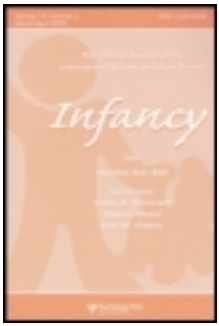

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The Mother-Infant Feeding Relationship Across the First Year and the Development of Feeding Difficulties in Low-Risk Premature Infants

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Although feeding problems are common during infancy and are typically accompanied by relational difficulties, little research observed the mother–infant feeding relationship across the first year as an antecedent to the development of feeding difficulties. We followed 76 low-risk premature infants and their mothers from the transition

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to oral feeding in the neonatal period to the end of the first year. Prior to hospital discharge, microlevel patterns of maternal touch and gaze were coded during feeding and nonfeeding interactions, global patterns of maternal adaptation were assessed, and infants' neurobehavioral status was tested. Psychomotor development was evaluated at 4 months. At 1 year, feeding difficulties were determined on the basis of maternal interview and direct observations of feeding interactions. Mothers of infants who exhibited feeding difficulties at 1 year showed less affectionate touch and gaze during nonfeeding interactions and more gaze aversion and lower adaptability during feeding interactions already in the neonatal period. Infants with feeding difficulties demonstrated poorer psychomotor performance at 4 months. Feeding interactions of infants with feeding difficulties at 1 year were characterized by higher maternal intrusiveness, lower infant involvement, and greater infant withdrawal. Less maternal affectionate touch and lower maternal adaptation in the neonatal period, poor infant psychomotor skills, and higher maternal intrusiveness and lower infant involvement at 1 year predicted feeding difficulties. The findings underscore the role of the relational components across the first year in the development of feeding difficulties.

During the first years of life, relational exchanges between mothers and infants revolve mainly around caregiving. Feeding, a life-sustaining function that is critical for growth and survival, provides a central context for the development of the dyadic relationship (Chatoor et al., 1997; Satter, 1990). Specific difficulties in the mother–child relationship, therefore, are likely to be especially noted during feeding and to result in the development of infant feeding problems (Chatoor, 2000). Yet, although research has noted that feeding difficulties in infancy tend to persist over time (Benoit, 2000) and are more common among premature infants (Thoyre, 2007), very few studies focused on the mother–infant feeding relationship across the first year by using direct observations of feeding interactions and examined these relational patterns as antecedents to the development of feeding problems.

THE RELATIONAL BASIS OF FEEDING DIFFICULTIES

It has been suggested that disruptions in the mother–infant relationship contribute to the development of feeding difficulties (Skuse, Gill, Reilly, Wolke, & Lynch, 1995). Chatoor (2000) coined the term feeding relationship to highlight the dyadic nature of feeding problems and the importance of utilizing direct observations of feeding interactions. Several authors have advocated a transactional approach to the study of feeding problems in infancy and suggested that infant biological dispositions and maternal controlling-intrusive feeding behavior influence each other in a reciprocal manner, leading to the deterioration of the feeding relationship (Benoit, Madigan, Lecce, Shea, & Goldberg, 2001; Chatoor, 2000; Feldman, Keren, Gross-Rozval, & Tyano, 2004; Hagekull, Bohlin, & Rydell, 1997). Interac-

tions between mothers and infants with feeding problems have been characterized by higher maternal intrusiveness (Feldman, Keren, et al., 2004), less maternal sensitivity (Hagekull et al., 1997), more infant negativity and withdrawal (Polan et al., 1991; Sanders, Patel, LeGrice, & Shepherd, 1993), and struggle for control (Chatoor, 2000; Wolke, Skuse, & Mathisen, 1990). These negative relational patterns were observed during feeding and nonfeeding interactions in children exhibiting both minor feeding difficulties and feeding disorders of infancy, pointing to the need to examine the mother–child feeding relationship in cases of infant feeding difficulties.

TOUCH, GAZE, AND THE FEEDING RELATIONSHIP

During the first months of life, mother–infant interactions involve physical closeness expressed through nonverbal cues, such as touch, gaze, gestures, and vocalizations (Feldman, 2007). Physical contact and proximity-seeking are central components of the attachment system and provide the foundation for the individual's sense of security throughout life (Bowlby, 1969). Since the early descriptions of infants who failed to thrive as a result of maternal touch deprivation (Spitz, 1945), relations between maternal touch patterns and infant physical growth and feeding difficulties have been suggested. Infant failure to thrive has been associated with less maternal physical closeness (Pollit, Eichler, & Chan, 1975) and less matter-of-fact touch during feeding (Polan & Ward, 1994). Furthermore, mothers of infants diagnosed with feeding disorders were found to provide less affectionate (i.e., nurturing and gentle types of touch, such as caressing, stroking, or kissing), proprioceptive (i.e., changing the infant's position in space or flexion-extension of the infant's limbs), and unintentional (i.e., accidental physical contact, such as brushing against child) touch to their infants and tend to position the infant out of the mother's arms' reach (Feldman, Keren, et al., 2004).

The relations between touch and physical growth have been studied primarily in the context of prematurity. During the first weeks of life, premature infants are deprived of the mothers' bodily contact, are exposed to aversive types of touch, and have difficulty regulating tactile stimulation (Als, 1986; Weiss, Wilson, Hertenstein, & Campos, 2000). Structured touch therapies, such as massage stroking and proprioceptive stimulation, were found to result in quicker weight gain (T. Field, 1995). Similarly, skin-to-skin contact (kangaroo care) has been shown to enhance the mother's affectionate touch during interactions in both the neonatal period (Feldman, Eidelman, Sirota, & Weller, 2002) and at 3 months postdischarge (Feldman, Weller, Eidelman, & Sirota, 2003), and to improve growth rates in preterm infants (Ludington-Hoe & Swinth, 1996). More maternal affectionate

touch in the postbirth period, in turn, contributed to cognitive and neurobehavioral outcomes in premature infants (Feldman & Eidelman, 2003).

