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Temperamental Approach/Withdrawal and Food Neophobia in Early Childhood: Concurrent and Longitudinal Associations

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Introduction

Food neophobia is the tendency to reject novel or unknown foods (Birch, 1999; Dovey, Staples, Gibson, & Halford, 2008). This construct has been linked to poor dietary outcomes in young children such as a reduced preference for all food groups, less dietary variety, and lower consumption and liking of vegetables (Dovey et al., 2008; Falciglia, Couch, Gribble, Pabst, & Frank, 2000; Galloway, Lee, & Birch, 2003; Russell & Worsley, 2008). Although it is believed that food neophobia reaches its peak during early childhood (Addessi, Galloway, Visalberghi, & Birch, 2005; Dovey et al., 2008), not all children respond negatively to new foods. Instead, individuals vary on their reactions with some individuals showing positive responses to novel foods (Pliner & Hobden, 1992). Much of the work investigating individual differences in food neophobia has focused on the contribution of external or environmental factors, such as parenting. However, there is some evidence to suggest that food neophobia during early childhood may be driven by child characteristics, such as temperament or personality (Pliner & Loewen, 1997). The purpose of the present study is to investigate whether temperament, specifically the tendency to approach or withdraw in the presence of novelty, is associated with food neophobia concurrently and longitudinally.

Temperament is defined as individual differences in emotional and behavioral reactivity and regulation that are relatively stable but may also be modifiable (Rothbart & Bates, 2006). Temperamental differences appear early in life and can account for why infants and children respond differently to the same stimuli (Goldsmith et al., 1987). Child temperament encompasses a wide range of dimensions, several of which may be related to food neophobia. One example is the dimension of discomfort, defined as negative affect related to sensory qualities of stimulation (Putnam, Rothbart, & Gartstein, 2008). Recent evidence reveals links between food neophobia and taste and smell sensitivity (Coulthard & Blissett, 2009; Johnson, Davies, Boles, Gavin, & Bellows, 2015), as well as a low enjoyment of tactile play measured observationally (Coulthard & Sahota, 2016; Coulthard & Thakker, 2015). Although these studies did not specifically measure child temperament or the

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dimension of discomfort, sensory sensitivity and discomfort appear to be highly overlapping constructs.

The present study focuses on another specific dimension of temperament that may also be linked to food neophobia: approach/withdrawal. This dimension characterizes individual differences in responses to novel stimuli, such as new toys, new people, and new situations. Children who are high in approach tend to show positive affect and physical movement toward novel stimuli, whereas children who are low on this dimension tend to show negative affect and withdraw from the same stimuli (Rothbart & Bates, 2006). The majority of research on approach/withdrawal during early childhood has focused on children's responses to new objects and new people (e.g. Kagan, Snidman, & Arcus, 1998), but approach/withdrawal may also relate to the ease or difficulty children have in trying and accepting novel foods.

In support of this argument, Pliner and Loewen (1997) found that the temperament dimension of shyness, which is driven by approach/withdrawal processes, predicted food neophobia in children ages 5 to 11. Specifically, children who were rated as more shy by their mothers were less likely to taste novel foods in a laboratory and were rated by their mothers as having higher levels of neophobia than less shy children. Additional evidence from infancy and adulthood also suggests a link between approach/withdrawal and food neophobia. For example, high approach infants consumed more of a novel vegetable, exhibited fewer facial expressions of distaste while trying a new food, and demonstrated greater acceptance of new foods on the first offer compared to low approach infants (Forestell & Mennella, 2012; Moding, Birch, & Stifter, 2014). In adults, higher levels of sensation seeking, or the tendency to seek out novel and thrilling activities, has been associated with lower levels of food neophobia (Pliner & Hobden, 1992). However, there is a lack of studies on the association between approach/withdrawal and food neophobia in early childhood. The present study aims to bridge this gap by investigating whether the tendency to withdraw or hesitate in response to novel objects and people is concurrently related to food neophobia in young children.

In addition to the lack of research on temperamental approach/withdrawal and food neophobia in early childhood, there are no existing longitudinal studies examining this association. However, studies on child temperament have shown toddler temperament to be linked to later reactions to novelty, including new objects and people, during the preschool years (e.g., Kagan, Reznick, Snidman, Gibbons, & Johnson, 1988). Thus, we might expect early forms of approach/withdrawal to relate to later responses to novel foods. We investigated this longitudinal relation in the present study by examining whether temperamental reactions to novelty at 18 months of age predicted levels of food neophobia at 4.5 years of age.

Parenting may also play a role in the association between temperament and food neophobia, but there are no studies to date on this topic. However, prior research has shown that parenting practices moderate the association between children's early approach/withdrawal behaviors and their later responses to novel objects and people (Arcus, 2001; Coplan, Arbeau, & Armer, 2008; Crockenberg & Leerkes, 2006; Rubin, Burgess, & Hastings, 2002).

A concurrent association between parent feeding practices and child food neophobia has also been established. For example, pressuring children to eat has been linked to higher levels of child food neophobia (Brown, Ogden, Vogele, & Gibson, 2008), whereas parental modeling of novel food consumption has been linked to lower levels of child food neophobia (Addessi et al., 2005). Since parenting plays a role in the association between early approach/withdrawal and later responses to novelty, as well as in children's levels of food neophobia, it is possible that parenting may also impact the longitudinal association between temperament and food neophobia. Thus, the present study investigated whether maternal pressuring and modeling moderated toddler approach/withdrawal tendencies to predict food neophobia at 4.5 years of age.

