



HHS Public Access

Author manuscript

Int J Obes (Lond). Author manuscript; available in PMC 2018 September 29.

Published in final edited form as:

Int J Obes (Lond). 2018 September ; 42(9): 1631–1638. doi:10.1038/s41366-018-0006-4.

Infant temperament and parent use of food to soothe predict change in weight-for-length across infancy: Early risk factors for childhood obesity

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Abstract

Objectives—Greater weight gain in infancy is a risk factor for childhood obesity. The present study examined the interaction between infant temperament and parent use of food to soothe infant distress (FTS) as predictors of weight gain across the first 2 years of life.

Subjects/Methods—160 mother-infant dyads were recruited into a longitudinal study. Infant temperament was assessed by parents through a questionnaire (surgency, negativity) and by observer ratings (surgency, irritability) during a laboratory visit when infants were 6 months. Parents also completed a 3-day infant cry diary when their children were 6 months of age to assess when they used food in response to infant cry/fuss bouts. Infant weight/length was measured in the lab at 6 and 18 months. Multiple regressions were run to test the moderating effect of FTS on weight gain.

Results—Significant interactions were revealed for both measures of surgency and parent FTS in predicting weight gain. Surgent infants whose parents had a greater tendency to use FTS had greater weight-for-length gain in one year than if their parents tended to use less FTS. The interaction between observer ratings of irritability and parent FTS was also significant but in an unexpected direction.

Conclusions—The findings point to the role of temperament, specifically surgency, in weight gain during infancy, but only if their parents used FTS. Surgency may have evoked this feeding practice that increased their health risk.

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Conflict of interest

The authors declare no conflict of interest.

Introduction

Because parents have a strong influence on the eating patterns of children, particularly in the earliest years, food parenting has become a key focus of research attempting to understand factors contributing to the risk for childhood obesity. However, few studies have examined how child characteristics, specifically temperament, may affect the feeding decisions parents make and the consequences of these decisions. Temperament, or individual differences in reactivity and regulation (1), likely influence how parents feed their children. Recent evidence has shown child temperament to be associated with feeding practices such as restrictive feeding (2), using food to calm (3), and the timing of introduction to solid foods (4, 5). In the present study, we examine the interaction between temperament and feeding practices and its relation to changes in weight-for-length across infancy, a precursor of childhood obesity.

The study of child temperament and both eating and weight status has increased significantly in the past years producing some illuminating findings. For example, high negativity, often called difficult temperament, has been concurrently and longitudinally associated with greater weight gain (6-8). Moreover, a specific type of negativity, anger reactivity (labelled “distress to limitations” in some infant temperament questionnaires), has been positively related to weight outcomes in a number of studies (9-12). Surgency, a temperament superfactor which comprises the traits of approach, activity level, and high intensity pleasure (1), has also been linked to eating behavior, greater weight gain, and higher BMI (13). These findings suggest that children, who are challenging, either through their high emotionality or their approach tendencies, may be at risk for childhood obesity. In the present study, we examine these temperamental traits in infancy as predictors of infant weight-for-length gain from 6 to 18 months of age. Previous research has relied almost exclusively on parent ratings of infant temperament which are known to be biased and to reflect more of the parents’ characteristics than the behavior of their child (14). To address this issue, both parent report of their child’s temperament and observer ratings during a laboratory visit were used in the present study.

Although research has demonstrated a direct relationship between temperament and weight outcomes, parent feeding practices are hypothesized to have a role in this association. Indeed, the acknowledgement that development is the outcome of a bi-directional relationship between the parent and the child, whereby both the child and the parent affect each other’s behavior, emphasizes the importance of child characteristics. Parental behaviors and decisions around feeding may be a reaction to their child’s individual differences and thus may moderate the relationship between temperament and weight status.