Mutual gazing is a salient feature of the mother–infant relational system during the first months of life (Messer & Vietze, 1984). Gaze synchrony, the cooccurrence of social gaze between mother and child during interactions, has been shown to predict infant attachment behavior at 1 year and lower behavior problems at 2 years (Feldman & Eidelman, 2004) and is considered a critical experience for the maturation of brain networks that support social development (Johnson et al., 2005). Yet, little is known about the impact of maternal gaze during early feeding on long-term feeding outcomes.

PREMATURITY AND EARLY FEEDING DIFFICULTIES

Adequate feeding and growth of preterm infants are major topics of concern for parents and clinicians during hospitalization in the neonatal intensive care unit (NICU) and across the first years of life (Pridham, Saxe, & Limbo, 2004; Thoyre, 2007). Due to the anatomical, physiological, and neurobehavioral immaturity that accompanies premature birth, the achievement of full and exclusive oral feeding is particularly challenging for preterm infants and their mothers. Typically, premature infants progress gradually from gavage (tube) to full oral feeding. Reduced intestinal motility and absorption, delayed gastric emptying, low esophageal tone, poor coordination of suck and swallow, cardiovascular and respiratory instability, and difficulty in maintaining awake state are among the typical problems in the transition to oral feeding in preterms (Neu, 2007; Thoyre & Carlson, 2003).

Studies of feeding outcomes in premature infants beyond hospitalization are scarce (Thoyre, 2007). Yet feeding difficulties are common across infancy, affecting about 25% of children aged 0 to 3 years (Benoit, 2000), and long-term feeding problems are frequent in preterm infants following hospital discharge (Benoit, 2000; Minde, 2000). More than one third of the children referred to a feeding clinic at age 2 had a history of prematurity (Rommel, De Meyer, Feenstra, & Veereman-Wauters, 2003), and at 12 months corrected age, 38% of the infants born at very low birthweight were reported to have feeding difficulties, as compared to only 17% of full-term infants (Pridham, 1994). Similarly, more than 40% of the parents of infants formerly hospitalized in a NICU described feeding problems in their infants at 12 months (Hawdon, Beauregard, Slattery, & Kennedy, 2000), and more than 70% of premature infants born at low medical risk presented feeding problems during their first year (Cerro, Zeunert, Simmer, & Daniels, 2002). A high incidence (33%–62%) of feeding problems was reported for high-risk premature infants during the first 3 years postdischarge (Sweet et al., 2003; Wood et al., 2003). These studies underscore the magnitude of feeding diffi-

culties in preterm infants beginning in the hospitalization period and continuing across the first years of life.

THE DEVELOPMENT OF FEEDING SKILLS IN THE SECOND HALF-YEAR OF LIFE

The second half of the first year marks an important stage in the development of feeding competencies for full-term and preterm infants alongside the development of feeding difficulties (Carruth & Skinner, 2002; Pridham, Steward, Thoyre, Brown, & Brown, 2007). During this period, infants become able to remove food from a spoon, handle solid foods, self-feed with fingers or spoon, and maintain focus on feeding until the meal is completed (Pridham et al., 2007). These skills facilitate the transition from a predominantly caregiver-regulated feeding to a more independent, self-regulated pattern that is typically established toward the end of the first year. The transition from externally regulated to internally controlled feeding is embedded within the mother–infant relationship (Chatoor & Ganiban, 2004). Although 1-year-olds typically require much feeding assistance, motor and cognitive development occurring at this stage increase the infant's independent participation in the feeding activity (Carruth & Skinner, 2002). Most infants (98%) aged 9 to 11 months are able to grasp food with their hands and show self-feeding skills, and similar findings are reported for preterm infants (Pridham et al., 2004). Independent infant feeding is typically accompanied by maternal support and joy experienced by mother and child to the accomplishment of self-regulated feeding. Toward the end of the first year, relational problems typical of feeding, such as struggle for control, maternal intrusiveness, and infant withdrawal during feeding, begin to emerge and infants who later demonstrate feeding disorders begin to show nonoptimal feeding behaviors such as food refusal, picky eating, unpredictable meals in terms of timing or place of feeding, and low food consumption (Carruth & Skinner, 2002; Chatoor, 2000; Keren & Feldman, 2002; Thoyre, 2007).

The development of feeding skills in premature infants is further complicated by the relational difficulties typically observed in this group. Premature infants have limited capacities to engage in social interactions and show less clear social behaviors than their full-term counterparts (Eckerman, Hsu, Molitor, Leung, & Goldstein, 1999). At the same time, mothers of premature infants tend to be more intrusive, show lower levels of sensitivity (Feldman, 2004), and have more difficulty interpreting the infant's behavioral cues (Eckerman et al., 1999; Geva et al., 2005; 2009), patterns associated with the development of feeding problems in infancy (Benoit, 2000). As such, the developmental risk posed by premature birth may be further complicated by the specific difficulties in the mother–infant rela-

tionship (Minde, 2000). Prematurity, therefore, provides a unique window to assess the potential role of the feeding relationship in the development of feeding difficulties.

THIS STUDY

In light of the preceding, this study assessed the mother–infant feeding relationship by observing relational patterns during feeding and nonfeeding interactions from the neonatal period until the end of the first year. Relational patterns across the first year were then examined as predictors of infant feeding difficulties at 1 year. The relational antecedents of feeding difficulties were examined in a group of low-risk premature infants due to the fact that preterm infants and their mothers often experience initial feeding and relational difficulties and in light of the high incidence of feeding problems reported for premature infants. The focus on preterm infants born at low medical risk was to tease apart the effects of prematurity per se from those of severe oral-motor problems, prolonged hospitalization, maternal fear for infant survival, and neurological damage, which are common among premature infants born at high medical risk.