The Present Study

The present study had two primary aims. Our first aim was to examine the association between child temperament and food neophobia. We addressed this aim in two ways: 1) we investigated whether children's tendencies to approach or withdraw in response to novelty and food neophobia were concurrently related at 4.5 years of age, and 2) we examined whether toddler temperament at 18 months of age was longitudinally related to 4.5 year neophobia. Based on prior research highlighting a link between aspects of approach/withdrawal, such as shyness, and food neophobia (Pliner & Loewen, 1997), it was hypothesized that children who were hesitant in response to novelty in the laboratory (i.e. exhibited longer latencies to play, shorter durations of engagement with novel objects) and as reported by their mothers (i.e. low surgency/extraversion, high negative affectivity) would show higher levels of food neophobia in the laboratory and as reported by their mothers in the present study. Further, since prior research has revealed that toddler temperamental approach/withdrawal predicts later reactions to novelty during early childhood (Kagan et al., 1988), it was hypothesized that responses to novelty at 18 months of age would predict food neophobia during the preschool period. Specifically, children who showed low levels of approach during toddlerhood were expected to show higher levels of food neophobia at 4.5 years of age in the laboratory and as reported by their mothers compared to children who showed high levels of approach during toddlerhood.

Our second aim was to explore whether the association between temperament and food neophobia was moderated by parenting. Although there is no prior research on this topic, parenting practices have been shown to moderate the association between early approach/withdrawal and later responses to novelty (Arcus, 2001; Coplan et al., 2008; Crockenberg & Leerkes, 2006; Rubin et al., 2002). Further, parent feeding practices have been concurrently linked to children's food neophobia (Addessi et al., 2005; Brown et al., 2008). Based on this research, we hypothesized that 18-month-old toddlers who showed low approach would be less neophobic during childhood when their mothers reported fewer pressuring feeding practices and higher levels of modeling. Conversely, we hypothesized that the children who showed high approach during toddlerhood would exhibit low levels of neophobia at 4.5 years of age regardless of their mothers' feeding practices.

Methods

Participants

Infant-mother dyads (N = 115; 52 female infants) were recruited as part of a longitudinal study with data collection occurring when the infants were within 2 weeks of being 4, 6, 12, and 18 months of age. The dyads were originally recruited through birth announcements and a local community hospital. Criteria for inclusion in the study were mothers' full-term pregnancy, ability to read and speak English, and maternal age greater than 18 years. The families were primarily Caucasian (n = 108) and mothers averaged 29.93 years of age (range = 19 - 41) at the birth of their infant and had at least 2 years of education beyond high school. Median annual income in this sample fell between $40,000 and $60,000. The majority of mothers were married (n = 93). All study procedures were approved by The Pennsylvania State University Human Subjects Institutional Review and written consent was obtained from parents for their own and their children's participation in the study.

The present study draws from the longitudinal study across infancy. Included in the present analysis are data from the 18 month laboratory visit (n = 95) and two visits when the children were 4.5 years of age (n = 82; M = 4.57 years at the first visit). Primary reasons for study attrition include family relocation and inability to contact families to schedule laboratory visits. There were no systematic differences between the participants who completed the 4.5-year visits and those who dropped out of the study on demographic variables (e.g., maternal education, family income).

Procedures

18 months—When the children were 18 months of age, they participated in a laboratory visit with their mothers that contained a variety of tasks designed to elicit the toddlers' tendencies to approach or withdraw in the presence of novelty. The present study focuses on one task in particular, the Risk Room, a widely used assessment of temperament in young children.

Risk Room **(Buss & Goldsmith, 2000; Goldsmith, Reilly, Lemery, Longley, & Prescott, 1999):** The Risk Room task is part of the Laboratory Temperament Assessment Battery (Lab-TAB) which is a standardized set of behavioral observation procedures used to assess early temperament of children. The toddler version of the Lab-TAB, used during the 18 month visit, was specifically designed for use with children under the age of three (Buss & Goldsmith, 2000). In the Risk Room task, mothers and toddlers entered a laboratory room that contained four objects: a tunnel, stairs next to a large mattress, a large black box with painted eyes and teeth, and a gorilla mask placed on a table. For the first three minutes, the mother and child were left in the room alone; the mother was asked to sit in a chair in the corner of the room and the child was told that he/she could play with the toys however he/she wanted. After three minutes had elapsed, an experimenter entered the room and asked the child to engage with the objects one at a time. The order of presentation for the objects and the specific prompts for each object were as follows: crawl through the tunnel, jump off the steps, put his/her hand in the box, and pet the monkey. These behaviors were demonstrated to the child (with the exception of crawling through the tunnel) and the child

was prompted up to three times to engage with each object. If the child engaged with the object as specified by the experimenter, the experimenter said, “Good job!” and moved to the next object. If the child did not engage with the object after three prompts, the experimenter said, “No? That's ok” and proceeded to the next object. During the experimenter-present episode of the task, the mother was asked to remain silent.

4.5 years—When the children were 4.5 years of age, they participated in two laboratory visits designed to assess their temperament, emotion regulation, and executive function abilities. Two tasks were of interest in the present study: the Risk Room task to assess children's tendency to approach in the presence of novel objects and a behavioral neophobia task to assess children's willingness to taste novel foods. These tasks took place in two separate laboratory visits scheduled approximately one month apart, but they both occurred as the first task of the visit after a brief interview with the parent (see below for detailed descriptions). Prior to these laboratory visits, the mothers completed questionnaires assessing their children's food neophobia and temperament, as well as their own feeding practices.

Risk Room: At the start of the first 4.5 year visit, children participated in a Risk Room task that was very similar to the Risk Room task at 18 months. However, this task contained five objects, three of which were the same as those at 18 months: a tunnel, stairs next to a large mattress, a large black box with painted eyes and teeth, a balance beam, and a transparent box containing a large toy spider. First, an experimenter asked the mother to sit in a chair in the corner of the room and then exited the laboratory and left the mother and child alone for two minutes. After the two minutes had elapsed, the mother was asked to leave the room and a second experimenter entered the room. This experimenter gave the child a maximum of three prompts to engage with each object. The order of presentation for the objects and the specific prompts for each object were as follows: crawl through the tunnel, climb up the stairs and jump onto the mattress, put his/her hand in the black box, walk across the balance beam, and unwrap the spider (from the mesh covering that surrounded the transparent box containing the spider). The task was executed in the same manner as described in the 18 month visit.