While most feeding practices, such as restriction, predominantly reflect the goals of the parent, e.g. “I don’t want my child to eat junk food”, the use of food to soothe is inherently dependent upon the parent’s responses to the child’s reactivity. Food to soothe (FTS), otherwise labelled feeding to calm or to regulate emotions (15-20), is defined as feeding in response to child distress that is unrelated to hunger (21). Parents who report using FTS have been found to have children who developed emotional eating styles (22) and to eat more energy dense snacks (23, 24). FTS has also been linked to eating in the absence of hunger, a

proven risk for obesity (25). Interestingly, only a handful of studies that have examined the relationship between FTS and child weight found no association (17, 24, 26).

In the majority of these studies, the direct relationship between FTS and child eating/diet/weight status was examined, but only one study measured the child's temperament. In a cross-sectional study, Stifter and colleagues (18) found parent report of FTS to be related to higher child weight status, but only for infants high in negativity. This result suggests that children's disposition may have elicited parent feeding responses and which in turn has negative consequences for the child's health. However, the study's methodological weaknesses (cross-sectional design, reliance on parent report) leave the question open as to whether the interaction between child temperament and parent FTS is a risk factor for childhood obesity.

It is important to keep in mind that while parents may rely on FTS occasionally, it only becomes a parent feeding practice when used repeatedly, a practice most likely to be evoked by infants who are temperamentally distressed, fussy or challenging. The consequence of frequently using food in circumstances unrelated to hunger is that children may come to understand that food has other reward-like qualities. This compromised ability to self-regulate their food intake consequently puts them at risk for obesity.

The goal of the present study was to further our understanding of how child characteristics interact with parent feeding practices to relate to infant weight outcomes. We focused on the use of food to soothe infant distress because this feeding practice is most likely to be elicited by the child's temperament. Toward this end, we conducted a longitudinal study for which we obtained parent and observer ratings of temperament, assessed FTS using an infant cry diary, and measured change in infant weight and length from 6 to 18 months, a known risk factor for childhood obesity (27). Based on the research literature we expected a challenging temperamental style, e.g., surgency and negativity, to be directly related to greater weight-for length gain. However, we hypothesized that this relationship would be enhanced for those infants whose mothers reported a greater tendency to use FTS.

Method

Participants

Infants and their primary caregivers ($N = 160$; 75 female infants) were recruited through birth announcements and a local community hospital for a longitudinal study. Inclusion criteria included a full-term pregnancy, mothers' ability to read and speak English, and maternal age greater than 18 years. The families were primarily Caucasian ($n = 152$). Mothers averaged 29.66 years of age, had at least 2 years of post-high school education, and were primarily married (82%). Infants were tested within two weeks of being 6, 12, and 18 months of age.

The present study includes data collected from infant cry diaries and questionnaires when infants were 6 months of age ($n = 148$), and lab visits to obtain infant and maternal weight at 6 and 18 months of age ($n = 136$). Attrition was primarily attributed to families relocating out of the area and failure to reach families to schedule visits. Mothers who dropped out of the study were less educated ($t(144) = 2.06, p = .04$) and stopped breastfeeding before 6

months infant age ($\chi^2 = 5.91, p = .02$). In the present study, N's vary as 2 infants did not cry/fuss during the 3-day diary period and 5 diaries did not have sufficient data to calculate the food to soothe interval (see below for details).

All study procedures were approved by The Pennsylvania State University Human Subjects Institutional Review Board and written consent was obtained from parents for their own and their children's participation in the study.

Procedures&Measures

Infant cry diary—Parents completed a 3-day, 24-hr diary (28) when infants were 6 months of age. The ruler-like diary has been used extensively in research on infant states (29). Parents recorded their infants' states (awake and content, sleeping, feeding, fussing, and crying) every 5 minutes using colored pencils. Parents also completed an attached form ranking the order of soothing techniques they used for each cry or fuss bout indicated in the diary. Soothing methods such as using sounds, motion, distraction or feeding were listed on a grid and parents were asked to note the order (1st, 2nd, 3rd, etc.) of each of the soothing behaviors they used in response to that cry/fuss bout.