Feeding difficulties at 1 year were defined on the basis of both maternal interview and observations of feeding interactions and included dimensions described in the literature as defining feeding problems at this age, including food refusal, picky eating, low food consumption, lack of independent and joyful feeding, distractible and unpredictable eating habits, and struggle for control (Benoit, 2000; Chatoor & Ganiban, 2004; Carruth & Skinner, 2002; Thoyre, 2007; Wolke et al., 1990; Zero to Three National Center for Infants, Toddlers and Families, 1999). It has been suggested that such feeding problems merit clinical concern and often develop into a full-blown feeding disorder of infancy (Chatoor et al., 1997; Keren & Feldman, 2002). Guided by transactional and ecological models, which underscore the complex interplay of biological and relational factors in the etiology of feeding problems (American Academy of Child and Adolescent Psychiatry, 1997; Sameroff & Fiese, 2000), maternal relational behavior during feeding and nonfeeding contexts, infant relational patterns and developmental status, and the home environment were assessed. Several hypotheses were proposed. First, based on the salient role of maternal touch and gaze in the neonatal period, particularly among premature infants (Feldman & Eidelman, 2007), microlevel patterns of maternal touch and gaze during feeding and nonfeeding interactions were examined as the maternal predictors of infant feeding difficulties at 1 year. Similarly, the mother's overall adaptation to the infant's pace and signals in the neonatal period contributes to a smoother transition to oral feeding (Silberstein et al., 2008) and was expected to predict better feeding outcome at 1 year. Second, based on previous research on children diagnosed with feeding disorders of infancy (Feldman, Keren, et al., 2004), we expected that feeding interactions between mothers and infants

with feeding difficulties would be characterized by lower maternal sensitivity, higher intrusiveness, less infant involvement, and higher infant withdrawal. Third, neonatal neurobehavioral status and infant psychomotor development at 4 months were tested as the infant factors, and we expected that infants who later developed feeding difficulties would show poorer neurobehavioral and motor skills already in early infancy. The links between poor early psychomotor skills and the development of feeding difficulties was of particular interest, based on previous research showing links between psychomotor abilities and feeding difficulties (Morley & Lucas, 1997). The home environment was examined to assess the associations between contextual conditions and feeding outcome. Finally, in light of research demonstrating greater proportions of male infants among children with feeding problems (D. Field, Garland, & Williams, 2003; Williams, Gibbons, & Schreck, 2005; Williams, Hendy, & Knecht, 2008), gender differences were examined for maternal, child, and contextual factors associated with feeding difficulties.

METHOD

Participants

Seventy-six premature infants and their mothers participated in the study. Participants were recruited during the first 2 weeks following birth in a tertiary care NICU to participate in a longitudinal follow-up of infant development. Infants were of low medical risk, with a mean gestational age of 32.5 weeks (*SD* = 1.4; range = 30–35.1 weeks), and mean birthweight of 1,676 g (*SD* = 323.5; range = 1,035–2,470 g). Exclusion criteria were intraventricular hemorrage grade 3 and 4, perinatal asphyxia, metabolic, genetic, or syndromatic disease. Exclusion psychosocial criteria included teenage pregnancy, single parenthood, or unemployment of both parents. All families were of a middle-class background (Harlap, Davies, Grower, & Prywes, 1977); mothers were above 21 years, lived with the infant's father, and were not using psychoactive drugs or psychiatric medication. The study was approved by the institutional review board and all families signed an informed consent. Thirty percent of mothers approached declined participation, citing time constraints, partner's refusal, or not feeling ready to deal with developmental aspects of care as main reasons; these mothers and infants did not differ from the participating families in infants' birthweight and gestational age, and in parental age and level of education.

Procedure

Mothers and infants were observed at three time points: 2 to 3 days prior to discharge from the hospital, at 4 months corrected age, and at 1 year corrected age. Prior to discharge (gestational age 36.5 ± 1.26 weeks), mothers and infants were

videotaped in a feeding interaction and a nonfeeding "play" interaction in the NICU. For the feeding interaction, a morning bottle-feeding session was videotaped. All mothers in the study bottle-fed their infants at least once a day. Bottle feeding was chosen in this study to allow for accurate measurements of outcome measures. Participating infants were bottle-fed during their stay in the NICU in at least four out of eight daily feedings. Most participating mothers (91%) expressed breast milk for at least one daily feeding. In addition to providing expressed breast milk, 65% of the mothers breast-fed their infants occasionally and 60% provided occasional skin-to-skin care. There were no differences between groups in the provision of breastfeeding and skin-to-skin contact. Feedings took place by the infant's cot and infants remained connected to a vital signs monitor. Mothers were instructed to feed their infants as they usually did and feeding was videotaped by camera that framed the feeding dyad and captured the mother's gaze direction and the infant's sucking movements. Nonfeeding, "play" interactions were videotaped in a private room adjacent to the NICU. Mother sat in a comfortable chair holding the infant in her arms and was asked to interact with the infant as she usually does. In addition to the videotaped interactions, infants' neurobehavioral status was tested by a trained neonatologist prior to discharge. Information on the infant's medical risk and feeding patterns, the mother's expression of breast milk, and the provision of skin-to-skin contact was collected from the hospital charts on the basis of the entire hospitalization period.

At 4 months corrected age (4.6 ± 0.55 months), dyads visited a university laboratory for developmental testing. At 1 year corrected age (11.0 ± 0.92 months) families were visited at home around one of the infant's mealtimes and mothers were instructed to feed the child as they routinely did. Mothers were then interviewed regarding the infant's feeding behavior and potential feeding difficulties and the home environment was assessed.

Measures

Term Age (36.5 Weeks Gestational Age): Hospital Assessment

Neurobehavioral status. Infants were examined with the Rapid Neonatal Neurobehavioral Assessment Procedure (RNNAP; Gardner, Karmel, Magnano, Norton, & Brown, 1990) by a trained neonatologist. The RNNAP has shown reliability and validity in differentiating premature infants at various levels of neurological risk and in predicting developmental outcome. It evaluates the integrity of neonatal reflexes, reactivity to visual and auditory stimulation, passive and elicited motor behaviors, and state control. A feeding subcategory that is part of the standard RNNAP was excluded from the score calculation for this study. The infant's performance in each subcategory is rated as normal or abnormal based on clinical

judgment. Lower neurobehavioral functioning is reflected in an increased RNNAP total score (see Gardner et al., 1990, for a full description).