Behavioral Food Neophobia Task: At the beginning of the second 4.5 year visit, the children participated in a behavioral food neophobia task based on the procedures outlined in Pliner and Loewen (1997). First, an experimenter told the child that he/she would taste several foods to see how much he/she liked them, but the child first had to identify which foods he/she wanted to taste. There were three novel food options: lychee (one small fruit, peeled), nori (dried seaweed served in a 1 inch × 3 inch strip), and haw jelly (a fruit leather made from hawthorn fruit served in a stack of two 0.5 inch × 1 inch strips). There were also two familiar foods: carrot (a single baby carrot) and graham cracker (1/4 piece). The foods were presented to the child in a semi-random order: graham cracker, novel food #1, novel food #2, carrot, and novel food #3. The children were always presented with a familiar food (graham cracker) first in order to ease them into the task, but the order of novel foods was randomized to control for possible order effects.

As the experimenter presented each of the foods, she first asked if the child knew the food. After the child had a chance to respond, the experimenter named the food for the child. Next, the child was asked up to two times if the he/she wanted to taste the food. If the child responded that he/she did want to taste the food, it was set aside for later tasting. Otherwise, the food was not presented again to the child. This procedure was followed for each of the foods and none were tasted until all of the foods had been presented to the child.

After all the foods were presented, the experimenter then presented the child with each of the previously selected foods to taste in the same order they were initially presented. The experimenter prompted the child to take a bite of the food up to two times and then waited for the child to respond. Next, the experimenter recorded whether or not the child took a bite of the food, offered the child a sip of water, and presented the child with the next food. This procedure was repeated until all of the selected foods were presented to the child.

Prior to the 4.5 year laboratory visit, mothers confirmed that the three novel foods were novel to their children. The nori and haw jelly were novel to all children, but a few children (n = 4) had already tasted lychee prior to the laboratory visit. In these cases, another novel fruit was used as a substitute: longan (one small fruit, peeled; n = 2) or jackfruit (one fruit served as a 1 inch × 1 inch piece).

Measures

18 months

Approach/withdrawal behaviors: Similar to previous studies (Fox, Henderson, Rubin, Calkins, & Schmidt, 2001; Putnam & Stifter, 2005), approach/withdrawal behaviors were rated in response to the experimenter-present episode of the Risk Room task at the 18-month laboratory visit. This particular episode was selected because the presence of the unfamiliar experimenter made this episode relatively high-risk compared to the episode with the mother and child alone. Three behaviors were coded using an interval-based computer program (Better Coding Approach, Danville, PA) that timed 5-second intervals: activity level, level of engagement with Risk Room objects, and spontaneous vocalizations. Activity level was coded on a 4-point scale ranging from 0 (child is completely still) to 3 (vigorous or exuberant activity). In intervals where the toddler exhibited two or more different levels of activity, the peak level of activity was selected. Engagement with the objects was coded on a 6-point scale ranging from 0 (no engagement with any object) to 5 (high active engagement, such as jumping off the steps or crawling through the tunnel quickly). The average levels of activity and engagement were calculated for each child across the experimenter-present episode of the task. Finally, the number of spontaneous, non-distressed vocalizations was counted across the same episode. Drift reliability was assessed on 20% of recordings for the activity level (ICC= .971), engagement (ICC = .996), and spontaneous vocalizations coding schemes (Cohen's kappa = .70).

Three additional behaviors were coded continuously per second: proximity to the mother, latency to play with the first object in the room, and duration of time playing with the novel objects. Proximity to the mother ranged from 1 (clinging to the mother) to 5 (greater than two arm's lengths from the mother). Toddlers' average level of proximity to the mother

throughout the experimenter-present portion of the task were calculated. Latency to engage with the first object was defined as the amount of time (in seconds) from when the child first entered the Risk Room to when they began engaging with one of the objects. Duration of time playing with objects in the room was defined as the total time (in seconds) the child engaged with any object from when the child first entered the Risk Room to when the task ended after the final prompt to engage with the mask. To account for variable task lengths and the amount of time considered uncodable between children (i.e. child not in view of camera), proportion scores were created for latency to play and duration of time playing by dividing the time spent in these behaviors by the total time coded for each child. Drift reliability was assessed on 20% of recordings for proximity (ICC = .996), latency to play (ICC = .921), and duration of time playing (ICC = .996).

Affect: Toddler positive and negative affect were rated in 5-second intervals based on facial and vocal expressions during the experimenter-present episode of the Risk Room task described above. Positive affect scores were coded on a 4-point scale ranging from 0 (No positive; no indication of positive facial affect and no positive intonation in voice) to 3 (High positive; smile with mouth open widely, intense laughing, or squealing with delight). Negative affect was also coded on a 4-point scale ranging from 0 (No negative; no indication of negative facial affect and no negative intonation in voice) to 3 (High negative; screaming, extreme crying, or large grimace with mouth open wide). Drift reliability was assessed on 20% of recordings (ICC = .983).

Temperament composite variables: Toddler temperament composite variables were created for approach/withdrawal, positive affect, and negative affect at 18 months of age. Since the individual approach/withdrawal behaviors tended to be moderately or strongly inter-correlated (*r*'s ranging from .15 to .82, all *p*'s < .08), a composite variable was created for *approach/withdrawal* behaviors across the experimenter-present portion of the Risk Room task by standardizing and averaging all the approach/withdrawal behaviors listed above. Higher scores on this composite variable indicated greater approach behavior during the task. Positiveand negative affect ratings were also averaged separately across the experimenter-present episode of the Risk Room task to create *positive* and *negative affect* composite variables.