The use of food to soothe infant distress was assessed by averaging the rank orders for using food in response to a cry/fuss bout across all 3 days of the diary record. *Average order of FTS*, therefore, could range from 1 to 7, with 1 indicating that food was used immediately in response to a cry or fuss. As FTS is defined as using food to soothe infant distress unrelated to hunger, we operationalized FTS as the use of other soothing methods before turning to food. Thus, a higher average order of using food in response to an infant's cry would reflect a greater tendency to use FTS. To validate our measure of FTS, we calculated the time interval between when the child was last fed and when food was used in response to the child crying and averaged these intervals across the 3-day recording period (*food to soothe interval*). Lastly, to control for variation in the amount of crying among the sample, the *total number of cries* from the soothing grid was calculated.

Infant temperament—Infant temperament was measured through parent ratings of their child's behavior during the past two weeks, and with objective observer ratings of infant behavior during the 6-month laboratory visit. *The Infant Behavior Questionnaire-Revised* (IBQ-R; 30) was completed by parents when their child was 6 months of age. This 173-item questionnaire asked mothers to rate the relative frequency of specific infant behaviors on a 7-point Likert scale from 1 ("Never") to 7 ("Always") in the past 1 to 2 weeks (e.g., "When being dressed or undressed during the last week, how often did the baby smile or laugh?"). Fourteen subscales are derived from these items, which can then be grouped into three broad factors: Negative Affectivity, Surgency/Extraversion, and Orienting/Regulation. As we are proposing that food to soothe would be used in response to more reactive/challenging infants, the Negative Affectivity and Surgency/Extraversion were used in the analyses. The Negative Affectivity factor includes items assessing anger, fear, sadness and discomfort ($\alpha = .72$) The Surgency/Extraversion factor taps the child's activity level, approach to novelty, high intensity pleasure, smiling/laughter, vocal reactivity, and perceptual sensitivity ($\alpha = .80$).

The *Infant Behavior Record* (IBR; 31) was also used as a measure of temperament. After the 6-month laboratory visit, which lasted approximately one hour, two research assistants who observed the child during the entire visit from lab entry to departure, rated the child independently and resolved any discrepancies through discussion before coming to a final score for each temperament scale. Experimenters were minimally trained on the application of the IBR prior to their ratings in an effort to simulate conditions under which parents rate their children's temperament. From the eight IBR scales rated by the observers, two composites were created to reflect the same factors derived from the IBQ. IBR Surgency was a composite of social approach (responsiveness to examiner; higher scores indicate greater friendliness and approach-oriented behaviors), positive affect (higher scores indicate more happiness), and activity level (higher scores reflect greater amounts of gross motor activity). IBR Irritability was comprised of two subscales, irritability reflects the infant's general negative responses to stimulation and reactivity reflects the ease with which the infant is excitable or sensitive to stimulation. Scores were averaged to create the IBR Surgency ($\alpha = .72$) and IBR Irritability ($\alpha = .40$; $r = .28$, $p < .001$) composites.

Infant weight—When infants were 6 and 18 months of age, weight and recumbent length were assessed. Infant weight was measured with a Seca 354 Digital Baby Scale (Hanover, MD) and infant length was measured with a Seca 416 Infantometer (Hanover, MD). Both measures were taken twice. A third measurement was taken if there was a discrepancy of more than 100g for infant weight or 1 cm for infant length. The measurements were averaged for the final weight and length variables. Weight-for-length z scores were calculated using the World Health Organization (WHO) growth standards taking into account the infant's sex. These standards have been recommended for use in children younger than 24 months of age (32). As rapid weight gain is a robust predictor of childhood and adult obesity (33-35), we examined change in infant weight-for-length by subtracting the 6-month weight-for-length z score from 18-month weight-for-length z score (WLZ) such that larger scores reflect greater change across the time period.

Potential covariates—A number of potential covariates were gathered through questionnaires and interviews with the parent, including information about family income, maternal education, duration of breastfeeding (weeks), age the infant was introduced to solid foods (weeks), and infant birthweight (grams). Maternal height and weight were measured at the 6 and 12 month lab visits. Maternal body mass index (BMI) was calculated and then averaged; pregnant women were not included in this variable.

