Mealtime interactions: the role of sensitive parental feeding behavior in the first years of life

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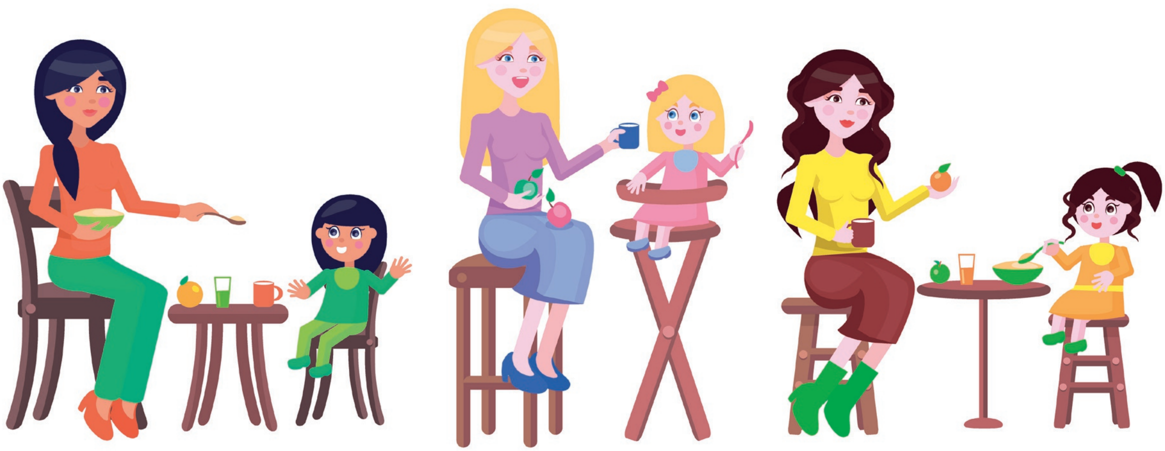

Chapter 3

Baby's first bites: Association between observed maternal feeding behavior and infant vegetable intake and liking

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Abstract

Positive experiences with the introduction of solid food in infancy may lead to positive associations with feeding in both parent and infant. During this transitional period, parental feeding behavior and infant eating behavior might mutually reinforce each other. A feeding style that is found to be associated with positive child eating behavior, is sensitive feeding. In the present study we tested bidirectional prospective relations between mother and infant behavior in a cross-lagged model using observations of two feeds on two consecutive days on which the first bites of solid food were offered. The sample consisted of 246 first-time mothers and their infants, whose feeding interactions were videotaped during two home visits. Maternal sensitive feeding behavior (consisting of responsiveness to child feeding cues, general sensitivity and non-intrusiveness) and maternal positive and negative affect were coded. In addition, infant vegetable intake was weighed and vegetable liking was reported by mother. Results showed at least some stability of maternal feeding behavior and infant vegetable intake and liking from the first to the second feed. In addition, during the second feed maternal sensitive feeding and positive affect were associated with infant vegetable intake (r=.34 and r=.14) and liking (r=.33 and r=.39). These associations were mostly absent during the first feed. Finally, infant vegetable liking during the first feed positively predicted maternal sensitive feeding behavior during the second feed (β=.25), suggesting that the infant's first response might influence maternal behavior. Taken together, mother and infant seem more attuned during the second feed than during the first feed. Future studies might include multiple observations over a longer time period, or micro-coding. Such insights can inform prevention programs focusing on optimizing feeding experiences during the weaning period.

Introduction

In the first year of an infant's life, the feeding process is a central feature of infant-caregiver interaction (Lindberg, Bohlin, & Hagekull, 1991). While the infant initially feeds solely on milk, after approximately 6 months this is no longer sufficient in terms of both energy and nutritional requirements (Butte et al., 2002; Reilly et al., 2005). In Western countries, the introduction of foods other than milk, i.e. the process of complementary feeding, generally starts around the age of 4-6 months. The first experiences with offering solid food can be challenging for parents, as they have to learn how to offer food other than milk, and to deal with new infant behavior at the same time (Van Dijk, Hunnius, & Van Geert, 2018). The first steps in this process might be particularly important, given that the foundation of how children relate to food and eating is formed during those very first experiences (Van Dijk, Van Voorthuizen, & Cox, 2012). This transitional period may be seen as a window of opportunity during which parents can influence eating behavior. Therefore, the present study focuses on observed maternal behavior (sensitive feeding and affect) when offering the infant his/her first bites of solid food (i.e., vegetable purées), and its bidirectional relation to infant intake and liking of those first bites.

Parents play a very important role in the process of complementary feeding, as they not only decide *what* foods to provide, but also *how* to feed their infant. The way parents feed children is suggested to impact children's eating behavior and related health outcomes, either positively, or negatively. For instance, pressuring children to eat was related to more pickiness in eating (Fisher, Mitchell, Smiciklas-Wright, & Birch, 2002; Galloway et al., 2006; Wardle, Carnell, & Cooke, 2005) as well as to eating in the absence of hunger (Costanzo & Woody, 1985; DiSantis et al., 2011; Hurley et al., 2011), and caused children to eat and like vegetables less (Galloway et al., 2006). In contrast, responsive feeding has been suggested to be the best way to feed young children. Definitions of responsive feeding vary widely, but the core principle is that parents who feed responsively, correctly perceive hunger and satiety signals of the infant during the feed, and respond promptly and appropriately to these signals (Disantis et al., 2011; Schwartz et al., 2011). Indeed, responsive feeding has been shown to relate to several beneficial health outcomes for young children, such as healthy eating behavior, and a healthy BMI (DiSantis et al., 2011; Lindsay et al., 2017; Spill et al., 2019). However, it has recently been suggested that responsive feeding might not be sufficient to promote outcomes such as healthy food preferences, because it mostly concerns how parents respond to signals of hunger and satiety, and not to other infant signals during the feed (Van der Veek et al., 2019). Alternatively, *sensitive feeding*, which broadens the concept of responsive feeding to incorporate sensitive parental responses to all infant cues during a feed, might be more effective in promoting healthy eating habits (Van der Veek et al., 2019). Sensitive feeding is based on Ainsworth's concept of parental sensitivity (Ainsworth et al., 1974) and includes understanding and anticipating the child's point of view, by sensitively responding to child signals of for example (dis)liking or rejection of food, distracted behavior, the wish to do things themselves (autonomy), or emotions in general. Such sensitive parental behavior is likely to foster a pleasant and safe atmosphere during mealtimes and may facilitate the child to associate eating with positive emotions, thereby encouraging young children's willingness to eat and try new (healthy) foods.

