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Development of Feeding Cues during Infancy and Toddlerhood

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Abstract

Purpose—To enhance responsive feeding, this study aimed to characterize the development of feeding cues during infancy and toddlerhood.

Study Design and Methods—A secondary analysis was performed on a dataset of first time, low-income African-American mother-infant pairs assessed at infant age 3, 6, 9, 12, and 18 months. A subsample with the 15 highest, middle, and lowest infant body mass index (BMI) Z-scores at 18 months was selected (n=45). Using video-recorded home feedings, early, active, and late receptiveness and fullness cues were assessed using the Responsiveness to Child Feeding Cues Scale at each time point. Descriptive statistics were used to characterize development.

Results—Early receptiveness cues were relatively rare over time, whereas active receptiveness cues were much more common. However, there were changes over time. For example, settling into the feeding decreased from ~50% at 3 and 6 months to 4.8% by 18 months, whereas postural attention and reaching for food increased after 6 months. In the first six months, falling asleep and decreasing muscle tone and activity level were the most common early fullness cues. Thereafter, taking interest in surroundings was most prevalent. Active fullness cues became increasingly diverse after 6 months, led by more assertive cues such as pushing or pulling away and communicating “no” verbally or non-verbally.

Clinical Implications—These findings provide an empirical description of waxing and waning in feeding cues and indicate increasing intentionality of cues over the first 18 months of life. Knowing common cues across development may aid clinicians in enhancing parental feeding responsiveness, avoiding overfeeding, thereby decreasing risk of early childhood obesity.

Keywords

Infant; Feeding Behavior; Parenting; Obesity

The majority of infants in the United States fall within normal limits for growth, yet obesity (95th percentile of weight-for-length) (Kuczmarski et al., 2000) affects 8.1%, a significant number (Ogden, Carroll, Kit, & Flegal, 2014). Obesity that develops during infancy can be followed obesity through childhood into adulthood (Baird et al., 2005). By 2030 there are projections of 65 million more obese adults and an additional \$48-66 billion/year in health costs in the United States associated with obesity related illnesses (Wang, 2011). These illnesses include hypertension, cardiovascular disease, and Type II diabetes mellitus, in children and adults (Daniels, 2006; Han, Lawlor, & Kimm, 2010). Obesity interventions, whether behavioral, pharmacological, or surgical, can have limited long-term efficacy and are not without risks (Caprio & Savoye, 2014; McGovern et al., 2008; Whitlock, Williams, Gold, Smith, & Shipman, 2005). Obesity prevention is a key public health strategy. The first two years of life have been cited as a particularly significant period for development of obesity and its prevention (Institute of Medicine Committee on Obesity Prevention Policies for Young Children, 2011).

Factors contributing to development of obesity in infants are numerous and complex in their interactions. Responsive feeding during infancy has been cited as a key target for prevention of obesity (DiSantis, Hodges, Johnson, & Fisher, 2011; Institute of Medicine Committee on Obesity Prevention Policies for Young Children, 2011; Thompson, Adair, & Bentley, 2013). DiSantis et al. (2011) presented a model to define responsive feeding and show how discordant feeding responsiveness may contribute to obesity. In this model, if caregivers regularly feed their infants in the absence of hunger and/or beyond fullness, the infant's ability to eat in response to hunger and fullness is undermined (Bruch, 1973; Costanzo & Woody, 1985; DiSantis et al., 2011). The infant and caregiver each have responsibilities; the infant must clearly communicate hunger and satiety and the caregiver must recognize, correctly interpret, and respond appropriately to infant feeding cues (DiSantis et al., 2011).