Data Analytic Plan

Pearson correlations were used to identify covariates to be used in the analyses. Multiple regression analyses were conducted to test study hypotheses. Covariates, infant temperament, parent use of FTS, and temperament x FTS interaction terms were entered as predictors of infant WLZ. A total of four models were analyzed, one for each temperament variable (parent-rated surgency, parent-rated negativity, observer-rated surgency, and observer-rated irritability). Significant interactions were probed by testing the simple slope of parent use of FTS, one standard deviation above and below the mean on the temperament

dimension. Statistical analyses were performed using SPSS version 24.0 and SAS version 9.4 and a significance level of $p < .05$ was retained.

Prior to addressing our main goals, we sought to confirm our operationalization of FTS by examining the relationship between average order of FTS and the mean FTS interval (time between a feed and a cry followed by a feed). Our rationale was that if the time since the last feed was brief then parents might interpret the cries as non-hunger related and use other techniques to soothe the child because they may assume their child is full. Our analysis revealed a negative correlation between the FTS interval (averaged over the 3-day diary) and average order FTS, $r = -.31, p < .001$. If the time since the last feed was short, parents were more likely to try other soothing techniques before using food to soothe their infants' cries.

Results

Table 1 presents the descriptives of the sample and the study variables. Of note, 6-month-old infants averaged 21 cry bouts over a 3-day period. Moreover, in response to those cries parents predominantly chose to use food to soothe relatively soon after their infants cried, $M = 1.9$.

Correlations among the study variables can be seen in Table 2. Several significant correlations emerged from the analysis including a positive correlation between parent and observer ratings of surgency and a strong negative relationship between observer ratings of surgency and irritability. The significant correlations among potential covariates and the core study variables indicate that birthweight, breastfeeding, and total cries should be used as covariates in the following analyses.

Multiple regression analyses were conducted to examine whether infant temperament, parent use of FTS, and their interaction predict WLZ. After controlling for the study covariates, all four models were significant, and three had significant interactions between temperament and FTS.

Both models examining surgency were significant (see Table 3, Model 1 & 3) and revealed significant interactions between surgency (both parent-rated and observer-rated) and FTS in predicting WLZ. Figure 1 shows that for children rated as high in surgency, by either parent or observer report, greater tendency to use FTS by parents was related to greater WLZ (parent-rated high surgency slope = $.28, p < .05$; observer-rated high surgency slope = $.33, p < .01$). Whereas, the association between low surgency and WLZ was the same regardless of FTS (p 's $> .05$).

The model for observed irritability also revealed a significant interaction between temperament and FTS. As Figure 2 illustrates, infants who were observed to be low in irritability during a lab visit were more likely to show a greater WLZ if their parents used more FTS (slope = $.26, p < .01$). There was no effect for FTS on WLZ for infants observed to be high in irritability.

Discussion

The goal of the present study was to examine whether child characteristics moderated the relationship between food parenting and change in weight-for-length across infancy. Using a 3-day infant diary to assess the order in which parents used food to soothe their infants' cries, the results showed that weight-for-length gain was greater for surgent infants of parents who used other soothing techniques before turning to food.

To understand early factors related to the risk for childhood obesity we chose to examine parent use of food to soothe, as it is a food parenting practice likely to be evoked by child temperament. Although many parents will respond to their young infants' cries with a feeding when they believe their child to be hungry, they may also use it to calm the infant for other non-hunger reasons including when no other soothing method works. In the present study, we conceptualized the use of food after using other soothing methods to be food to soothe (FTS). Parents who responded more often to their crying infants with non-nutritive soothing techniques before turning to food suggests that they did not interpret the cries to be hunger-related. Our finding that the time since the last feed was shorter for parents delaying using food to soothe supports this contention. Ultimately, these parents did resort to using food to reduce crying. One reason may be that the parents become distressed themselves because the child is not calming down and turn to food because of its effectiveness (36). Parents may have also concluded that the child was indeed hungry. Although it was not possible to ascertain what mothers were thinking without asking them in the moment, the decision to use FTS, we believe, was due to the difficulty soothing the distress of their infants, which lies partially within the child. That is, child temperament may have evoked parent use of food to soothe. However, our hypothesis that both highly negative and surgent infants would be at greater risk of childhood obesity through this parent feeding practice was not fully supported. Rather, only infants rated and observed to be surgent had greater changes in weight-for-length if their parents turned to food after unsuccessfully using other soothing methods. These results add to the accumulating evidence that surgency and related approach-oriented emotions are a risk factor for childhood obesity.