In addition to sensitive feeding, parental positive affect during mealtimes might also contribute to a positive atmosphere during a meal and thereby influence a child's eating behavior. Positive affect is not necessarily sensitive behavior, as it does not always include an appropriate response to child signals but rather is a general parental state (Mesman & Emmen, 2013). In the literature, parental affect indeed distinguishes from parental sensitivity, as it is found to be associated with different aspects of child behavior than sensitivity (Davidov & Grusec, 2006). With respect to feeding, high levels of parental positive affect (e.g., smiling, complimenting) may encourage children to eat or try something new, by showing them that it is safe to do so. In contrast, showing signs of negative affect (e.g., irritation, harshness) might signal unsafety to children, contributing to (even more) resistance when eating, or to the development of negative associations with eating in general. However, within the feeding context, little research has been done on parental affect, and studies that do exist were conducted with older children. These studies found that a positive affective atmosphere was indeed related to more positive child outcomes, such as a lower BMI in 8-12 year-olds (Berge et al., 2014; Rhee et al., 2016), and more healthy eating behavior in teens (Neumark-Sztainer, Wall, Story, & Fulkerson, 2006). Therefore, the present study will investigate maternal affect while feeding infants in addition to the concept of sensitive feeding, and how this relates to infant food intake and liking.

When studying parent-child interactions, it is important to take into account that parent and child behavior often, if not always, influence each other. Indeed, there is growing evidence that parent-child interactions within the feeding context are reciprocal, meaning that the child may influence parent behavior just as much as the parent might influence child behavior (Jansen et al., 2018; Skouteris et al., 2011). So far, cross-lagged model analyses have provided evidence for such bidirectional effects between parental feeding practices on the one hand, and child characteristics on the other hand, such as child appetite, BMI and fussy eating (Afonso et al., 2016; Fildes et al., 2015; Jansen et al., 2017; Webber et al., 2010). This is in line with the literature on other parenting constructs, as a large amount of evidence supports the idea of parent-child relationships being bidirectional (Newton, Laible, Carlo, Steele, & McGinley, 2014). Therefore, the present study will test bidirectional prospective relationships between mother and child behavior in a cross-lagged model using two feeds on two consecutive days.

In addition, the present study focuses on the stability of the investigated maternal and infant behaviors. Feeding an infant is a daily occurring situation for both parent and infant. Although parental behavior may vary from day to day due to all kinds of factors such as the parent's or the child's mood, many studies have shown some stability in parental behavior over time, both in short-term (Bornstein, Motti, Joan, Diane, & Haynes, 2006; Endendijk, Groeneveld, Dekovic, & Van den Boomen, 2019), and in the long term (Dallaire & Weinraub, 2005; Landry, Smith, Swank, Assel, & Vellet, 2001). However, according to dynamic system theory, systems in transitional periods are found to be extra vulnerable to contextual influences, which would lead to increased behavioral variability (Thelen & Smith, 1993). Performing behavior for the first time, such as during the first phase of complementary feeding, would lead to instability of the system. In the context of feeding, only a few studies have looked at the short-term stability of parental feeding behavior and infant eating behavior in the first year of life (Van Dijk et al., 2009; 2012; 2018). In those studies, more variability of behavior was found during the first two weeks of complementary feeding compared to later on, which was the case for infant food intake, as well as synchronization between mother and infant in terms of offering and accepting food. However, these studies did not examine the variability of maternal behavior on its own, and sample sizes were very small. Insights are relevant with respect to (reliable) measurement of early feeding situations, as well as for health professionals supporting parents in the first phase of complementary feeding.

In the present study, the following research questions are addressed: (1) Are maternal sensitive feeding behavior and maternal affect stable from the first to the second feed? (2) Are infant vegetable intake and liking stable from the first to the second feed? (3) Are maternal sensitive feeding behavior and maternal affect associated with infant vegetable intake and liking during the same feed? (4) Are maternal sensitive feeding behavior and maternal affect during the first feed predictive of infant vegetable intake and liking during the second feed? (5) Are infant vegetable intake and liking during the first feed predictive of maternal sensitive feeding behavior and maternal affect during the second feed? A visualization of the cross-lagged path model that will be tested, by evaluating the fit of the models, is depicted in Figure 1.

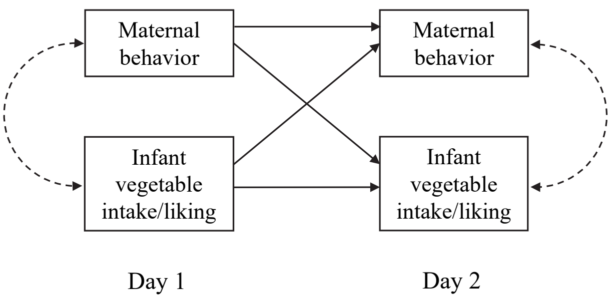


Figure 1. Diagram of the research questions.

Several characteristics of both mother and infant in earlier studies have been found to be related to either parental feeding practices, child vegetable intake, or both. Important examples are breastfeeding duration (DiSantis et al., 2013; Sullivan & Birch, 1994), maternal educational level (Cooke, Ingwersen, Vinyard, & Moshfegh, 2003; Vereecken, Keukelier, & Maes, 2004), child eating behavior (Cooke et al., 2006; Haycraft & Blissett, 2012), child BMI (Afonso et al., 2016; Jansen et al., 2014; Wardle & Carnell, 2007), and child temperament (Anzman-Frasca, Stifter, & Birch , 2012; Stifter, Anzman-Frasca, Birch, & Voegtline, 2011), which will all be taken into account as covariates when analyzing the data.