Medical risk. Infant medical risk was measured with the Clinical Risk Index for Babies (International Neonatal Network, 1993), a quantitative measure of neonatal risk for infants born prematurely, which is a more accurate predictor of risk than birthweight or gestational age alone.

Four Months: Laboratory Assessment

Cognitive testing. Infant cognitive development was assessed by a trained professional at a university lab with the Bayley Scales of Infant Development, 2nd edition (Bayley–II; Bayley, 1993). The Bayley–II yields two developmental indexes: Mental (MDI) and Psychomotor (PDI).

One Year: Home Assessment

Feeding difficulties interview. Mothers were interviewed regarding their infants' feeding behavior and potential feeding difficulties. Ten questions tapped common difficulties typical of infants at this age based on previous research (Benoit, 2000; Chatoor, 2000; Hawdon et al., 2000; Keren & Feldman, 2002; Pierrehumbert, Nicole, Muller-Nix, Forcada-Guex, & Ansermet, 2003; Zero to Three National Center for Infants, Toddlers and Families, 1999). Questions assessed whether meals are predictable and follow a certain routine; whether there is a designated place for the meals (e.g., special chair and special location or the child can eat anywhere, such as in front of the TV, in his or her own room); whether the child sits during the meals or may roam around; whether mother and child are both present during meals or the child eats alone; whether the child is a picky eater; if the child eats sufficiently or food consumption is limited; if there are specific foods the child refuses or avoids; if feeding interactions typically contain struggle; if mother experiences any pleasure or satisfaction during feeding; and if the child shows any signs of pleasure, satisfaction, self-motivated feeding, or positive affect during feeding. The 10 items were scored in a binary fashion with a nonoptimal answer scoring 1 (e.g., meals are not predictable, struggle often occurs during feeding) and a more optimal answer scoring 0. Internal consistency of the 10 items was $\alpha = .73$. The sum of the 10 interview items (range = 0–10) was standardized to create the mother-reported feeding difficulty score. The reason for standardization was to combine the maternal interview feeding difficulty score with the observed feeding difficulty score (see later) into a single score of feeding difficulty.

Home environment. The quality of the home environment was evaluated using the Home Observation for Measurement of Environment (HOME; Caldwell & Bradley, 1978). The HOME includes 55 items and information registered dur-

ing a 1- to 1.5-hr observation period in addition to direct questions asked to the parents. The total HOME score was used in this study.

Coding

Term age: Feeding interactions. Six minutes of feeding interactions were coded at a university laboratory on a computerized system (The Observer, Noldus Co.) using the Coding of Interactive Behavior–Newborn (CIB; Feldman, 1998), a well-validated system for coding mother–newborn interactions (Feldman & Eidelman, 2003, 2007; Feldman, Eidelman, & Rotenberg, 2004; Feldman, Weller, Zagoory-Sharon, & Levine, 2007). One infant and four maternal categories were microcoded and behaviors within each category are mutually exclusive. The following codes were used in this study: mother's touch: affectionate (kissing, caressing, hugging, gently stroking, or mother touching infant with clear positive affect), functional (wiping mouth, arranging clothes or blanket), and no touch (mother just holds baby); mother's gaze: to infant, avert to bottle (i.e., mother averts her gaze from infant to look at the bottle), and gaze aversion (no eye contact with infant or bottle); infant feeding performance: robust (mouth well closed around nipple, well defined and vigorous sucks), weak (mouth relaxed around nipple, weak and shallow sucks), or not feeding (infant does not feed while having nipple in mouth). In addition, maternal adaptation—the degree to which the mother adjusts her behavior to the infant's signals during feeding—was coded globally on a scale of 1 (*low*) to 5 (*high*). Coding was conducted by two coders experienced in preterm infant feeding. Interrater reliability was measured on 12 (16%) dyads and averaged 92%, kappa = .84 (range = .78–.91).

Nonfeeding "play" interactions. Coding of videotapes was similarly conducted at a university laboratory using the CIB–Newborn system (Feldman, 1998). Seven minutes of videotaped interactions were coded. The mother touch (affectionate, functional, and no touch) and mother gaze (to infant, and no eye contact) categories were used in this study, similar to the feeding interactions. Coding was conducted by two trained coders. Reliability conducted for 11 interactions (14%) averaged 91%, kappa = .84 (range = .81–.87).

One year: Feeding interactions. Feeding was coded using the CIB Manual (Feldman, 1998), which has been validated for the observations of play and feeding interactions, and the coding of feeding interactions has been shown to differentiate infants diagnosed with feeding disorders from healthy infants and from infants diagnosed with other psychiatric disorders of infancy (Feldman, Keren, et al., 2004; Keren & Feldman, 2002; Keren, Feldman, & Tyano, 2001). The CIB is a global rating system of parent–child interaction that is used to assess both play and feeding interactions. The system includes 42 codes rated from 1 (*a little*) to 5 (*a lot*) that are summarized into several relational composites. In addition to the 42 codes that address global relational behavior of the parent, the child, and the dyad and are used,