Surgency is a cluster of temperament characteristics (e.g., high activity level, high intensity pleasure, approach behaviors) that indicate an approach orientation to new objects, people, and situations. Recently, Moding & Stifter (37) showed that greater approach to novelty in infancy and toddlerhood to be related to positive responses to new foods. This underlying approach motivation may explain past findings linking greater negativity to higher weight status. A closer look at this research, however, shows anger to be more strongly related to weight status in childhood than the emotions of fear or sadness. (13, 16, 38, 39). Anger, while a negative emotion, is conceptualized as reflecting approach (vs. withdrawal) processes because of its adaptive function and biological underpinnings (40) and is often associated with approach behaviors. Interestingly, in Rothbart's factor analysis of child temperament dimensions based on parent reports, anger while loading on the negative affectivity factor also loaded on the surgency factor (30). Approach motivation also underlies individual differences in reward sensitivity, a trait associated with higher weight in both children and adults (41-43).

Although child characteristics, particularly those related to approach motivation, may be directly related to the risk for childhood obesity, our findings suggest that the feeding context enhances this relationship. By responding with food to infant distress that is unrelated to hunger parents may encourage the association of feeding with the reduction in crying, which in turn, may lead to the child's understanding of food as rewarding. Through repeated use, non-hunger related FTS may override, or make less effective, the child's appetite signals, thereby promoting increased intake and excessive weight gain (44). Given surgent children's approach motivation and reward sensitivity, they may be particularly vulnerable to this feeding practice.

While parent report of infant negative affectivity was not related to weight-for-length gain across infancy, observed irritability interacted with parent use of food to soothe but not in the expected direction. Whereas, the relationship between high irritability and weight-for-length change was not moderated by FTS, observed low irritability during the lab visit interacted with FTS to predict greater changes in weight-for-length. One explanation is that because of their low irritability, parents may not respond urgently to their cries, particularly if they were recently fed. Alternatively, given the high negative relationship between observed surgency and irritability, it may be that the majority of low irritable children were also those who were high in surgency, and thus this finding duplicates the significant interaction for observed surgency. Indeed, a post-hoc analysis of the interaction between irritability and FTS in predicting weight-for-length gain became non-significant when observed surgency was included in the model.

The present study has many strengths including the longitudinal study design, the use of both parent and observer ratings of temperament, and a measure of food to soothe that is less biased than traditional parent reports. However, these strengths must be considered alongside a few limitations. First, the use of FTS beyond the 3 days of data collection when infants were 6 months of age was not measured. Future research should consider measuring FTS longitudinally. Second, no information on the amounts or types of foods they used to soothe their infants' cries was assessed. The majority of the infants were on solid foods thus information on whether the foods were nutrient-dense or energy-dense may play a role in the association between temperament, FTS and weigh gain. In addition, the types of foods parents used to soothe infants, such as whether they used foods intended for meals, could have helped to further tease apart when parents used food in response to perceived hunger. Future studies should examine these possibilities. Finally, the demographics of the study sample limit the results generalizability of results to the larger population.

In summary, the findings of the present study indicate that infant temperament, particularly temperamental surgency, in the context of parent use of food to soothe, may contribute to changes in weight across the first two years of life. Infants rated as surgent by their parents and observers showed greater gain in weight-for-length if their parents used food to soothe. Acknowledging that child characteristics can evoke certain parent feeding behaviors that can put the child at risk for obesity will assist preventative interventions aimed at parent feeding practices in targeting specific populations (surgent infants) and identifying modifiable factors (FTS).