Method

Participants

The study included 246 first-time mothers and their infant. Mean age of the mothers was 31.0 years (*SD* = 4.7). Infants (48% boys) were between 17.3 and 27.7 weeks of age during the first home-visit (*Mean* = 20.3 weeks, *SD* = 1.9). With respect to highest achieved educational level, 41.6% of mothers had a lower educational level (finished high school or vocational school), 38.7% finished a degree comparable to a bachelor's degree and 19.8% obtained a master's degree. Up until the first home-visit at child age of 4-6 months, 57% of the mothers bottle-fed their infant, 23% breastfed their infant and 20% used a combination of breast and bottle feeding.

Procedure

The present study is part of a large longitudinal randomized controlled trial called Baby's first bites, in which one of the main goals is to enhance vegetable intake in infants (Van der Veek et al., 2019). The study was approved by the Ethics Review Board of the Institute of Education and Child Studies, Leiden University (ECPW-2015/116), as well as by the Medical Research Ethics Committee of Wageningen University and Research (NL54422.081.15). For the present study, pretest data were used. Participants were recruited from the general population in the four Dutch provinces close to the two participating universities. Information was sent to potential participants by email, using email addresses obtained from Nutricia Nederland B.V. (a company focussing on nutrition during the first years of life) and WIJ Special Media (a company focusing on pregnancy and the first years of life in general). In addition, only within the vicinity of Wageningen, brochures were handed out at youth health care centres. The following inclusion criteria had to be met: first-time mothers; healthy term infants (37-42 weeks of gestation); planning to start complementary feeding at child age of 4-6 months; sufficient knowledge of the Dutch language; willing to start complementary feeding with commercially available vegetable/fruit purées; willing to be videotaped. Mothers with major psychiatric diagnoses were excluded, as well as twins or children with medical problems that could influence their ability to eat. Further details about how participants were recruited can be found in the study protocol (Van der Veek et al., 2019). Both parents of the infants signed an informed consent form, unless the father did not live with the mother and did not have parental authority. If mothers were interested in the study, they received a short list of signals that might help them decide whether their infant was ready to start complementary feeding (e.g., "child can sit-up straight and stabilize head"; "child shows interest in your food"). As soon as mothers contacted the research team by e-mail or telephone to inform us their infant was ready, the first home visit was planned within two weeks. Prior to the first home visit, all mothers filled out online questionnaires, which assessed among other things child drinking behavior, child temperament, self-reported maternal feeding style, and maternal depression. In addition, they were instructed to give their infant rice-flour porridge with a spoon for 5-7 days prior to the first home visit (*Mean* = 6.5 days; *Median* = 7 days), in order to familiarize the infant with eating from a spoon. Subsequently, all mothers were asked to feed their infant pure-vegetable purée in commercially available jars (brand Olvarit) provided by the researchers, during two home visits on two consecutive days. All infants received cauliflower and green beans, in counterbalanced order. During the first home visit on Day 1, the mother was asked about some background characteristics such as educational level and whether she breast- or bottle fed her infant. In addition, during the first as well as the second home visit, a feeding interaction was videotaped, during which the mother was asked to feed the infant the vegetable purée. Finally, we recorded when the observed feed started, as well as when the mother had last offered a milk feed.

Measures

Maternal behavior during feeding. Feeding interactions were taped and coded from the beginning of the feed (first spoon offer) until the end (final spoon offer). The duration of the video was used as an indication of the duration of the feed, and was 8 minutes and 36 seconds at Day 1 (*SD* = 4m36), and 8 minutes and 49 seconds at Day 2 (*SD* = 5m01). Shortest video duration was 2 minutes and 10 seconds, the longest duration 35 minutes. The following aspects of maternal feeding behavior were coded: responsiveness to stop signals of the child, sensitivity, positive and negative affect. After intensive training, a reliability set of 30 videos was coded by all four coders, yielding intercoder reliabilities (intraclass correlations, single rater, absolute agreement) of > .70 for all scales between all individual coders (Cortina, 1993). For all 246 mother-infant pairs, videotaped feeding interactions of Day 1 and Day 2 were coded by the four coders. The coders were not familiar with the family they were coding. For the benefit of the large RCT where the scores of Day 1 and Day 2 will be combined, the two videos made of each family were scored by the same coder, with a few months in between coding Day 1 and Day 2. Also for the benefit of the RCT, we made sure that coders were blinded for group status of the family.

Responsiveness to infant's stop signals. This scale was based on the responsiveness to child fullness cues scale as described in the Responsiveness to Child Feeding Cues Scale coding instrument (RCFCS; (Hodges et al., 2013)). In the original scale, the responsiveness of the mother was based on her response to the fullness cues expressed by the child, taking into account the frequency and intensity of child fullness cues prior to the mother's decision to stop the feed. In essence, mothers that stop the feed in response to less intense and/or frequent child satiety cues, score higher on responsiveness. However, because our feeding interactions concerned the infant's very first bites, some adaptations had to be made to the original scale. A description of the scale we used can be found in Appendix I. The first adaptation we made, was broadening the content of the scale to infant stop signals in general, instead of labelling them as fullness cues. This was done because the feeding sessions concerned the very first bites, and most infants were only tasting a little without reaching satiety before they showed disinterest and stop signals. The second adaptation we made, was removing the frequencies of child satiety/stop signals as anchors for the scores. The various fullness cues as described by Hodges and colleagues were, in contrast to the original instrument, not coded separately, because this was not the objective for the current study, nor for the larger RCT. Instead, all coders were trained on recognizing the signals and on distinguishing them in terms of intensity. As in the original scale, maternal responsiveness was scored on a 5-point scale, ranging from highly unresponsive (1) to highly responsive (5). In other words, the decision of the mother to end the feed was scored as far too late (1), too late (2), slightly late (3), on time (4), or prompt (5). In case this maternal behavior could not be observed, for example when the child finished all the food without showing any stop signals, or the mother restricted the child from finishing all the food, mother was given a score of 9 (not applicable). Interrater reliability was good (ICC = .75 - .87).