More recent studies have provided further evidence of associations between parental feeding behaviors that are less responsive and factors associated with obesity risk or increased adiposity (body fat). In a study of a diverse group of parents of 2-month-old infants, Perrin et al. (2014), found a range of self-reported parenting behaviors associated with obesity risk, including consistently feeding in response to crying, bottle propping, and encouraging the finishing of food. In another study, mothers who were observed to engage in more verbal or physical encouragements to eat and more intrusive feeding behaviors had children with greater adiposity at 15, 24, and 36 months (Lumeng et al., 2012). These results are consistent with findings that self-reported pressuring (aimed at increasing consumption) or indulgent feeding styles were associated with greater infant energy intake though lower weight-for-age among non-Hispanic Black infants (Thompson et al., 2013). In a study of infants less than 4 months old, mothers who reported being less responsive had infants who consumed more formula, many to the point of spitting up (Ventura, Inamdar, & Mennella, 2015)

Longitudinal study of feeding cue development has been limited (Gesell & Ilg, 1937; Morris, Rogers, & Taper, 1983; Paul, Dittrichova, & Papousek, 1996) with only Gesell and Ilg (1937) and Morris, Rogers, and Taper (1983) going beyond the first year of life as infants

become increasingly independent in their feeding behaviors. Thus, an important tool to enhance parental responsiveness remains underdeveloped.

This study provided an opportunity to enhance understanding of developmental progression of feeding cues during infancy in several ways. We focused on non-Hispanic Black infants, a group disproportionately affected by obesity during infancy and later development (Ogden et al., 2014) and underrepresented in empirical study of feeding cues. We used video observations of feeding from early in infancy through toddlerhood and an observational coding scale, the Responsiveness to Child Feeding Cues Scale (Hodges et al., 2013), that was specifically designed to assess infant feeding cues and responsiveness of caregivers to the cues.

Study Design and Methods

This is a secondary analysis of data from the Infant Care, Feeding and Risk of Obesity Study (Infant Care Study), an observational cohort study that assessed non-Hispanic Black mother/infant dyads from 3 to 18 months postpartum (Wasser et al., 2011). The Infant Care study was primarily designed to examine how parenting and infant feeding styles are related to infant diet and risk of infant being overweight in the household environment.

Sample

In the Infant Care study, first time non-Hispanic Black mothers aged 18-35 years and their 3-month-old infants were recruited through the Special Supplemental Nutrition Program for Women, Infants, and Children (WIC) clinics in North Carolina and assessed during in-home visits at infant age 3, 6, 9, 12, and 18 months. A total of 217 mothers and infants were recruited at baseline (at infant age 3 months). Mothers had to be willing to participate in home visits and assessments and have healthy infants >35 weeks' gestation. Infants with Down syndrome, epilepsy, cleft lip or palate, cerebral palsy, failure to thrive, mental retardation, severe food allergies or any condition that might affect appetite, feeding or growth were excluded.

Of the original 217 dyads, 125 had complete video-recorded feeding observation data at 18 months. Stratified purposeful subsamples of mother-infant dyads with the 15 highest, 15 middle, and 15 lowest infant BMI Z-scores ($N = 45$ dyads) based on the score distribution at 18 months were selected to distinguish patterns of maternal feeding responsiveness among groups based on infant weight at 18 months of age. The BMI-Z score is a statistical measure of the relationship of an infant's BMI compared to the mean BMI of the total 125 infants who were eligible for this study. Analysis of feeding cues at all time points was performed for the 45 dyads that were included.

Feeding Cues

Infant Feeding Cues were assessed using items from the Responsiveness to Child Feeding Cues Scale (RCFCS), which was developed to measure observed feeding interaction quality during infancy and toddlerhood (Hodges et al., 2013). The RCFCS is based on attachment theory (Ainsworth & Bell, 1969; Bowlby, 1969; Lamb & Easterbrooks, 1981) and reflects a transactional perspective (Sameroff & Chandler, 1975) of responsive feeding, in which

infant and caregiver behaviors affect and are affected by one another over the course of feeding. Behaviors assessed for hunger and fullness in the infant and toddler were selected from a variety of sources, including the limited existing literature at the time (Crow, 1977; Gesell & Ilg, 1937; Korner, Chuck, & Dontchos, 1968; Morris et al., 1983), other measures including the Nursing Child Assessment Feeding Scale (Sumner & Spietz, 1994), qualitative research on factors influencing maternal decisions to initiate and stop feeding their infants (Hodges, Hughes, Hopkinson, & Fisher, 2008), and the clinical and research experiences of the RCFCS development team, including a nurse practitioner, a lactation physiologist, nutritionists, and a developmental psychologist.