Acknowledgments

The study was supported by a grant from the NIDDK (DK081512) awarded to the first author. Support for the second author was provided in part by Agriculture and Food Research Initiative Grant no. 2011-67001-30117 from the USDA National Institute of Food and Agriculture, Childhood Obesity Prevention Challenge Area e A2121. The authors want to thank the families who participated in the study.

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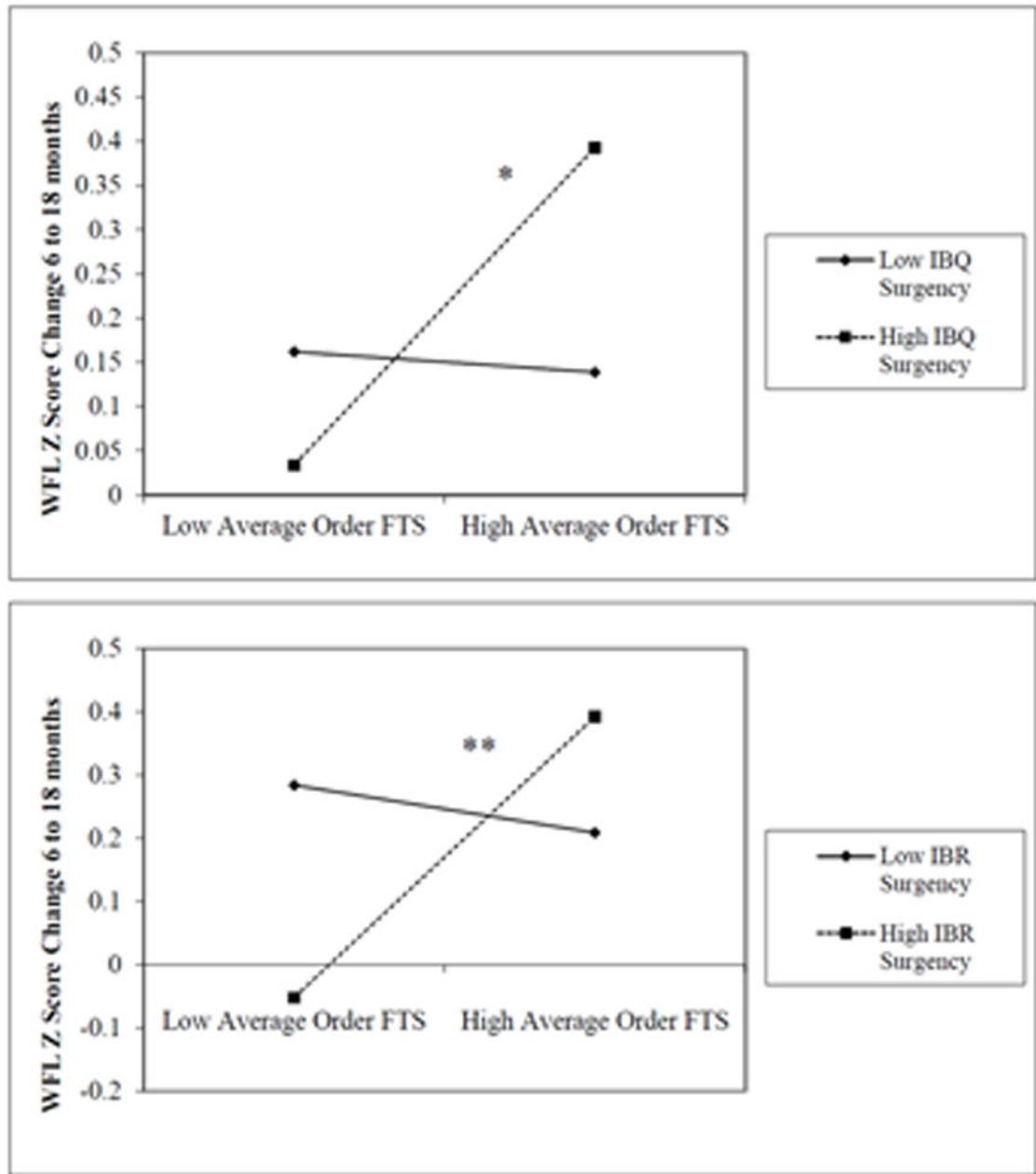