4.5 years

Approach/withdrawal responses: To assess children's approach/withdrawal responses to the five novel objects in the Risk Room at 4.5 years, latencies to engage with each object and duration of time playing with the objects in the presence of the experimenter were coded continuously per second in a similar manner to 18 months. However, the children's latencies to engage with each object were coded and averaged to create an average latency to engage score for each child at 4.5 years. The child's duration of time playing with novel objects was coded in the same manner as 18 months. Drift reliability was assessed on 20% of recordings for the latency to engage (ICC = .932) and duration of time playing coding schemes (ICC = . 941).

Child behavioral neophobia: Children's behavioral neophobia was defined as the number of novel foods the child refused to taste during the novel food task (range 0 to 3). This number was recorded by the experimenter administering the task and all foods that did not successfully enter the child's mouth or make contact with the child's tongue were counted. As Pliner and Loewen (1997) suggest, it is possible that some children's willingness to try new foods in the laboratory setting could be affected by other variables that may be unrelated to food neophobia, such as satiety. Thus, upon arrival to the laboratory visit, mothers were asked to report the time since their child last ate. The number of minutes since each child last ate was calculated and used as a covariate in all analyses predicting behavioral neophobia.

Parent-rated child neophobia: Prior to the 4.5 year laboratory visits, mothers completed the Food Neophobia Scale for Children (FNS-C) (Pliner, 1994). This 6-item questionnaire was adapted from the Food Neophobia Scale for adults (Pliner & Hobden, 1992) and assesses the children's willingness to try novel foods (e.g. my child does not trust new foods, my child is afraid to eat things s/he has never had before). Each item was rated on a 4-point scale ranging from 0 (strongly disagree) to 3 (strongly agree). Scores for each of the items were averaged with higher scores indicating higher levels of neophobia. Cronbach's alpha showed good internal consistency for this scale in the present study ($\alpha = .93$).

Child temperament: Also prior to the 4.5 year laboratory visits, mothers reported on their children's temperament using the Children's Behavior Questionnaire (CBQ) Short Form (Putnam & Rothbart, 2006). This questionnaire requires parents to report on their children's behavior within the past six months using 7-point scales ranging from 1 (extremely untrue) to 7 (extremely true). The 94-item questionnaire consists of 15 scales assessing specific dimensions of temperament, such as fear (amount of negative affect related to anticipated pain or distress and/or potentially threatening situations) and shyness (slow or inhibited approach in situations involving novelty or uncertainty). The individual dimensions can be combined to form three broad superfactors: surgency/extraversion, negative affectivity, and effortful control. Of interest in the present study were the superfactors of surgency and negative affectivity because they represent the reactivity components of temperament and similar broad dimensions have been found across multiple samples of children (Rothbart & Bates, 2006). Both the surgency and negative affectivity superfactors showed good internal consistency in the present study according to Cronbach's alpha (α's = .89 and .82, respectively).

Maternal feeding practices: Also prior to the 4.5 year laboratory visit, mothers completed the Comprehensive Feeding Practices Questionnaire (CFPQ) (Musher-Eizenman & Holub, 2007). This 49-item questionnaire assesses 12 different feeding practices on 5-point scales ranging from 1 (never) to 5 (always) or 1 (disagree) to 5 (agree). Two scales were of interest in the present study because they may be related to levels of child neophobia based on previous research: pressure (sample item: “My child should always eat all of the food on his/her plate”; $\alpha = .71$) and modeling (sample item: “I model healthy eating for my child by eating healthy foods myself”; $\alpha = .85$).

Potential Covariates—Since the following variables may be related to child food neophobia at 4.5 years of age, they were examined as potential covariates in the present study: demographic variables (maternal education, family income, child sex), maternal BMI, and infant feeding history (age the child was introduced to solid foods and exclusive breastfeeding for 4 months or not). Upon arrival to the laboratory, mothers reported their current demographic information through an interview. Level of education was reported in years and family income was delineated into 7 categories: 1) Less than $10,000; 2) $10,000-$20,000; 3) $20,000-$40,000; 4) $40,000-$60,000; 5) $60,000-$80,000; 6) $80,000-$100,000; 7) $100,000+. Maternal height and weight were measured at both the 18 month and 4.5 year laboratory visits and used to calculated maternal BMI (pregnant women were not included in these variables). Finally, when the infants were 4, 6, 12, and 18 months of age, mothers completed the *Baby's Basic Needs Questionnaire (BBNQ)* which assessed the infants' feeding history (Stifter, Anzman-Frasca, Birch & Voegtline, 2011). Mothers reported the infants' current feeding method and the age the infants had been introduced to solid foods (in weeks) ($M = 17.70$, $SD = 4.53$) and formula, if applicable. Based on the responses to these items, infants were classified into two groups: infants exclusively breastfed for at least 4 months ($n = 31$) and infants who were exclusively breastfed for less than 4 months ($n = 51$).

Data Analysis Plan

Preliminary analyses—First, the distributions of all variables were examined and determined to be normally distributed; thus, parametric tests were conducted for all subsequent analyses. Next, in order to test for potential covariates related to food neophobia at 4.5 years of age, correlations, independent samples t-tests, and one-way ANOVA's were conducted between the behavioral and parent-rated food neophobia variables and the demographic variables, maternal BMI, and feeding history variables. It is also possible that the order of presentation for the novel foods during the laboratory visit (6 possible presentation orders) and the amount of time since the children last ate (in minutes) would be related to children's levels of behavioral food neophobia, so these variables were also tested as potential covariates.