with some modification in the definition of the codes, to assess both play and feeding sessions, the system includes four additional codes that are specific to feeding interactions and are not included in the relational composites. These four feeding-specific codes address the degree of feeding difficulties observed in the feeding relationship. Feeding codes were constructed on the basis of previous research that pointed to these aspects as markers of feeding disorders of infancy (Chatoor, 2000; Keren & Feldman, 2002; Zero to Three National Center for Infants, Toddlers and Families, 1999). These include: (a) distractibility—the degree to which the child and the mother–child relationship is not focused on the feeding task and the child's attention is continuously directed toward other activities or the child is preoccupied in avoiding the food; (b) independence—the degree to which the child eats alone and shows self-initiated feeding activity (applicable from 9 months of age); (c) negotiation/struggle—the degree to which the feeding interaction is marked by struggle for control or other forms of negotiation, threatening, or use of force; and (d) feeding efficacy—the degree to which the feeding task was successful and the child completed the food mother prepared within a reasonable period. Previous research has shown that both the feeding-specific codes and the global relational composites differentiated the feeding interactions of children with clinically diagnosed feeding disorders from those of typically developing children and children with other psychiatric disorders of infancy (e.g., sleep disorders, affective disorders; Feldman, Keren, et al., 2004; Keren, Feldman, & Tyano, 2001, 2003). The four feeding-specific codes were averaged into a single composite ($\alpha = .72$) and their standardized score was used to index the observed "feeding difficulty" score.

Of the 42 CIB codes that are used to create relational composites, four composites were used in this study, consistent with previous research: (a) maternal sensitivity was the average of maternal acknowledgment of infant interactive signals, imitation of infant's behavior, elaboration of infant's vocalizations and movements, gaze directed to infant, warm and positive affect, appropriate tone of voice, appropriate range of affect, resourcefulness in dealing with infant negative states, praise of infant's behavior, and supportive presence ($\alpha = .85$); (b) maternal intrusiveness was the average of maternal overriding behavior, describing the degree to which mother disregards the infant's signals and interrupts infant's ongoing behavior, and mother-led interaction, the degree to which interactions were judged to be led by maternal, rather than infant's needs, pace, and agenda ($\alpha = .77$); (c) infant involvement was the average of infant positive affect, infant directs gaze to mother or object of joint attention (e.g., food), infant positive vocalization or speech, infant alertness, initiation of interactive bids, and infant-led interaction ($\alpha = .80$); and (d) infant withdrawal was the degree to which the infant was uninvolved, non participating, and detached from the feeding activity. Prior to coding of the interactions, coders were trained to 90% reliability on all codes. Coding was conducted by two coders who were unaware of the criteria used for determining group membership. Interrater reliability measured on 11 (14%) dyads averaged 94%, intraclass $r = .92$ (range = .84–.99).

As suggested (Chatoor, 2000), we divided infants into two groups of difficult and nondifficult feeders on the basis of both maternal interview and observed feeding interactions at 1 year. The standardized mother-reported feeding difficulty score and the standardized observed feeding difficulty score were summed to create the infant feeding difficulty score. The two scores were interrelated, $r = .48$, $p < .001$. Children in the top 25% on the feeding difficulty score were considered difficult feeders ($n = 19$) and those in the bottom 75% were considered nondifficult feeders ($n = 57$).

RESULTS

Prior to data analysis, medical and demographic information for difficult and nondifficult feeders is presented in Table 1. The two groups were comparable in terms infant birthweight, gestational age, medical risk, breast or formula milk feeding, maternal and paternal age, maternal education, number of siblings, male–female distribution, and appropriate for gestational age (AGA)/small for gestational age (SGA) ratio.

TABLE 1
Family Demographic and Infant Medical Variables

	Difficult Feeders[a]		*Nondifficult Feeders*[b]		
	M	*SE*	*M*	*SE*	*p*
Birthweight (g)	1644.3	77.2	1682.3	41.1	.66
Gestational age (weeks)	32.5	0.46	32.2	0.26	.58
Clinical Risk Index for Babies (medical risk)	0.6	0.31	0.4	0.16	.24
Expressed breast milk feeds (out of eight daily feedings) at neonatal intensive care unit	4.8	0.86	4.6	0.34	.87
Mothers' age (years)	31.7	1.15	33.2	0.97	.31
Mothers' education (years)	14.4	0.52	15.2	0.23	.11
Fathers' age (years)	33.3	1.32	35.8	0.93	.29
Fathers' education (years)	13.7	0.29	14.7	0.21	.08
Number of siblings	0.9	0.51	0.6	0.10	.39
	n		*n*	χ^2	*p*
Primipara/multipara	11/8		19/38	3.58	.11
Male/female ratio	12/7		28/29	1.22	.37
AGA/SGA	13/6		50/7	1.02	.38

Note. AGA/SGA = appropriate for gestational age/small for gestational age.
[a]$n = 19$. [b]$n = 57$.

Differences Between Difficult and Nondifficult Feeders Across the First Year

Term Age: Feeding Interactions

A multivariate analysis of variance (MANOVA) conducted for maternal touch behavior during feeding with group (difficult/nondifficult feeders) and infant gender as the between-subject factors showed no main effect for group, $F(3, 70) = 1.12$, *n.s.* A similar MANOVA conducted for maternal gaze behavior showed an overall effect for group, $F(3, 70) = 2.93$, $p < .05$, $\eta^2 = .09$. Univariate tests (Table 2) showed that mothers of infants in the difficult feeders group spent more time averting their gaze from the infant to the bottle as compared to mothers of nondifficult feeders. A MANOVA conducted for infant feeding performance showed no difference between groups, $F(3, 70) = 1.68$, *n.s.* An ANOVA conducted for maternal adaptation during feeding indicated that mothers of difficult feeders showed less adaptability (3.13 ± 0.25) compared to mothers of nondifficult feeders (3.85 ± 0.17), $F(1, 72) = 4.51$, $p < .05$, $\eta^2 = .07$. No gender

TABLE 2
Maternal Gaze and Touch Behaviors in the Neonatal Period

	Difficult Feeders[a]		*Nondifficult Feeders*[b]		
	M	*SE*	*M*	*SE*	*F(1, 72)*
Feeding interaction					
Mothers' touch					
Affectionate	0.01	0.009	0.01	0.003	0.48
Functional	0.04	0.016	0.05	0.007	0.70
No touch	0.86	0.046	0.89	0.013	0.52
Mothers' gaze					
To infant	0.72	0.034	0.75	0.024	0.22
Avert to bottle	0.06	0.011	0.03	0.008	8.14**
No eye contact	0.21	0.028	0.22	0.028	0.03
Nonfeeding "play" interaction					
Mothers' touch					
Affectionate	0.52	0.081	0.73	0.04	12.62**
Functional	0.24	0.051	0.17	0.019	1.92
No touch	0.23	0.072	0.14	0.022	3.51
Mothers' gaze					
To infant	0.75	0.064	0.89	0.028	7.04*
No eye contact	0.23	0.074	0.12	0.028	7.13**

Note. The value of the mean represents the proportion of time for each behavior out of the total time of the interaction.

