescent Psychiatry, 42, 76–84.

Jacobi, C., Schmitz, G., & Agras, W. S. (2008). Is picky eating an eating disorder? International Journal of Eating Disorders, 41, 626–634.

Klesges, R. C., Coates, T. J., Brown, G., Sturgeon-Tillisch, J., Moldenhauer-Klesges, L. M., Holzer, B., et al. (1983). Parental influences on children's eating behavior and relative weight. Journal of Applied Behavior Analysis, 16, 371–378 .

Lumeng, J. C., & Burke, L. M. (2006). Maternal prompts to eat, child compliance, and mother and child weight status. The Journal of Pediatrics, 149, 330–335 e331.

Mallan, K. M., Liu, W.-H., Mehta, R. J., Daniels, L. A., Magarey, A., & Battistutta, D. (2013). Maternal report of young children's eating styles. Validation of the Children's Eating Behaviour Questionnaire in three ethnically diverse Australian samples. Appetite, 64, 48–55.

Marchi, M., & Cohen, P. (1990). Early childhood eating behaviors and adolescent eating disorders. Journal of the American Academy of Child & Adolescent Psychiatry, 29, 112–117.

Mascola, A. J., Bryson, S. W., & Agras, W. S. (2010). Picky eating during childhood: A longitudinal study to age 11 years. Eating Behaviors, 11, 253–257.

Mosli, R. H., Lumeng, J. C., Kaciroti, N., Peterson, K. E., Rosenblum, K., Baylin, A., & Miller, A. L. (2015). Higher weight status of only and last-born children. Maternal feeding and child eating behaviors as underlying processes among 4–8 year olds. Appetite, 92, 167–172. https://doi.org/https://doi.org/10.1016/j.appet.2015.05.021.

Pesch, M. H., Appugliese, D. P., Kaciroti, N., Rosenblum, K. L., Miller, A. L., & Lumeng, J. C. (2016). Maternal encouragement and discouragement: Differences by food type and child weight status. Appetite, 101, 15–22.

Pesch, M. H., Harrell, K. J., Kaciroti, N., Rosenblum, K. L., & Lumeng, J. C. (2011). Maternal styles of talking about child feeding across sociodemographic groups. Journal of the American Dietetic Association, 111, 1861–1867.

Pesch, M. H., & Lumeng, J. C. (2017). Methodological considerations for observational coding of eating and feeding behaviors in children and their families. International Journal of Behavioral Nutrition and Physical Activity, 14.

Pesch, M. H., Miller, A. L., Appugliese, D. P., Rosenblum, K. L., & Lumeng, J. C. (2016). Affective tone of mothers' statements to restrict their children's eating. Appetite, 103, 165–170.

Pesch, M. H., Miller, A. L., Appugliese, D. P., Rosenblum, K. L., & Lumeng, J. C. (2017). Mothers of obese children use more direct imperatives to restrict eating. Journal of Nutrition Education and Behavior, 17, S1499–S4046.

Pliner, P. (1994). Development of measures of food neophobia in children. Appetite, 23, 147–164.

Pliner, P., & Hobden, K. (1992). Development of a scale to measure the trait of food neophobia in humans. Appetite, 19, 105–120.

Radesky, J., Miller, A. L., Rosenblum, K. L., Appugliese, D., Kaciroti, N., & Lumeng, J. C. (2015). Maternal mobile device use during a structured parent–child interaction task. Academic Pediatrics, 15, 238–244.

Shorr, I. (1986). How to weigh and measure children. New York, NY: United Nations.

Sleddens, E. F., Kremers, S. P., & Thijs, C. (2008). The Children's eating behavior questionnaire: Factorial validity and association with body mass index in Dutch children aged 6–7. International Journal of Behavioral Nutrition and Physical Activity, 5, 49.

Smith, A. D., Herle, M., Fildes, A., Cooke, L., Steinsbekk, S., & Llewellyn, C. H. (2017). Food fussiness and food neophobia share a common etiology in early childhood. Journal of Child Psychology and Psychiatry, 58, 189–196.

Surette, V., Ward, S., Morin, P., Vatanparast, H., & Bélanger, M. (2017). Food reluctance of preschool children attending daycare centers is associated with a lower body mass index. Journal of the Academy of Nutrition and Dietetics, 117, 1749–1756.

Taylor, C. M., Wernimont, S. M., Northstone, K., & Emmett, P. M. (2015). Picky/fussy eating in children: Review of definitions, assessment, prevalence and dietary intakes. Appetite, 95, 349–359.

Tharner, A., Jansen, P. W., Kiefte-de Jong, J. C., Moll, H. A., van der Ende, J., Jaddoe, V. W., et al. (2014). Toward an operative diagnosis of fussy/picky eating: A latent profile approach in a population-based cohort. International Journal of Behavioral Nutrition and Physical Activity, 11, 14.

Volger, S., Sheng, X., Tong, M., Zhao, D., Leung, T., Zhang, F., et al. (2013). Dietary patterns and nutrients intakes of preschool children with picky-eating behaviours. ESPGAN 2013 13e1141.

Wardle, J., Guthrie, C. A., Sanderson, S., & Rapoport, L. (2001). Development of the Children 's Eating Behaviour Questionnaire. Journal of Child Psychology and Psychiatry, 42(7), 963–970.

Werthmann, J., Jansen, A., Havermans, R., Nederkoorn, C., Kremers, S., & Roefs, A. (2015). Bits and pieces. Food texture influences food acceptance in young children. Appetite, 84, 181–187.