Sensitivity. To rate maternal sensitivity towards all child behavior shown during the feed, the Ainsworth sensitivity scale was used (Ainsworth et al., 1974). Mothers were scored on the original 9-point scale, ranging from highly insensitive (1) to highly sensitive (9). The highly sensitive mother (9) "virtually always responds sensitively, with any lapses being small and extremely rare", while the highly insensitive mother (1) "responds insensitively almost all of the time, with sensitive responses being extremely rare or absent, gearing almost exclusively to her own wishes, moods, and activity." Examples of maternal insensitive behavior are not responding to infant signals of distress (serious lapses), or not responding to infant vocalizations or interest in surroundings (mild lapses). Interrater reliability was good (ICC = .73 - .85).

Non-intrusiveness. Maternal non-intrusiveness, which is the equivalent of the "interference-cooperation-scale" as defined by Ainsworth (Ainsworth et al., 1974), included the extent to which the mother did or did not interfere with the child's signals or behavior. Again, mothers were scored on the original 9-point scale, ranging from highly intrusive (1) to highly non-intrusive (9). The highly *non*-intrusive mother (9) "Never interferes with the child's behaviors or intentions unnecessarily and lets child lead the interaction", while the highly intrusive mother (1) "Almost continuously interferes with the child's behaviors or intentions unnecessarily, while the child virtually never gets room to lead the interaction". Examples of maternal intrusive behavior are physical or forceful interruptions or restraints (serious lapses), or redirecting the child's attention towards mother when exploring surroundings (mild lapses). Interrater reliability was good (ICC = .73 - .90).

Positive Affect. This scale was developed using several maternal affect scales that have been widely used in different contexts (Miller et al., 2002) as a basis. Both verbal (e.g., compliments) and non-verbal (e.g., smiling, caressing) expressions were included to score maternal positive affect. Positive affect was scored on a 5-point scale, ranging from no positivity towards the child at all (1) to positivity in almost the entire video (5). Interrater reliability was good (ICC = .73 - .92).

Negative Affect. This scale was developed using several maternal affect scales that have been widely used in different contexts (Miller, McDonough, Rosenblum, & Sameroff, 2002) as a basis. Both verbal (e.g., name-calling, punishing) and non-verbal (e.g., irritated, harsh behavior) expressions were included to score maternal negative affect, which was scored on a 5-point scale, ranging from no negativity towards the child at all (1) to negativity throughout almost the entire interaction (5). Interrater reliability was good (ICC = .72 - .92).

Vegetable intake. During the two feeds on Day 1 and Day 2, all infants received cauliflower during one feed and green beans during the other, in counterbalanced order. Commercially available jars (125 gr, brand Olvarit) were provided, and the mother was allowed to either feed from the jar or put the purée in a bowl. In order to measure infant vegetable intake, the jar/tray was weighed before and after the feed using a standard small kitchen scale (Soehnle, Fiesta 65106). In order to limit error, next to the jar and/or bowl, the spoon, bib and cloth the parent used to clean the child were weighed before and after as well. Before the feed was about to start, the mother was told the duration of the feed was entirely up to her and that she should act as she would normally do, in order to make sure the feeding interaction occurred as natural as possible. In order to facilitate this, the researcher stayed out of sight as well. The weight in grams before and after the feed was written down and the mean difference was calculated, to one decimal point. In case some purée was spilled (e.g., fell on the floor while feeding), the mother was asked to use the cloth that was about to be weighed to wipe it clean. In addition, the mother was asked not to take any bites from the purée herself.

Vegetable liking. The procedure to assess vegetable liking followed the procedure used by Barends and colleagues (Barends et al., 2013). At the end of each feeding session, the mother was asked how much she thought the infant liked the food, by means of a 9-point scale ranging from 1 (dislikes very much) to 9 (likes very much).

Covariates

The models were adjusted for theoretically relevant mother and child characteristics (assessed before the first home-visit) that were significantly related to either maternal behavior or infant vegetable intake/liking. The following factors were adjusted for: maternal age, the number of weeks the mother breastfed the infant, maternal educational level, child age, gender, temperament (distress to limitations; IBQ-R; (Putnam et al., 2014)), child eating behavior with respect to breastmilk and/or formula intake (food responsiveness, satiety responsiveness, slowness in eating, enjoyment of food; BEBQ; (Llewellyn et al., 2011)), place of study (Leiden or Wageningen), whether the child's behavior during the home-visit in general was representative or not according to the mother, the degree of alertness of the child during the home visit, and which vegetable (cauliflower or green beans) was offered. Representativeness of child behavior, child alertness, and type of vegetable were added to the models twice: for Day 1 as well as Day 2. The number of hours the child had not eaten prior to the observed feed, maternal depression, maternal age, child age, maternal BMI, child BMI, and other child temperamental factors were not related to core variables and therefore not corrected for.

Statistical analysis

Hypotheses were specified before the data were analyzed and the analysis plan was pre-specified. Any data-driven analyses will be clearly identified and discussed appropriately.

Bivariate associations between all variables were assessed by means of Pearson's correlations. Subsequently, structural equation models (SEMs) with robust standard errors were estimated to evaluate the parameters in a cross-lagged model (Hom & Griffeth, 1991). Because some cases missed values on certain variables (e.g., 7 cases were not observed on Day 2), restricted full information maximum likelihood (FIML) was used to estimate model parameters using the maximum available pairwise data for each association (Enders & Bandalos, 2001). Two separate models were tested: one for the outcome Vegetable Intake, and one for the outcome Vegetable Liking. In both models the latent predictor "Sensitive Feeding" was used, defined by linear contributions of Responsiveness to stop signals (Responsiveness), Sensitivity and Non-Intrusiveness. In addition, Positive Affect and Negative Affect were tested as separate predictors of the two outcome measures, resulting in six models in total. All variables and models were corrected a priori for the time-specific covariates described earlier, by computing residualized scores before entering them into the model. Because residualized scores (artificially) reduce the model degrees of freedom, all models were evaluated with df-corrected fit indices (Zimmerman, 2007). All models were evaluated with and without covariates. In case any differences arose in terms of results, those were reported in the results section. The fit of the models was considered acceptable-to-good if the comparative fit index (CFI) was >.90 and the root mean square error of approximation (RMSEA) was <.08 (Browne & Cudeck, 1992). Finally, following Feingold (Feingold, 2015), Cohen's *d* effect sizes were obtained and reported for all models by rescaling the path coefficients for the standard error of the estimate (beta). Values of .20, .50 and .80 were considered a small, moderate and large effect, respectively (Cohen, 1992). With respect to correlations calculated between mother and child behavior within the same day, .10, .30 and .50 were used as cut-offs for a small, moderate and large correlation, respectively (Evans, 1996). Analyses were performed using SPSS version 25 and the lavaan package 0.6-5 in R version 3.6.2.