Figure 1. Interactions between parent-rated surgency (top) and observer-rated surgency (bottom) at 6 months and the use of food-to-soothe (FTS) predicting change in weight-for-length z-scores between 6 and 18 months. *Note.* ** $p < .01$, * $p < .05$.

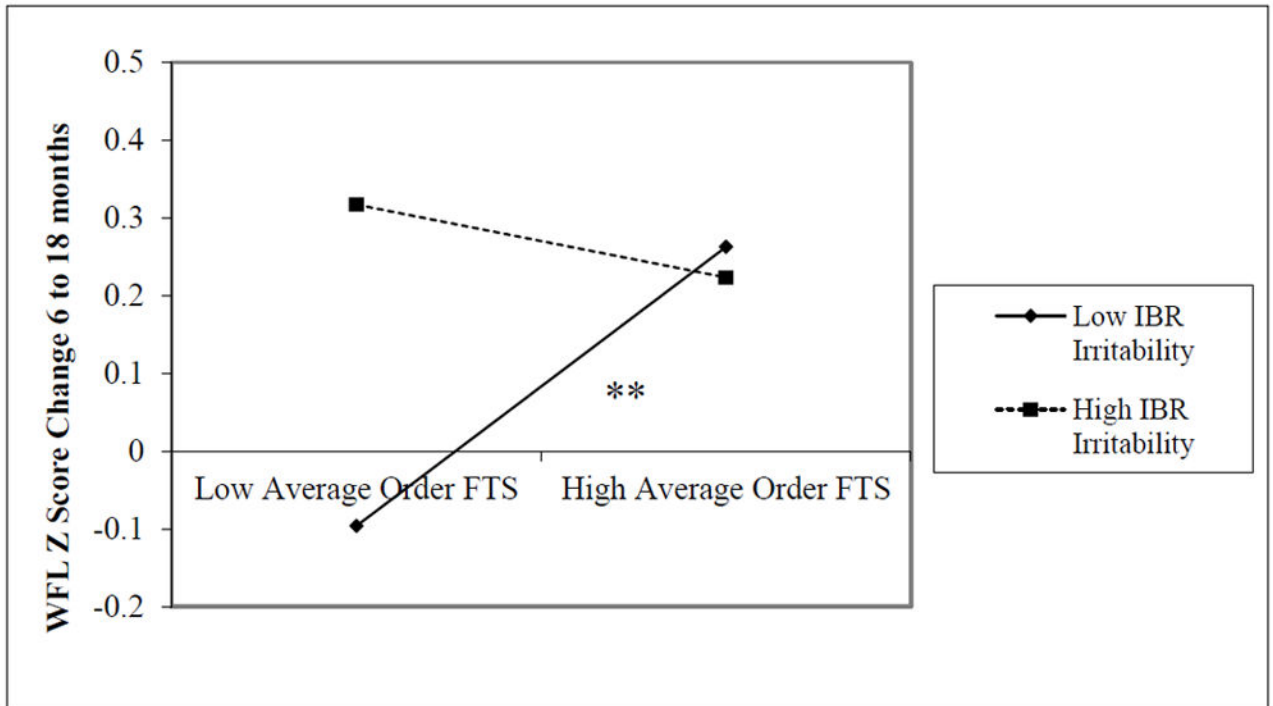


Figure 2. Interaction between observer-rated irritability at 6 months and the use of food-to-soothe (FTS) predicting change in weight-for-length z-scores between 6 and 18 months. *Note.* ** $p < .01$

Table 1

Descriptive Statistics for Covariates, Food to Soothe, Infant Temperament, and Infant Weight