Child sex was significantly related to parent-rated neophobia such that males had higher levels of neophobia ($M = 1.56$, $SD = .76$) than females ($M = 1.17$, $SD = .70$) ($t(83) = 2.47$, $p = .02$). Thus, child sex was entered as a covariate in all analyses predicting parent-rated neophobia. No significant associations emerged between the potential covariates and behavioral neophobia. However, in order to control for potential differences in satiety between children, the number of minutes since the children last ate was entered as a covariate in all models predicting behavioral neophobia. No other demographic or feeding history variables were significantly related to neophobia at 4.5 years, so they were not considered further. Finally, since only one covariate was entered in models predicting both behavioral and parent-rated neophobia, these covariates were entered in the same step as the predictor variables.

Primary analyses—The first study aim was addressed through two sets of multiple regression analyses. To examine the concurrent association between temperament and food

neophobia, children's latencies to play and duration of time playing with objects in the Risk Room at 4.5 years, as well as the parent-rated surgency and negative affectivity superfactors, were entered as predictors of behavioral and parent-rated neophobia while controlling for covariates. Next, the longitudinal association between temperament and food neophobia was tested by entering the toddler temperament composite variables at 18 months of age (approach/withdrawal, positive affect, negative affect) into multiple regression analyses predicting behavioral and parent-rated food neophobia at 4.5 years of age while controlling for covariates.

To address the second study aim, longitudinal multiple regression analyses were conducted to predict behavioral and parent-rated food neophobia at 4.5 years of age from the following variables: toddler temperament at 18 months of age (approach/withdrawal, positive affect, and negative affect), parenting (pressuring, modeling), and interactions between toddler temperament and parenting. Since there were no specific hypotheses about the contribution of one parenting variable over another, each parenting variable and its interactions with temperament were examined in separate regression models.

Results

Preliminary Analyses

Descriptive statistics for all study variables can be found in Table 1 and correlations between the covariates, temperament (toddler and 4.5 year), parenting, and food neophobia variables can be found in Table 2. As expected, the temperament variables were correlated concurrently and longitudinally. At 18 months of age, approach/withdrawal behaviors were moderately correlated with both positive and negative affect in the Risk Room. Similarly, latency to play with objects in the Risk Room at 4.5 years was negatively correlated with the children's duration of time playing with the objects. However, the children's behavioral responses in the Risk Room at 4.5 years of age were uncorrelated with parent-rated temperament at the same age. Toddler approach/withdrawal behaviors at 18 months were significantly correlated with higher levels of parent-rated surgency at 4.5 years of age, suggesting modest cross-method stability.

As expected, behavioral and parent-rated neophobia at 4.5 years of age were moderately correlated indicating that children who tried fewer novel foods at the 4.5 year visit were seen by their mothers as more neophobic.

Primary Analyses

Aim 1: Associations between temperament and food neophobia

Concurrent associations: Two multiple regression analyses were used to predict behavioral and parent-rated neophobia at 4.5 years of age from all concurrent measures of temperament: latency to play, duration of time playing, parent-rated surgency, and parent-rated negative affectivity. As shown in Table 3, the first model predicting behavioral neophobia was non-significant. However, both the duration of time children played with objects in the Risk Room and parent-rated negative affectivity at 4.5 years of age were significantly associated with behavioral neophobia after controlling for the amount of time

since the children last ate prior to the visit. Children who spent less time playing with objects in the Risk Room and children who were rated as higher in negative affectivity by their mothers refused more novel foods. The second model examining parent-rated food neophobia was significant. Again, negative affectivity at 4.5 years was associated with food neophobia. Children rated as high in negative affectivity were reported by their mothers as having higher levels of food neophobia. Children's latency to play with objects in the Risk Room and levels of parent-rated surgency were not significantly related to behavioral or parent-rated food neophobia.

Post-hoc analyses: Since the negative affectivity superfactor emerged as a significant predictor of both behavioral and parent-rated food neophobia, post-hoc analyses were conducted to determine whether these associations were driven by any specific subscales that comprise this superfactor, such as fear which might be associated with food neophobia since it is the emotion most closely linked to withdrawal. The models predicting behavioral and parent-rated food neophobia were re-run with the following five subscales in place of the negative affectivity superfactor: anger, discomfort, falling reactivity (inverse), sadness, and fear. The model predicting behavioral neophobia was not significant ($p = .126$). Further, none of the individual subscales were significantly related to behavioral neophobia. However, the model predicting parent-rated neophobia was significant ($R^2 = .28$, $F(9, 71) = 3.02$, $p = .004$). In this model, fear was significantly associated with parent-rated food neophobia ($B = .19$, $t = 2.30$, $p = .025$), such that children who were rated as more fearful by their mothers were also rated as more neophobic.

Longitudinal associations: To examine the longitudinal associations between temperament and food neophobia, the temperament variables (approach/withdrawal, positive affect, and negative affect) at 18 months were entered into multiple regression models predicting behavioral and parent-rated food neophobia at 4.5 years of age. As shown in Table 4, toddler negative affect during the Risk Room at 18 months emerged as a significant predictor of behavioral neophobia in Model 4. Toddlers who exhibited more negative affect refused more novel foods in the laboratory at 4.5 years of age. These main effects were present after controlling for the amount of time since the children last ate prior to the laboratory visit at age 4.5 years. Toddler approach/withdrawal behavior and positive affect were not significantly associated with behavioral neophobia in either of the models.

Also as shown in Table 4, toddler negative affect at 18 months also emerged as a significant predictor of parent-rated neophobia in both models. Toddlers who exhibited more negative affect in the Risk Room were rated as more neophobic by their mothers at 4.5 years of age. However, the main effect for negative affect was qualified by an interaction with maternal pressure in Model 5 (discussed below). Positive affect during the Risk Room also emerged as a significant predictor of parent-rated neophobia in Model 6. Toddlers who exhibited more positive affect were rated as less neophobic by their mothers at 4.5 years of age. These associations were present after controlling for child sex. Again, the toddler approach/withdrawal behaviors were not associated with parent-rated child neophobia.