Results

Preliminary analyses

Descriptives of all variables are depicted in Table 1. Observational data was available for all 246 mothers on Day 1. For 7 mothers no observational data was present on Day 2, due to various reasons (i.e., technical problems with the camera, child had already eaten before the visit took place, father fed the child because the mother was absent). With respect to the variable Responsiveness to infant's stop signals, 21 and 23 out of 246 mothers had missing data on Day 1 and Day 2, respectively, because the mothers' responsiveness could not be judged during those observations (score 9). With respect to Vegetable Intake, 1 mother had a missing value on Day 2, because the child had already eaten before the home visit took place. Finally, another 10 values on Vegetable Liking were missing on both Day 1 and Day 2, because the mother did not write down the liking score. Skewness was indicated in some instances, however because a) the sample size ($N = 246$) was large, b) robust standard errors were used when estimating the models, and c) multivariate correction took place for all models, skewness of variables and outliers were not considered problematic in terms of assumptions and interpretation of outcomes. The only exception was Negative Affect, as this variable was extremely positively skewed due to only a very small number of scores >1. Therefore, this variable was dichotomized for both Day 1 and Day 2 (0 = no negativity, 1 = at least some negativity). Although Positive Affect and Vegetable Intake were also (negatively) skewed, it was decided not to dichotomize these variables, as this skewness was much less severe. Finally, Pearson's correlations were calculated, as depicted in Table 2. With respect to assumptions, no multicollinearity was present, and residual distributions did not reveal significant deviations from normality.

Table 1. Descriptive statistics.

Variable	Day 1			Day 2		
	N	M (*SD*)	Range	N	M (*SD*)	Range
Responsiveness to stop signals	225	3.47 (*1.31*)	1-5	216	3.47 (*1.31*)	1-5
Sensitivity	246	6.18 (*1.85*)	2-9	239	6.18 (*1.85*)	1-9
Intrusiveness	246	5.99 (*1.94*)	1-9	239	6.00 (*1.93*)	1-9
Positive Affect	246	4.45 (*0.83*)	2-5	239	4.41 (*0.83*)	2-5
Negative Affect	246	1.27 (*0.61*)	1-4	239	1.31 (*0.63*)	1-4
Infant vegetable intake	246	22.95 (*23.53*)	1-124	245	24.95 (*26.11*)	1-126
Infant vegetable liking	236	5.68 (*1.72*)	1-9	235	5.56 (*1.89*)	1-9

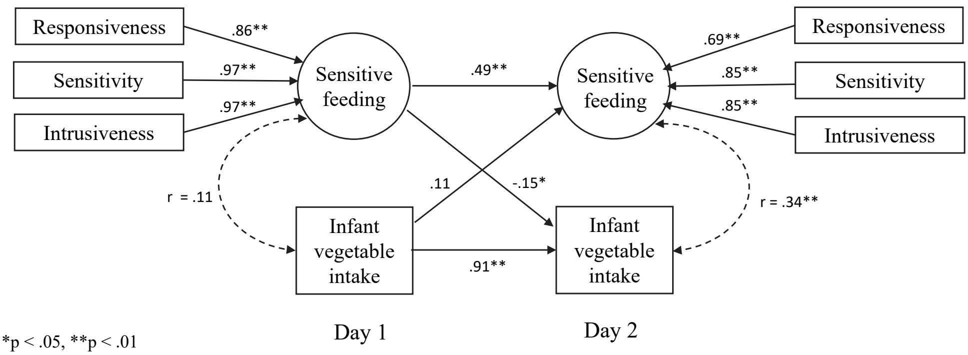
Table 2. Pearsons correlations between all variables.

	1	2	3	4	5	6	7	8	9	10	11	12	13
1. Intake^{D1}	-												
2. Intake^{D2}	.67**	-											
3. Liking^{D1}	.50**	.37**	-										
4. Liking ^{D2}	24**	.47**	.44**	-									
5. Responsiveness ^{D1}	.07	-.06	.24**	.07	-								
6. Sensitivity ^{D1}	.08	-.01	.26**	.09	.83**	-							
7. Intrusiveness ^{D1}	.07	-.03	.24**	.09	.83**	.93**	-						
8. Positive Affect ^{D1}	-.06	-.03	.10	.07	.44**	.67**	.61**	-					
9. Negative Affect ^{D1}	.15*	.10	.07	-.05	-.27**	-.43**	-.42**	-.63**	-				
10. Responsiveness ^{D2}	.05	.14*	.22**	.29**	.33**	.26**	.26**	.07	-.07	-			
11. Sensitivity ^{D2}	.07	.20**	.28**	.37**	.36**	.45**	.43**	.37**	.23**	.75**	-		
12. Intrusiveness ^{D2}	.06	.21**	.27**	.37**	.35**	.38**	.39**	.23**	-.20**	.75**	.92**	-	
13. Positive Affect ^{D2}	-.12	.04	.14*	.26**	.15*	.29**	.27**	.50**	-.38**	.29**	.63**	.53**	-
14. Negative Affect ^{D2}	.14*	.04	-.02	-.24**	-.18*	-.27**	-.29**	-.31**	.37**	-.34**	-.55**	-.53**	-.70**

Note. *p < .05; ** p < .01. ^{D1} = Day 1, ^{D2} = Day 2. Responsiveness = Responsiveness to stop signals.