The RCFCS includes feeding cues that reflect developmental transitions from early infancy through toddlerhood up to 2 years of age (see Table 1). There are 48 different types of feeding cues; 20 thought to reflect hunger and 28 thought to reflect fullness or satiation (Blundell et al., 2010). The RCFCS was designed to allow microanalytic coding (Bakeman & Quera, 2011) and is used to code videos of feeding interactions. Hunger cues are coded (ideally 10 minutes prior to the first bite or food to mouth in the case of breast or bottle-feeding) until the caregiver begins to prepare food (infant is placed in feeding location/position or caregiver begins to prepare food—whichever comes first). Fullness cues are coded beginning 1 minute after the 1st bite is taken until food or the infant is removed from the feeding location. All 48 hunger and fullness cues are coded from the time of food preparation until 1 minute after the first bite in order to assess the degree of the infant's receptiveness to or disinterest in feeding (Hodges et al., 2013). Feeding cues are categorized as early (e.g., sucking on objects, slowing or pausing), active (e.g., opening mouth wide when presented with food, pushing food away), or late (e.g., crying) to reflect the ways that infants are thought to communicate, subtly at first but increasingly overt until a response is received (Beebe & Stern, 1977).

Procedures

In the Infant Care study, mothers were video-recorded with a systematic protocol in their home environments during a feeding episode with their infants at 3, 6, 9, 12, and 18 months (Sacco, Bentley, Carby-Shields, Borja, & Goldman, 2007). The research team told mothers they and their infant would be video-recorded during feeding and a camera would be set up in the feeding location. Mothers were asked to show and tell what they were feeding their infant and to act as they normally would if the research team were not present. Once recording began, the videographer did not look directly at the mother or the infant, but instead assessed feeding progress through the camera's viewfinder. Recording ended when the mother said feeding was completed and showed what food was remaining (if applicable). Due to the protocol with which the videos were recorded, coding of cues consistent with the RCFCS's definition of hunger was not possible.

Two coders (authors HW and BC) received extensive training from the first author (EAH) and tested to 85% agreement against gold standard training tapes prior to coding tapes. Interrater reliability and observer drift were assessed initially through testing against a gold-standard, then every 2 months, and at the end of coding. Coding meetings were held bi-weekly. Forty tapes (~18% of the total sample) were coded by both HW and BC to assess

interrater reliability through weighted Cohen's kappa at each infant age and overall. Coders were limited to no more than 2 tapes per day and 8 tapes per week to minimize fatigue. They were blinded to the research questions and infants' BMI Z score. Videos were randomly assigned to coders initially; then assigned a coding schedule to ensure that tapes were coded out of chronological order and no subjects had two feedings coded the same day. Weighted kappas for interrater reliability were $k = 0.75$ for receptiveness and $k = 0.71$ for fullness.

Analysis

Descriptive statistics of feeding cue frequency at each time point were used to characterize developmental progression using SPSS version 22.0

Results

Participants

On average mothers were obese and in their early 20s at baseline (see Table 2). Less than half were currently working, >40% were not educated beyond high school, and most were single. Just over half of the infants were male. Only 20% of the infants were being breastfed at 3 months of age; 93.3% were receiving formula and 80% were already consuming solid foods, which aligns with the overall Infant Care sample (Wasser et al., 2011).

Feeding Cues

Early receptiveness cues were relatively rare over time, with sucking the most dominant, though it predictably decreased as infants transitioned to complementary foods (foods other than breastmilk or formula). Active receptiveness cues were much more common compared to early receptiveness cues, with opening mouth wide, latching on, or feeding self, predominating at each time point (see Figure 1; supplemental digital content). Rooting or nuzzling was rare in this group, seen only twice, at 3 months of age and none thereafter. However, there were patterns of increasing and decreasing of cues reflecting development over time. For example, settling into the feeding decreased from ~50% at 3 and 6 months to 4.8% by 18 months, whereas postural attention and reaching for food increased at 6 months and remained relatively stable to 18 months. Excitatory limb movements peaked at 6 months, but thereafter accounted for a relatively low percentage of active receptiveness cues overall. Fidgeting or squirming and excitatory or affirming vocalizations were infrequent. Crying, a late receptiveness cue was rarely seen, and moving the head frantically from side to side and temper tantrums were not seen at all.