Aim 2: Moderating role of maternal feeding practices—To examine the potential moderating role of parenting on the longitudinal association between temperament at 18

months of age and food neophobia at 4.5 years of age, the parenting variables (maternal pressuring and modeling) and their interactions with temperament at 18 months were included in models predicting behavioral and parent-rated food neophobia. Only one significant interaction emerged. As shown in Table 4, maternal pressure moderated the association between toddler negative affect and parent-rated neophobia in Model 5. Following Aiken and West's (1991) guidelines, the association between toddler negative affect and parent-rated child neophobia was examined separately for high and low levels of maternal pressure (one standard deviation above and below the mean, respectively). Figure 1 illustrates this association. Follow-up tests revealed that the slope for toddler negative affect was significantly different from zero at high levels of maternal pressure, $b = 9.98$, t = 3.61, $p < .001$ (indicated by asterisks in Figure 1). For children of mothers reporting a more pressuring feeding style, higher levels of negative affect at 18 months of age were associated with greater child neophobia, and lower levels of negative affect were associated with less child neophobia. The slope for negative affect was not significantly different from zero at low levels of maternal pressure, $b = -2.19$, $t = -1.71$, $p = .09$. No other significant interactions emerged between toddler temperament and parenting to predict food neophobia at 4.5 years.

Discussion

Previous research has revealed that food neophobia is linked to poor dietary outcomes in young children, such as poor dietary variety and nutrient intakes (Dovey et al., 2008; Falciglia et al., 2000; Galloway et al., 2003). For this reason, it is important to identify factors that are associated with high levels of food neophobia, especially during early childhood when food neophobia reaches its peak (Dovey et al., 2008). The purpose of the present study was to investigate one factor that may be related to food neophobia both concurrently and longitudinally: temperamental approach/withdrawal processes. Our results were largely consistent with our hypothesis that approach/withdrawal behaviors and the emotions associated with these behaviors would be related to food neophobia. Our findings revealed that certain children, specifically those who exhibit high levels of negative affect when confronted with novelty, tend to be at a heightened risk for developing food neophobia compared to their peers.

We first examined the concurrent association between food neophobia and other well-established measures of child temperament, such as parent-ratings of negativity and observations of children's responses to novel objects in a Risk Room at 4.5 years of age. Consistent with our hypotheses, a moderate association between temperament and food neophobia emerged. Importantly, this finding was consistent across several measures. Children who spent less time engaging with novel objects in the Risk Room at 4.5 years of age refused more novel foods. Further, children who were rated as highly negative by their parents also received high ratings for food neophobia and refused more novel foods in the lab. It is important to note that the relations between both parent ratings and observations of temperament and behavioral neophobia, in particular, suggest that the association between temperament and food neophobia exists beyond the shared variance that may result from utilizing parent ratings alone. In sum, the consistent findings for an association between temperamental withdrawal, including high levels of negative affect and hesitation to engage

with novel objects, and food neophobia provide further support for the proposal that food neophobia may be linked to approach/withdrawal tendencies in young children.

Since parent ratings of negative affectivity emerged as a significant predictor of both behavioral and parent-rated neophobia, follow-up tests were conducted to see whether these associations were driven by one or more specific emotions that comprise the negative affectivity scale. Our results suggest that parent perceptions of their child's fearfulness, rather than any other negative emotion, may be responsible for the relation between negativity and food neophobia. Since fear is the emotion most closely linked to withdrawal (Saarni, Campos, Camras, & Witherington, 2006), this result is consistent with our hypothesis that food neophobia would be associated with the concurrent tendency to withdraw in response to novelty. In the case of food neophobia, fear may motivate individuals to avoid the potential dangers of ingesting harmful substances or toxins (Rozin, 1976). In support of this argument, recent research has linked selective eating and food neophobia in children to high levels of anxiety and an attentional bias toward novel fruit and vegetable stimuli, respectively (Farrow & Coulthard, 2012: Maratos & Staples, 2015). Attentional biases towards threat have been implicated in fear and anxiety disorders (Cisler & Koster, 2010), so the results of these two studies are consistent with the findings of the present study linking fear and food neophobia.

To further examine the associations between temperamental approach/withdrawal and food neophobia, we next investigated whether toddler approach/withdrawal tendencies predicted food neophobia at 4.5 years of age. Although, no studies to date have examined early measures of approach/withdrawal as predictors of food neophobia, we hypothesized that a longitudinal association would emerge in the present study due to established relations between approach/withdrawal and later responses to other novel objects (Kagan et al., 1988). As expected, toddlers who exhibited high levels of negative affect and low levels of positive affect in the Risk Room at 18 months of age tasted fewer novel foods in the laboratory and were rated by their parents as having high levels of food neophobia at 4.5 years of age. Taken together with the concurrent findings in the present study, it appears that children who have a tendency to exhibit negativity when presented with novel stimuli are at a heightened risk for developing food neophobia compared to their peers.

Based on the lack of longitudinal studies on temperament and food neophobia, the length of time between measurement of these two constructs in the present study, and the research on the effects of parenting on both temperament and food neophobia, we had expected maternal feeding practices to play a role in the association between early approach/withdrawal processes and later food neophobia. Contrary to hypotheses, only maternal pressure appeared to impact the association between toddler temperament and food neophobia. When mothers reported a high pressuring feeding style, children with low levels of negative affect in response to novelty had lower levels of food neophobia, but children with high levels of negative affect had higher ratings of food neophobia. This finding suggests that while maternal pressure may lessen neophobia in some children, it seems to have adverse effects on the children who are already at-risk for developing high levels of neophobia.