Main analyses

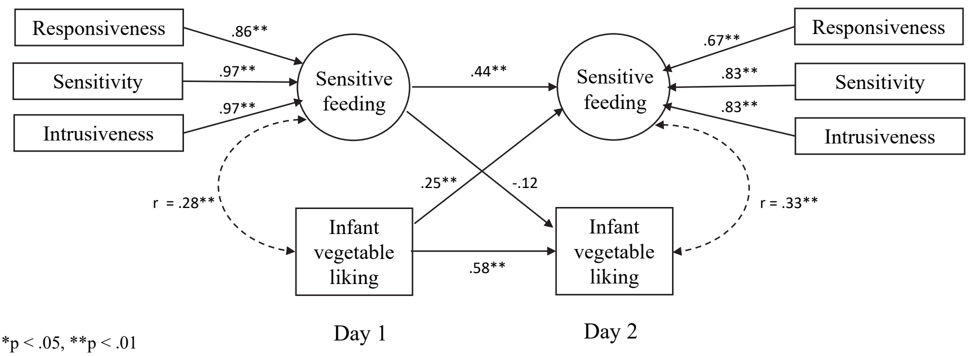
Sensitive Feeding and Vegetable Intake. The model had a good fit (Table 3) and is shown in Figure 2. Sensitivity and Intrusiveness fitted slightly better on the latent variable Sensitive Feeding compared to Responsiveness to stop signals on both measurement days, although all three variables showed high factor loadings. First, Sensitive Feeding on Day 1 predicted Sensitive Feeding on Day 2, by showing a small to moderate positive association (d = .40). Second, a small to moderate amount of stability was found for Vegetable Intake (d = .47). Third, a moderate correlation was found between Sensitive Feeding and Vegetable Intake, but only on Day 2. Fourth, Sensitive Feeding on Day 1 showed a small but significant negative association with Vegetable Intake on Day 2 (d = -.14). However, this association was not present in the model without covariate correction, nor was there a significant correlation between the three separate concepts gathered under the construct Sensitive Feeding on Day 1 on the one hand, and Vegetable Intake on Day 2 on the other hand (Table 2). Finally, Vegetable Intake on Day 1 was not found to be associated with Sensitive Feeding on Day 2.



*p < .05, **p < .01

Figure 2. SEM Sensitive feeding and infant vegetable intake.

Sensitive Feeding and Vegetable Liking. The model had a good fit (Table 3) and is shown in Figure 3. Again, Sensitive Feeding on Day 1 predicted Sensitive Feeding on Day 2, by showing a small to moderate positive association (*d* = .34). Second, a moderate to large amount of stability was found for Vegetable Liking, from Day 1 to Day 2 (*d* = .51). Third, moderate positive correlations were found between Sensitive Feeding and Vegetable Liking on both Day 1 and Day 2. Fourth, Sensitive Feeding on Day 1 was not found to be related to Vegetable Liking on Day 2. Finally, Vegetable Liking on Day 1 predicted Sensitive Feeding on Day 2, by showing a small positive association (*d* = .20).



*p < .05, **p < .01

Figure 3. SEM Sensitive feeding and infant vegetable liking.

Maternal affect

With respect to the four models considering maternal affect (positive and negative affect), the first model fit resulted in four fully satiated models (RMSEA = 0.00, CFI = 1.00). To prevent overfitting, the (four) intercept parameters were not estimated, but fixed to a value of 0. As the actual estimations of the intercepts in these models were all close to 0, no loss of fit was detected: the range and maximum of the residuals were equivalent to those from the non-fixed models.

Positive Affect and Vegetable Intake. The model had an adequate fit, with a RMSEA score that was slightly too high (.10) and an adequate CFI score (.90; Table 3), and is shown in Figure 4. First, Positive Affect on Day 1 predicted Positive Affect on Day 2, by showing a small to moderate positive association (*d* = .43). Again, a small to moderate amount of stability was found for Vegetable Intake, from Day 1 to Day 2 (*d* = .47). Third, a small positive correlation was found between Positive Affect and Vegetable Intake, but only on Day 2. Finally, neither cross-over path was significant, indicating that Positive Affect on Day 1 did not predict Vegetable Intake on Day 2, and Vegetable Intake on Day 1 did not predict Positive Affect on Day 2.

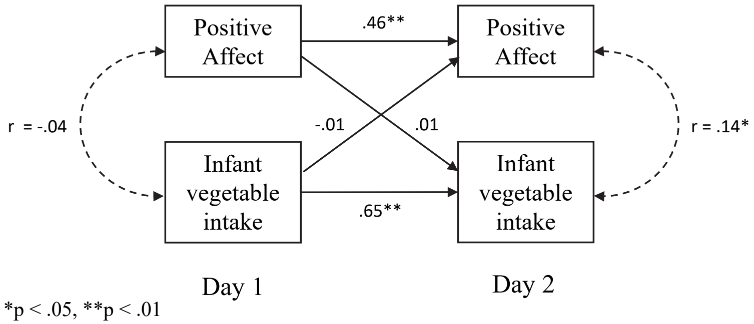


Figure 4. SEM Positive affect and infant vegetable intake.

Positive Affect and Vegetable Liking. The model had a good fit (Table 3) and is shown in Figure 5. First, Positive Affect on Day 1 predicted Positive Affect on Day 2, by showing a small to moderate positive association (*d* = .43). Second, a moderate to large amount of stability was found for Vegetable Liking, from Day 1 to Day 2 (*d* = .55). Third, a small positive correlation was found between Positive Affect and Vegetable Liking, but only on Day 2. Finally, neither cross-over path was significant, indicating that Positive Affect on Day 1 did not predict Vegetable Liking on Day 2, and Vegetable Liking on Day 1 did not predict Positive Affect on Day 2.