[a]$n = 19$. [b]$n = 57$.

*$p < .05$. **$p < .01$.

effects or Gender × Group interaction were found for the feeding session in the neonatal period.

Term Age: Nonfeeding "Play" Interactions

A MANOVA conducted for maternal touch during the "play" session, with group and gender as the between-subject factors, showed an overall effect for group, $F(3, 72) = 4.41$, $p < .01$, $\eta^2 = .24$. Univariate tests (Table 2) showed that mothers of infants in the difficult feeders group provided less affectionate touch during play interactions prior to discharge from the hospital. An overall effect was found for gender, $F(3, 72) = 5.26$, $p < .01$, $\eta^2 = .21$. Univariate tests showed that mothers provided less affectionate touch to girls than to boys (0.63 ± 0.03 and 0.78 ± 0.04, respectively; values represent the proportion of affectionate touch out of the total time of the interaction). A similar MANOVA for maternal gaze behavior showed an overall effect for group, $F(2, 70) = 3.77$, $p < .05$, $\eta^2 = .12$. Univariate tests (Table 2) indicated that mothers spent less time looking at and more time averting from the infants in the difficult feeders group.

4 Months: Cognitive Testing

ANOVA for the infants' PDI scores at 4 months showed that infants in the difficult feeding group scored lower ($M = 83.15$, $SD = 9.86$) than infants in the nondifficult feeding group ($M = 90.45$, $SD = 9.92$), $F(1, 71) = 3.95$, $p < .05$, $\eta^2 = .05$. MDI scores of the difficult ($M = 86.2$, $SD = 10.8$) and nondifficult feeders ($M = 87.8$, $SD = 13.3$) did not show significant differences, $F(1, 71) = .34$, *n.s.*

One Year: Feeding Interactions

AMANOVA conducted for the mother and infant relational composites (mother sensitivity, mother intrusiveness, infant involvement, infant withdrawal), with group and gender as the between-subject factors, showed an overall effect for group, $F(4, 72) = 3.84$, $p < .01$, $\eta^2 = .23$. Univariate tests (Table 3) showed that in the difficult feeders group, mothers were more intrusive, infants were less involved, and infants were more withdrawn. ANOVA conduced for the total HOME score revealed no differences between groups, $F(1, 71) = .87$, *n.s.,* possibly as all of our families were of low-risk middle-class background. No main or interaction effects for infant gender were found for the interaction variables at 1 year.

Predicting Infant Feeding Difficulties at One Year

A hierarchical multiple regression model was computed to assess infant, relational, and environmental factors across the first year as predictors of feeding difficulties at 1 year. The criterion variable was the continuous feeding difficulty score,

TABLE 3
Relational Behavior During Feeding Interactions at 1 Year in Difficult and Nondifficult Feeders

	Difficult Feeders[a]		*Nondifficult Feeders*[b]		
	M	*SD*	*M*	*SD*	*F(1, 72)*
Mother sensitivity	2.94	.83	3.09	.87	.51
Mother intrusiveness	1.65	.94	1.08	.61	5.78*
Infant involvement	2.54	.72	3.11	.85	7.43**
Infant withdrawal	1.73	.64	1.22	.68	5.21*

Note. Codes are rated on scale of 1 to 5.
[a]$n = 19$. [b]$n = 57$.
*$p < .05$. **$p < .01$.

derived on the basis of maternal interview and direct observations. Variables that showed meaningful differences between groups were entered into the equation, to assess their combined contribution to the prediction of infant feeding difficulty. Prior to presenting the regression model, the intercorrelations between variables included in the model are presented in Table 4.

As seen in Table 4, correlations were found between relational composites at 1 year: More maternal sensitivity was related to lower intrusiveness, higher infant involvement, and lower withdrawal. Mother adaptation in the neonatal period was related to less maternal gaze aversion. Relational behavior at the neonatal period correlated with patterns at 1 year: Maternal adaptation during feeding at term age was negatively related to maternal intrusiveness at 1 year; maternal gaze aversion during feeding in the neonatal period was related to less infant involvement during feeding at 1 year, and maternal affectionate touch during "play" in the neonatal period was marginally related to maternal sensitivity at 1 year.

Variables were entered into the regression in six blocks according to developmental progression. In the first block, the infant neurobehavioral score at term age was entered to parse out variance related to the infant neurobehavioral functioning. In the next three blocks, mothers' affectionate touch during nonfeeding, maternal gaze aversion during feeding, and maternal global adaptability during feeding at term age were entered to examine the contribution of maternal behaviors in the neonatal period. In the fifth block, the infant motor development score (PDI) at 4 months was entered due to the documented relations between delayed motor growth and feeding difficulties. Finally, the sixth block contained the four relational composites of the feeding interaction at 1 year: maternal sensitivity, mother intrusiveness, infant involvement, and infant withdrawal. Results are presented in Table 5.