This study has many strengths including the use of both observational and parent ratings of food neophobia and temperament, the inclusion of concurrent and longitudinal analyses, and the examination of multiple parenting behaviors and characteristics. However, these strengths need to be considered alongside the study limitations. One, this study lacks behavioral and parent ratings of food neophobia during toddlerhood. Without these measures, we were not able to test the concurrent association between approach/withdrawal processes and food neophobia during toddlerhood and the stability of food neophobia overtime. Two, this study did not include observations or parent ratings of parenting practices in the context of novel foods or general novelty. Since the food neophobia and temperament measures used here characterize children's behaviors in response to novelty, it may also be important to understand how parents behave in similar novel contexts. Perhaps the lack of these types of parenting measures is one reason why parenting did not have a large effect on the association between temperament and food neophobia in the present study. Finally, although recent studies have revealed a strong link between child sensory sensitivity and food neophobia (e.g. Coulthard & Blissett, 2009; Johnson et al., 2015), we were unable to include a measure of sensory sensitivity in the present study and our post-hoc analyses did not reveal a link between the temperament dimension of discomfort and food neophobia as might be expected. Thus, it remains unclear how sensory sensitivity may or may not be linked to child temperament. Future studies should examine this relationship.

Conclusions

The results of the present study were largely consistent with our hypothesis that temperamental approach/withdrawal processes would be associated with food neophobia both concurrently and longitudinally. In particular, our findings revealed that both parent ratings and behavioral observations of food neophobia were concurrently associated with well-established measures of temperamental approach/withdrawal, such as parent questionnaires and behavioral observations of children in a risky context with an unfamiliar experimenter. Our longitudinal findings compliment these cross-sectional results by again showing that temperamental withdrawal, specifically high levels of negative affect or low levels positive affect, predicted food neophobia three years later. Collectively, our findings emphasize that children low in temperamental approach may be at heightened risk for developing food neophobia compared to their peers. Further, these neophobic tendencies may be strengthened by certain parenting behaviors, such as pressuring feeding practices. Additional research is needed to determine whether there are parenting practices or other environmental factors that may alleviate negative responses to novel foods in low approach children, who are most at-risk for developing high levels of food neophobia.

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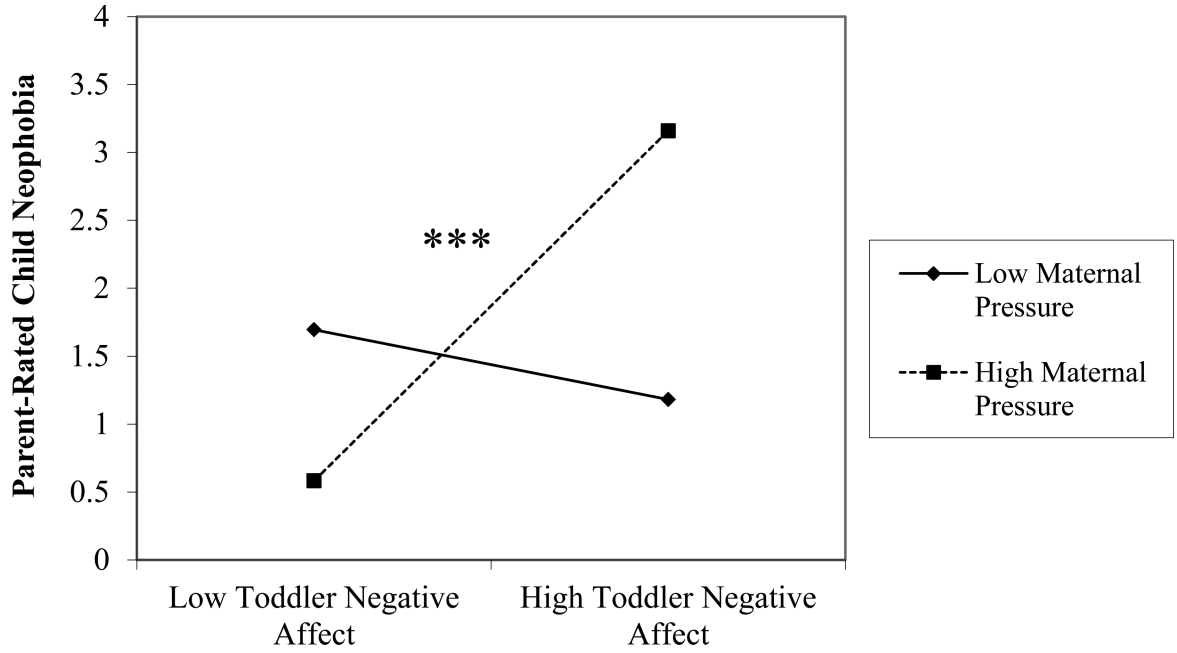

Figure 1.
Interaction between toddler negative affect and maternal pressure predicting parent-rated child neophobia at 4.5 years of age.

Table 1

Descriptive Statistics for Covariates, Temperament, Parenting, and Food Neophobia Variables

	% or M	*SD*	Min	Max
Covariates:				
Child Sex:				
Males:	52.40%	—	—	—
Females:	47.60%	—	—	—
Time Since Last Ate (Min)	105.42	70.00	1.00	367.00
Toddler Temperament (18 months):				
Approach/Withdrawal[b]	−.05	.79	−1.62	1.62
Positive Affect[b]	.16	.21	.00	1.27
Negative Affect[b]	.04	.13	.00	.76
Child Temperament (4.5 years):				
Duration of Time Playing[b]	.24	.09	.00	.43
Latency to Engage[b]	5.15	5.86	.60	36.40
Surgency[p]	4.92	.69	3.05	6.52
Negativity[p]	3.99	.73	2.57	5.47
Parenting:				
Pressure	2.66	.74	1.00	4.25
Modeling	3.84	.78	1.00	5.00
Neophobia:				
Behavioral	1.61	1.11	.00	3.00
Parent-Rated	1.38	.76	.00	3.00

Note.