	<i>M</i>	<i>SD</i>	<i>Min</i>	<i>Max</i>
<u>Covariates:</u>				
Birthweight (grams)	120.15	18.03	69.00	178.00
Duration of Breastfeeding (weeks)	23.49	20.59	0.00	50.00
Total Cries	20.79	9.84	3.00	50.00
<u>Food-to-Soothe:</u>				
Average Order FTS	1.90	.67	1.00	4.13
Mean FTS Interval (min)	189.45	67.25	67.85	400.70
<u>Infant Temperament:</u>				
Surgency- Parent-rated	4.78	.69	3.09	6.26
Negativity- Parent-rated	3.31	.66	1.79	5.84
Surgency- Observer-rated	5.76	1.14	2.00	8.33
Irritability- Observer-rated	4.92	1.00	2.50	7.50
<u>Infant Weight</u>				
WFL z-score Change 6 to 18 months	.17	.55	-1.20	2.33

Note. M = Mean, SD = Standard Deviation, FTS = Food-to-soothe, WFL = weight-for-length

Table 2
Correlations among Covariates, Food-to-Soothe, Infant Temperament, and Infant Weight

Variable	1	2	3	4	5	6	7	8	9	10
1. Birthweight	---	.10	.04	-.12	.02	.07	-.02	.25**	.02	-.17 ⁺
2. Duration of Breastfeeding		---	.10	.00	-.26**	-.30**	-.03	-.16 ⁺	.19*	-.16 ⁺
3. Total Cries			---	.24**	-.26**	-.18*	.33**	-.04	.03	.02
4. Average Order FTS				---	-.31**	-.12	.13	-.26**	-.02	.13
5. Mean FTS Interval					---	.20*	-.01	.04	.02	.10
6. Surgency- Parent-rated						---	.20*	.22**	-.13	.07
7. Negativity- Parent-rated							---	.02	-.01	-.12
8. Surgency- Observer-rated								---	-.50**	-.15 ⁺
9. Irritability- Observer-rated									---	.07
10. WFL z-score Change 6 to 18 months										---

⁺ $p < .10$,

* $p < .05$,

** $p < .01$

Table 3

Predicting Infant Weight Gain from Infant Temperament and Food to Soothe

	<i>B</i>	<i>SE(B)</i>	β	<i>F</i>	<i>R</i> ²
1. Surgency- Parent-rated					
Birthweight	-.01	.00	-.22*	2.62*	.12
Duration of Breastfeeding	.00	.00	-.14		
Total Cries	.00	.01	.04		
Parent-rated Surgency	.05	.08	.06		
Average Order FTS	.14	.08	.17+		
Parent-rated Surgency x FTS	.21	.10	.20*		
2. Negativity- Parent-rated					
Birthweight	-.01	.00	-.20*	2.33*	.11
Duration of Breastfeeding	-.01	.00	-.18*		
Total Cries	.01	.01	.09		
Parent-rated Negativity	-.15	.08	-.17+		
Average Order FTS	.10	.07	.12		
Parent-rated Negativity x FTS	-.03	.13	-.02		
3. Surgency- Observer-rated					
Birthweight	-.01	.00	-.17+	3.31**	.15
Duration of Breastfeeding	-.01	.00	-.17+		
Total Cries	.00	.01	.01		
Observer-rated Surgency	-.04	.05	-.07		
Average Order FTS	.14	.08	.17+		
Observer-rated Surgency x FTS	.17	.06	.26**		
4. Irritability- Observer-rated					
Birthweight	-.01	.00	-.16+	3.24**	.10
Duration of Breastfeeding	-.01	.00	-.20*		
Total Cries	.00	.01	-.01		

	<i>B</i>	<i>SE(B)</i>	β	<i>F</i>	<i>R</i> ²
Observer-rated Irritability	.09	.05	.18 ⁺		
Average Order FTS	.10	.07	.12		
Observer-rated Irritability x FTS	-.16	.06	-.25 ^{***}		

Note.

⁺ $p < .10$

* $p < .05$

*** $p < .01$