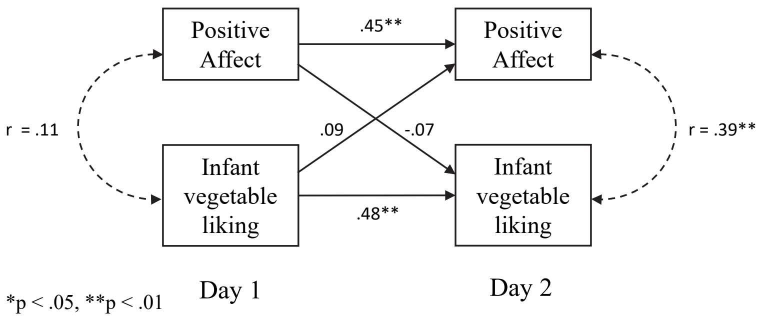


Figure 5. SEM Positive affect and infant vegetable liking.

Negative Affect and Vegetable Intake. The model had an adequate fit (Table 3) and is shown in Figure 6. First, Negative Affect on Day 1 predicted Negative Affect on Day 2, by showing a small positive association (*d* = .19). Second, a small to moderate amount of stability was found for Vegetable Intake, from Day 1 to Day 2 (*d* = .46). Finally, no associations were found between Negative Affect and Vegetable Intake.

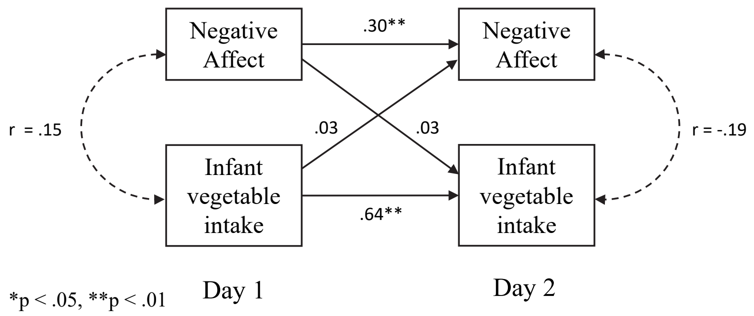


Figure 6. SEM Negative affect and infant vegetable intake.

Negative Affect and Vegetable Liking. The model had a good fit (Table 3) and is shown in Figure 7. First, Negative Affect on Day 1 predicted Negative Affect on Day 2, by showing a small positive association (*d* = .21). Second, a moderate to large amount of stability was found for Vegetable Liking, from Day 1 to Day 2 (*d* = .55). Third, a small negative correlation was found between Negative Affect and Vegetable Liking, but only on Day 2. Finally, neither cross-over path was significant, indicating that Negative Affect on Day 1 did not predict Vegetable Liking on Day 2, and Vegetable Liking on Day 1 did not predict Negative Affect on Day 2.

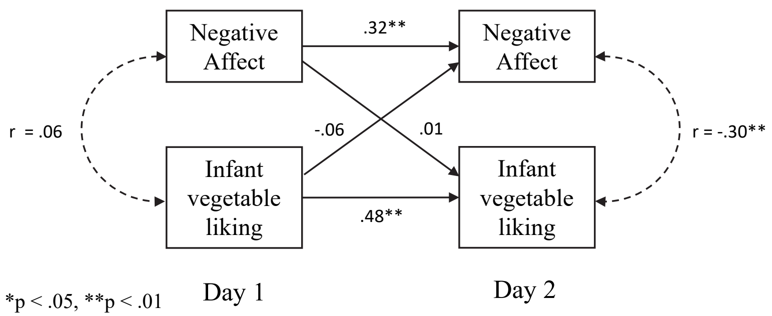


Figure 7. SEM Negative affect and infant vegetable liking.

Discussion

The present study is the first to show that maternal behavior during feeding is associated with infant vegetable intake and liking of the very first bites of solid food. Moreover, some stability was found from the first feed to the second feed one day later, with respect to both maternal behavior and infant vegetable intake and liking.

With respect to stability of maternal behavior, small to moderate associations were found from the first to the second feed, for all maternal behaviors, indicating at least some stability for sensitive feeding as well as affect. Other studies measuring observed maternal sensitivity show similar results, although associations were usually somewhat stronger (Bornstein et al., 2006; Endendijk et al., 2019). Our findings of lower stability are in line with the effects of transitional periods as described in dynamic system theory, as a lack of routine probably leads to more behavioral variation between the two observations (Thelen & Smith, 1993). Studies of Van Dijk et al. looking at synchronization of mother and infant behavior during feeding confirm this idea as well, as they found less synchronization to be present between mother and infant in the early stage of complementary feeding compared to feeds later on (Van Dijk et al., 2012; 2018). The two-day stabilities of sensitive feeding and positive affect were quite similar in our study, but for maternal negative affect less stability was found. This might be an emotional state even more dependent on situational factors (such as a child not willing to eat, or parent or child being tired) compared to the other measures.

With respect to both vegetable intake and liking, moderate to strong stability was found from the first to the second feed. These findings are in line with other studies conducted in older children (Moore et al., 2005), although stability in our study was somewhat weaker than in those studies. However, our results are not in line with the findings by Van Dijk and colleagues (Van Dijk et al., 2009), where a lot less stability (i.e., higher variability) was found during the first bites. An explanation could be that their measurements were performed on several days within two weeks time, while ours were performed on two consecutive days, possibly leading to less "noise" between our measurements. Finally, vegetable intake was found to be more stable than mother-reported vegetable liking. This might be explained by the subjective nature of our liking measure. Compared to our concrete measure of vegetable intake, the mother's estimate of the child's appreciation of the taste might be more sensitive to other factors, such as the child's general facial expressions or mood, or maternal characteristics (e.g., optimism vs. pessimism, quality of reflective functioning, her own appreciation of the particular vegetable).

In addition to the stability found for maternal and child behavior, significant associations between maternal feeding behavior and infant vegetable intake and liking were found.