[b] behavioral observation

[p] parent-rating

Table 2

Correlations between Covariates, Temperament, Parenting, and Food Neophobia Variables

Variable	1	2	3	4	5	6	7	8	9	10	11	12
1. Time Since Last Ate (Min)	---	−.03	.12	.04	−.12	.01	.32**	.06	.06	−.03	−.13	−.11
2. Toddler Approach/Withdrawal[b]		---	.38**	−.36**	−.06	.19+	.30**	−.13	.09	.22*	−.24*	−.15
3. Toddler Positive Affect[b]			---	−.13	.06	.04	.10	.05	−.10	−.02	−.25*	−.22*
4. Toddler Negative Affect[b]				---	−.02	.08	.01	.10	−.12	−.01	.28*	.23*
5. Latency to Engage[b] (4.5Y)					---	−.48**	−.01	−.09	.08	.00	.01	.00
6. Duration of Time Playing[b] (4.5Y)						---	.13	.09	−.32**	−.01	−.21+	−.05
7. Surgency[p] (4.5Y)							---	−.28**	.14	−.05	−.10	−.22*
8. Negative Affectivity[p] (4.5Y)								---	.19+	−.11	.21+	.40**
9. Maternal Pressure									---	.07	.06	.06
10. Maternal Modeling										---	−.13	−.04
11. Behavioral Neophobia											---	.27*
12. Parent-Rated Neophobia												---

Note.

+ p < . 10

* $p < .05$

** $p < .01$.

[b] behavioral observation

[p] parent rating

Table 3

Multiple Regression Results Predicting Behavioral and Parent-Rated Neophobia from Concurrent Temperament Measures at 4.5 years of Age

	B	*SE*(B)	β	*F*	R^2
I. Behavioral Neophobia (4.5Y)				2.23^{+}	.14
Time Since Last Ate (Minutes)	.00	.00	−.18		
Latency to Engage^{b} (4.5Y)	−.03	.02	−.13		
Duration of Time Playing^{b} (4.5Y)	−3.35	1.51	−.28*		
Surgency^{p} (4.5Y)	.06	.21	.04		
Negative Affectivity^{p} (4.5Y)	.41	.18	.27*		
II. Parent-Rated Neophobia (4.5Y)				5.08***	.25
Child Sex	−.47	.15	−.32**		
Latency to Engage^{b} (4.5Y)	.01	.02	.05		
Duration of Time Playing^{b} (4.5Y)	−.49	.92	−.06		
Surgency^{p} (4.5Y)	−.10	.12	−.09		
Negative Affectivity^{p} (4.5Y)	.42	.11	.41***		

Note.

$^{+}$p < .10

**p* < .05.

^{b}behavioral observation

^{p}parent rating

Table 4

Multiple Regression Results Predicting Behavioral and Parent-Rated Neophobia from Toddler Temperament Composite Variables

	B	*SE*(B)	β	*F*	R^2
III. Behavioral Neophobia (4.5Y)				2.29*	.21
Time Since Last Ate (Minutes)	.00	.00	−.15		
Toddler Approach/Withdrawal[b]	−.18	.18	−.13		
Toddler Positive Affect[b]	−1.31	.72	−.26+		
Toddler Negative Affect[b]	2.60	1.59	.31		
Maternal Pressure	.23	.21	.15		
Approach/Withdrawal[b] X Maternal Pressure	−.28	.34	−.10		
Positive Affect[b] X Maternal Pressure	−.98	.77	−.17		
Negative Affect[b] X Maternal Pressure	1.00	3.98	.05		
IV. Behavioral Neophobia (4.5Y)				1.87+	.18
Time Since Last Ate (Minutes)	.00	.00	−.11		
Toddler Approach/Withdrawal[b]	−.09	.20	−.06		
Toddler Positive Affect[b]	−1.02	.63	−.20		
Toddler Negative Affect[b]	2.11	1.02	.25*		
Maternal Modeling	−.18	.17	−.13		
Approach/Withdrawal[b] X Maternal Modeling	.13	.24	.07		
Positive Affect[b] X Maternal Modeling	−.25	1.00	−.03		
Negative Affect[b] X Maternal Modeling	.16	2.28	.01		
V. Parent-Rated Neophobia (4.5Y)				3.96**	.31
Child Sex	−.45	.16	−.30		
Toddler Approach/Withdrawal[b]	.05	.11	−.05		
Toddler Positive Affect[b]	−.78	.46	−.22+		
Toddler Negative Affect[b]	3.89	1.03	.65***		
Maternal Pressure	.29	.13	.28*		
Approach/Withdrawal[b] X Maternal Pressure	.27	.21	.15		
Positive Affect[b] X Maternal Pressure	−.09	.50	−.02		
Negative Affect[b] X Maternal Pressure	8.35	2.59	.59**		
VI. Parent-Rated Neophobia (4.5Y)				2.54*	.22
Child Sex	−.53	.17	−.35**		
Toddler Approach/Withdrawal[b]	−.03	.13	−.03		

	B	*SE*(B)	β	*F*	R^2
Toddler Positive Affect[b]	−.94	.42	−.26*		
Toddler Negative Affect[b]	1.43	.69	.24*		
Maternal Modeling	.01	.11	.01		
Approach/Withdrawal[b] X Maternal Modeling	.12	.16	.09		
Positive Affect[b] X Maternal Modeling	.50	.63	.09		
Negative Affect[b] X Maternal Modeling	1.22	1.53	.09		

Note.

+ p < .10

* *p* < .05

** *p* < .01

*** *p* < .001.

[b] behavioral observation