TABLE 4
Pearson Correlations Between Study Variables

Variable	*1*	*2*	*3*	*4*	*5*	*6*	*7*	*8*	*9*	*10*
1. Neurobehavioral status (term age)	—	.12	.07	.13	.16	.09	.03	.05	–.11	.08
2 .Mother affectionate touch (term age)		—	–.12	.20^{+}	.10	.22^{+}	–.13	.04	–.10	.41***
3. Mother gaze aversion (term age)			—	–.32*	–.05	–.03	–.02	–.31*	.12	.21^{+}
4. Mother adaptation (term age)				—	.15	.13	–.30*	.14	–.08	.24*
5. Motor development (PDI) (4 months)					—	–.04	.02	–.12	–.15	.29*
6. Mother sensitivity (1 year)						—	–.41**	.46***	–.37**	.13
7. Mother intrusiveness (1 year)							—	–.38**	.42***	.30**
8. Infant involvement (1 year)								—	–.49***	–.40***
9. Infant withdrawal (1 year)									—	.14
10. Feeding difficulties (1 year)										—

Note. PDI = Bayley–II Psychomotor Development Index.
*$p < .05$. **$p < .01$. ***$p < .001$. $^{+}p > .10$.

TABLE 5
Predicting Feeding Difficulties at 1 Year

	Beta	*R^2 Change*	*F Change*
Term age			
Neurobehavioral status	.17	.00	0.26
Maternal affectionate touch	–.32**	.15	9.62**
Maternal gaze aversion	.09	.01	0.76
Mother adaptation	–.24*	.05	3.98*
4 months			
Psychomotor Development Index	–.26*	.05	4.02*
1 year			
Mother sensitivity	–.05	.15	4.22*
Mother intrusiveness	.25*		
Infant involvement	–.29*		
Infant withdrawal	.16		

Note. R^2 total = 0.41, $F(9, 59) = 4.02$, $p < .01$.
*$p < .05$. **$p < .01$.

As seen in Table 5, the model as a whole was significant and explained 41% of the variance in infant feeding difficulties at 1 year. Less maternal affectionate touch during nonfeeding "play" interactions, less maternal adaptation during feeding interactions, lower psychomotor skills at 4 months, and higher maternal intrusiveness and low infant involvement during feeding at 1 year were each uniquely predictive of feeding difficulties at the end of the first year.

DISCUSSION

A longitudinal study that begins at birth and assesses the development of feeding difficulties by using direct observations of feeding interactions has rarely been conducted. This study is among the first to examine maternal, child, and contextual determinants of infant feeding difficulties across the first year of life in premature infants and assess neonatal predictors of feeding difficulties at 1 year. Feeding difficulties were defined on the basis of both maternal report and direct observations and regarded feeding problems typical of infants at this age, including struggle for control, low food consumption, picky eating, unorganized and distractible feeding habits, and little independent and efficacious feeding. The focus in this study was on the relational basis of feeding difficulties as observed in both feeding and nonfeeding contexts beginning in the neonatal period and up to the end of the first year. Overall, the results indicate that for this group of low-risk premature infants, several relational components of feeding and nonfeeding interactions prior to hospital discharge, the infant's psychomotor development, and the mother–child feeding relationship at 1 year were each uniquely predictive of feeding outcome at 1 year.

Microlevel patterns of affectionate touch and en-face gaze are salient components of the human mother's behavioral repertoire after birth (Barratt, Roach, & Leavitt, 1992; Feldman & Eidelman, 2007). This study explored the relationship between maternal touch and gaze behaviors following premature birth and the development of the feeding relationship. Results indicated that these early maternal behaviors differentiated dyads in which the infant later became a difficult feeder. Interactions between mothers and infants with feeding difficulties were characterized by less affectionate maternal touch and low visual contact already in the postbirth period, suggesting that these patterns may serve as early markers of potential feeding difficulties

The findings that mothers of difficult feeders provided less affectionate touch in the neonatal period are consistent with previous research on the associations between feeding disorders, certain types of maternal touch, and lack of physical closeness (Feldman, Keren, et al., 2004; Polan & Ward, 1994). Since the early works on maternal deprivation (Spitz, 1945), the mother's physical presence was thought to provide a primary relational experience that shapes various aspects of

development. Affectionate touch—a nurturing, warm, and gentle type of touch that is unique to parents as compared to other caregivers (Miller & Holditch-Davis, 1992)—is a key element of the maternal behavior repertoire during the bonding stage (Barratt et al., 1992). This type of touch develops on the basis of the bonding hormone oxytocin during pregnancy (Feldman et al., 2007) and promotes physical, cognitive, and emotional growth (Feldman & Eidelman, 2003; Pollit, Gilmore, & Valcarcel, 1978; Weiss, Wilson, Seed, & Paul, 2001). Consistent with theoretical perspectives on maternal proximity in mammals (Hofer, 1995), it appears that the mother's provision of affectionate tactile contact in the initial bonding period serves an essential regulatory function that provides the foundation for a well-regulated feeding relationship. The marginal correlations found between affectionate touch in the postpartum and maternal sensitivity during feeding at 1 year are consistent with previous findings on the link between early affectionate touch and maternal sensitivity during play at 1 year (Feldman, Eidelman, et al., 2004). These findings could suggest that affectionate touch during the initial bonding period is a marker of the mother's ongoing positive style that is later expressed via a different set of behaviors in feeding as well as nonfeeding contexts.

Mothers of preterm neonates who later became difficult feeders looked less at their infants during the nonfeeding "play" interactions, showed more gaze aversion during feeding, and their feeding sessions were marked by lower maternal adaptation to the infant's pace and signals. In addition to touch, maternal visual contact with the infant is a salient feature of the adaptive and responsive maternal style (Barratt et al., 1992). Although the effect of social and affective cues on human eating behavior is well acknowledged (Birch, Zimmerman, & Hind, 1980), little is known about the specific role of maternal gaze for the development of infant feeding. Recent evidence suggests that social interactions that included looking at the infant's face during feeding increased food intake among bottle-fed full-term infants aged 7 to 14 weeks, underscoring the importance of visual social cues to the young infant's feeding behavior (Lumeng, Patil, & Blass, 2007). It is also important to note that premature infants are often bottled-fed during the hospitalization period, even when some of its content is expressed maternal breast milk, and the limited experience of breastfeeding might further disrupt the development of adequate feeding. It thus appears that in the context of infant bottle-feeding, the mother's continuous gaze at her child might be especially meaningful for the development of the feeding relationship. The finding that maternal adaptation, which supports a smoother transition to oral feeding in premature neonates (Silberstein et al., 2009), predicted less feeding difficulties at 1 year further points to the importance of attuned maternal adjustment during the infant's first feeding attempts for the development of optimal feeding.