Notably this was often only the case on Day 2, while on Day 1 very few significant associations were found. An explanation for this might be that mother and infant behavior during this very first feed on Day 1 fluctuated even more than on Day 2, when the dyad already had one previous experience to build upon. However, standard deviations of Day 1 and Day 2 were similar. A more likely explanation, therefore, seems to be that mother and infant were indeed more attuned during the second feed, compared to the first feed, which is in line with findings of Van Dijk and colleagues of increased synchronization of mother and infant in the first few weeks (Van Dijk et al., 2012; 2018). Associations with infant vegetable intake and liking were consistent for sensitive feeding as well as affect: the more sensitively and positively and the less negatively the infant was fed by the mother, the more grams of vegetables s(he) consumed and the more signs of liking the food were noticed by the mother. One explanation might be that infants feel more safe and comfortable in a positive atmosphere where the mother responds to their needs, for example in terms of pacing, empathy, sharing emotions, and are therefore more willing to keep eating and are expressing more joy during the feed. However, it might also be that it is easier for a mother to be positive and respond sensitively to an infant who is actively eating while showing enjoyment, compared to an infant who responds less positively to the food. It is likely that the more enthusiastically the infant accepts the vegetables, the more relaxed and happy the mother might feel during concurrent and future feeds, which could positively influence the way she responds to her infant's cues.

The significant cross-over effect found in this study implies this latter direction of effect. Infant vegetable liking on the first day was found to significantly relate to higher rates of maternal sensitive feeding on the second day. Vegetable liking was mother-reported and entirely reflected her perception of the feed. This underlines the suggestion that a positive feeding experience during the first feed might influence the mother's behavior during the second feed, by making her more willing or eager to attune to the infant's needs, or in case the feeding experience was negative, nervous or tense and therefore less capable to attune. Child behavior predicting parental behavior during feeding, instead of the other way around, is something that was found in some other studies as well. For example, in a large twin study in the UK, evidence was found for the influence of infant weight and infant appetite on parental feeding behavior (Fildes et al., 2015; Van Jaarsveld, Johnson, Llewellyn, & Wardle, 2010). It is noteworthy that the present study only found some support for the idea that infant behavior might influence maternal behavior, and none for the possible influence of maternal behavior on infant behavior during feeding. Many studies emphasize the path from parental to child behavior more than the other way around, but this study underlines the importance of taking bi-directionality into account when studying feeding interactions.

Another less expected small negative cross-over effect was found from maternal sensitive feeding on Day 1 to infant vegetable intake on Day 2. However, because this negative association, contrary to the significant effects in all other models, was entirely absent without covariate correction and absent in correlations with the three single components of our sensitive feeding construct, it is likely to be a spurious effect and too unstable to interpret. The other cross-overs that were tested were not significant. To be able to study possible cross-over effects more extensively, future studies might include more feeding interactions than just two, possibly leaving some more time in between. Another possibility is studying the interaction in even more detail, for example using a micro-coding system as described in the studies of Van Dijk and colleagues (Van Dijk et al., 2009, 2012; 2018). In those studies co-regulation during feeding was studied by coding all maternal and infant behavior using a time-series analysis technique, but sample sizes were small and no associations with child characteristics were examined.

With respect to the latent construct sensitive feeding, responsiveness to infant stop signals, general maternal sensitivity and maternal non-intrusiveness all fitted nicely into the overarching construct. High factor loadings on our construct of sensitive feeding underline that responsive feeding might involve more than is generally measured, and supports the suggestion that it might be better to broaden the construct to *sensitive* feeding (Van der Veek et al., 2019). Such a broader construct is more in line with Ainsworth's concept of parental sensitivity (Ainsworth et al., 1974) and entails responding to all kinds of child signals during the feed, which is likely needed to create a feeding situation where the child feels safe and understood in general and is even more equipped to form a positive association with family mealtimes and (healthy) food.

Strengths and limitations

Strengths of the present study include the focus on the first bites of solid food, studying bidirectional relationships, and the use of video observations. With respect to the latter, most studies use self-report measures to assess parental feeding behaviors. However, video observations might capture parental behaviors that would not be captured by means of self-report measures, because self-reports may more readily measure what parents think they are doing or even what they think they should be doing (i.e. attitudes) than actual behavior (Hodges et al., 2013).

The present study has several limitations that should be mentioned as well. First, no conclusions on cause and effect can be drawn as we did not employ an experimental design. Second, the observations of Day 1 and Day 2 were coded by the same coder, for the purposes of the larger study. Although coding of the two days occurred with at least two months in between, the coder might have recognized some families when coding them for the second time, which may have inflated estimates of stability somewhat. Third, infant vegetable liking was measured by means of mother-reports. It would have been useful to also have an observed measure of this concept. However, results of vegetable liking were quite similar to results of vegetable intake, suggesting the validity of the self-report measure of liking. In addition, generalizability of the results is somewhat limited because a) the study only concerned mothers, b) participants had to be willing to start complementary feeding with jarred purées, and c) the majority of our participants was Caucasian and highly educated. Future studies should aim to include a more diverse sample (e.g., fathers, more families with a lower socioeconomic status).

Conclusion

In conclusion, the present study observed interactions in the earliest phase of complementary feeding. Results show at least some stability of all measured constructs of both mother and child behavior from the first to the second feed. In addition, sensitive and positive maternal feeding behavior was found to be positively associated with both infant vegetable intake and liking, mostly during the second feed, suggesting increased synchronization of the dyad. Finally, infant vegetable liking was found to predict maternal sensitive feeding from one day to the next. As such, our results point out that it is important to take bi-directionality into account when studying parent-infant interactions during feeding, and not to merely assume that parental behavior will influence child behavior. Future research should further explore whether and how feeding experiences of both parent and infant mutually reinforce each other during this first phase of complementary feeding and if this actually affects child eating behavior in the long run, for example by observing repeatedly and for a longer period of time, or by using micro-coding. Such insights are relevant for prevention efforts trying to improve maternal sensitive feeding, because these will only be effective if maternal sensitive feeding indeed positively influences child eating behavior. When positive experiences are created during the very beginning, they are likely to set the tone for future feeding interactions, enabling children to develop healthy eating habits and behaviors.