Early cues indicating disinterest in feeding were most often infants taking more interest in their surroundings than food or looking away (see Figure 2; supplemental digital content). This cluster of cues jumped in frequency from 6 to 9 months and thereafter remained the most common early disinterest cue. Decreasing activity level predominated at 3 and 6 months, but decreased at 9 months and was not seen afterward. Moving the hand to the face, not opening the mouth until the spoon was at the lips, slowing or pausing, and averting the gaze were less prevalent, but persisted over time. Decreased muscle tone, turning the head in response to food, and grimacing, pouting, or frowning were rarely observed. The most prevalent active disinterest cues included detaching from the nipple and turning or pulling

away abruptly (see Figure 3; supplemental digital content). These were followed in prevalence by infants: taking off their bib, attempting to leave the feeding location, refusing to open their mouths when food was presented, and playing with food or surrounding items. Other cues were more rarely seen, though infants shaking their heads or saying “No” were among the most frequent at 18 months.

In the first six months, decreasing muscle tone and activity level were the most common early fullness cues (see Figure 4). Thereafter, taking interest in surroundings was most prevalent. Slowing or pausing and bringing the hand to the face were among the most frequent early fullness cues at all time points. Overall, a transition was seen from decreasing activity to more alertness and less interest in continuing with feeding.

In the first 6 months, falling asleep and detaching from the nipple were the most frequent active fullness cues, followed by pulling or turning away abruptly (see Figure 5). Active fullness cues became increasingly diverse after 6 months, led by more assertive cues such as playing with food or surrounding items, pushing or pulling away, and communicating “no” verbally or non-verbally. Detaching from nipple began its steady decrease at 12 months of age, reflecting the transition to complementary foods. Late cues, such as crying, were observed on only a few occasions (data not shown).

Discussion

These findings provide empirical description of waxing and waning in feeding cues and indicate increasing intentionality (more deliberate than reflexive use) of cues over the first 18 months of life and are consistent with the single prior study of similar design and longitudinal scope of Gesell and Ilg (1937). Consistency in feeding cue development is noteworthy despite approximately 70 years between studies and Gesell and Ilg’s sample of 10 dyads of middle class non-Hispanic White children. Parallels in development of fullness behaviors, though not as varied as those in this study, was also noted in a study of 20 Czech infants over the first 6 months of life (Paul, Dittrichová, & Papoušek, 1996) and 30 approximately year old English infants (Young & Drewett, 2000).

This study adds descriptions of a more comprehensive range of observed feeding cues than previously documented. The cues are organized in ways that are thought to reflect the ways infants communicate (Beebe & Stern, 1977), which refines future research and provides enhanced clinical guidance.

Since participants were low-income, non-Hispanic Black first-time mothers and their infants, generalizability is limited. However, as these infants were all typically developing, there is little reason to suspect differences in the range of feeding behaviors on the basis of race alone. This is underscored by the consistency with prior findings in other racial groups (Gesell & Ilg, 1937; Paul, Dittrichová, & Papoušek, 1996; Young & Drewett, 2000). Infant feeding behaviors are grounded in a relationship with a caregiver and adapt within that context (Sander, 1975). General parenting styles and behaviors vary both within and between cultures (Keller et al., 2006), which has been demonstrated in self-reported parental feeding styles, as well (Lumeng et al., 2012). Thus, while it is possible that infants in other

ethnic groups may demonstrate different *patterns* of feeding cues at different points along development based on the parenting they receive, significant variation in *types* of cues has not been observed (Hodges & Fisher, 2007).

An important consideration is the sample's low breastfeeding rate. One might expect differing patterns of cues for infants whose mothers engage in exclusive breastfeeding or breastfeeding of longer duration. Lower breastfeeding rates have been associated with higher self-reported maternal control of feeding (Brown, Raynor, & Lee, 2011) or pressuring and indulgent feeding styles (Thompson et al., 2013).