Group differences in maternal touch patterns were found only during the nonfeeding "play" session. Possibly, the full expression of the mother's touch repertoire may be constrained during feeding, when the mother's hands are occupied

in carrying out the task at hand. Although the mother's global style, in terms of sensitivity or intrusiveness, is stable over time (Belsky, Rovine, & Taylor, 1984), the manifestation of maternal sensitivity in the different modalities is often context-dependent (Holditch-Davis, Miles, & Belyea, 2000; Reissland, Shepherd, & Stephenson, 1999). Our findings suggest that feeding and nonfeeding encounters provide important yet distinct contexts for the expression of maternal behavior, and the inclusion of both settings might afford a more comprehensive assessment of the dyadic relationship.

The findings that difficult feeders also showed poor psychomotor development and that PDI scores at 4 months predicted feeding difficulties at 1 year highlight the fact that feeding problems are likely based on poor infant motor skills. Previous studies have pointed to the links between psychomotor skills and feeding problems (Feldman & Eidelman, 2003; Morley & Lucas, 1997; Tan, Abernathy, & Cooke, 2008). The findings in this study are consistent with these results and suggest that relationship difficulties around feeding and immature psychomotor abilities might constitute two separate paths to the development of feeding difficulties. Although the groups of difficult and nondifficult feeders did not differ on medical risk or neurobehavioral status at term age, it is possible that mothers provided less touch and gaze to premature neonates who were less alert and neurologically mature and that the reduced levels of such essential maternal inputs during a sensitive period for social and physical growth further delayed these infants' psychomotor development.

Additional markers of nonoptimal feeding relationships were observed at the end of the first year. Interactions between infants with feeding difficulties and their mothers were characterized by higher maternal intrusiveness, lower infant involvement, and higher infant withdrawal. These findings are consistent with previous reports demonstrating high maternal intrusiveness and increased infant withdrawal during feeding among infants with feeding disorders (Feldman, Keren, et al., 2004). Similar findings emerged in a large cohort of infants referred to a community-based infant mental clinic and diagnosed with a range of psychiatric disorders of infancy. The highest scores for maternal intrusiveness and infant withdrawal during feeding were observed in cases of feeding disorders (Keren et al., 2003). Such intrusive and controlling maternal behavior is generally more common among mothers and premature infants (Feldman & Eidelman, 2006) and is thought to stem from the mother's efforts to promote development and respond to the infant's unclear social cues (Greene, Fox, & Lewis, 1983). Maternal intrusiveness was found to carry negative consequences on feeding outcomes among infants in general (Feldman, Keren, et al., 2004), and premature infants in particular (Singer et al., 1996), and the findings reported here are consistent with these studies. Although maternal sensitivity was not found to differ among groups, it is possible that during feeding interactions, which are goal-oriented and focus on the fulfillment of a basic need, the nonoptimal maternal style is mainly expressed through her controlling and intrusive behavior, whereas during the more relaxed play session, which highlights the synchronous

give-and-take exchange between mother and child, sensitivity might be a stronger marker of a positive mother–child relationship. In addition, infant involvement in the feeding situation emerged as an important factor that differentiated the groups and predicted feeding difficulties at 1 year, and difficult feeders were found to be less involved, engaged, alert, and initiating during the joint feeding activity. The findings that maternal adaptation during feeding in the neonatal period correlated with lower intrusiveness at 1 year and that mother gaze aversion in the same setting was related to less infant involvement suggest that nonoptimal patterns that differentiate difficult feeders from their peers might have their roots in relational behavior observed already in the first weeks of life.

The etiology of feeding problems in infancy and early childhood is multidetermined (Benoit, 2000). The results show that both infant factors, such as psychomotor development, and relational patterns across the first year were predictive of feeding outcome. The fact that multiple relational patterns observed during both feeding and nonfeeding contexts using microanalytic as well as global measures were each uniquely predictive of feeding outcomes underscores the relational basis of feeding difficulties in this group. It is suggested that although low-risk premature infants are not prone to major medical and long-term neurodevelopmental risks, this population nonetheless has a higher susceptibility for mild relational disturbances. Our findings suggest that microlevel observations of both feeding and nonfeeding interactions might provide a valuable window for assessing relational risk. Furthermore, the data support theoretical and clinical approaches to infant mental health suggesting that early interventions should target the primary relationships (Sameroff & Emde, 1989) and that direct observations are required to assess the specific component of the dyadic relationship that should become the focus of intervention (Feldman & Keren, 2004). The data suggest that the relational behaviors that should become the focus of intervention are maternal visual regard and affectionate touch in the neonatal period as well as the mother's intrusive and controlling behavior and the child's lack of engagement during feeding during the second half-year. Educating mothers of premature infants as to the importance of touch and gaze and the risk for developing intrusive behavior might help foster a more optimal feeding relationship in this group.

Limitations of the study relate to the fact that no physiological or temperamental measures were collected, which might have contributed to studying the biological basis of infant feeding difficulties. Because our sample included only middle-class families, it is important to examine the ways in which high contextual risk, such as single parenting or poverty, interact with premature birth and maternal relational patterns in shaping infant feeding difficulties. Future research is required to follow dyads at risk for feeding problems stemming from various sources, such as maternal affective disorder, high contextual risk, or infant motor problems, beginning in the first days of life and up to later childhood and adolescence to further understand the relational basis of feeding problems across childhood.

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