Participants were aware that their interactions were being recorded so there is potential that they were distracted by or reacted to the camera and the research assistants. As part of the study protocol, mother-infant dyads were given time to acclimate to presence of research staff and videographers did not interact or make eye contact with dyads over the course of feeding.

Clinical Implications

Knowing common cues at various points in development may aid clinicians in enhancing parental feeding responsiveness. Parents can be taught common cues to indicate their infant's readiness to eat along with cues that their infant is getting full. Many of the cues described are specific to feeding and relatively overt and clear, others are more subtle or non-specific (e.g., mouthing, which may simply reflect infant exploratory behavior, or crying, which can have any number of sources). Rather than relying on any particular cue in isolation, it is more likely that parents correctly interpret hunger and fullness when they rely on combinations of cues paired with knowledge of timing and content of the infant's last meal. Given variability in meal-to-meal intake across any given day (Pearcey & de Castro, 1997) it is likely that cues will vary over the course of the day, as well, in light of variations in hunger and satiety and parents should be made aware of this. By knowing how these cues change over time, clinicians can offer anticipatory guidance to parents that can help support responsive feeding, thereby preventing overfeeding, and thereby decreasing risk of obesity during infancy.

Clinical Implications for Nurses

- Nurses in clinical settings can use these cues to be more responsive feeders when caring for patients who are infants.
- Nurses can offer anticipatory guidance to parents about the ways feeding cues change over development to enhance parental feeding responsiveness and prevent overfeeding.
- Nurses can teach caregivers to be attentive their particular child's cues, explaining that cues can range from subtle to overt, may differ meal to meal, and will change with age.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

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Callouts

The first two years of life are a particularly important period for development of obesity and its prevention.

Helping caregivers recognize the range of hunger and fullness cues an infant might express over the course of development is essential to responsive feeding.

The range of feeding cues is organized in the way infants are thought to communicate.

Knowing common cues at various points in development may aid clinicians in enhancing parental feeding responsiveness.

Figure 4.
Early Fullness Cues from 3-18 Months

Figure 5.
Active Fullness Cues from 3-18 Months

Table 1

Responsiveness to Child Feeding Cues Scale (RCFCS) Feeding Cues

Child Feeding Cues	EARLY	ACTIVE	LATE
Hunger/ Receptiveness	Sucking	Rooting/nuzzling	Moving head frantically from side to side
	Opening/closing mouth repeatedly	Asking for food/excitatory or affirming vocalization	Crying
	Smacking/licking lips	Excitatory limb movement	Temper tantrum
	Increased alertness	Leaning/crawling/walking toward food	
		Bring or show bottle/spoon/cup/food to caregiver	
		Hitting caregiver on arm/chest	
		Motion to be placed in feeding location	
		Postural attention	
		Settling into feed/decrease in tension ^a	
		Open mouth wide/latching on/feeding self ^a	
		Fidgeting or squirming ^b	
		Fussing or whining ^b	
Fullness/ Disinterest	Hand-to-face	Pushes tray or feeding hand away	Crying
	Decreased muscle tone	Gives back food/utensils/bottle/cup	Sleeping
	Does not open mouth until spoon at lips	Pulls/turn away abruptly	Physically struggling/arching
	Takes interest in surroundings/looks away	Falling asleep	Vomiting
	Decreased activity level	Maximal lateral gaze aversion	
	Lip grimace/pout/frown	Refuse to open mouth	
	Slows or pauses	Takes off bib/attempts to leave feeding location	
	Gaze aversion	Biting spoon/nipple	
	Turning head in response to food	Detach from nipple	
		Tray pound	
		Saying 'no' or shaking head 'no'	

Child Feeding Cues	EARLY	ACTIVE	LATE
		Plays with food or surrounding items	
		Spitting or ejecting food from mouth	
		Fussiness or whining ^{<i>b</i>}	
		Physically agitated/squirming ^{<i>b</i>}	

Note.

^{*a*} = Receptiveness only.

^{*b*} = Negative Active Cue.

Table 2

Maternal and Infant Characteristics

Characteristics	Low (n = 15)	Median (n = 15)	High (n = 15)	Total (n = 45)
Maternal	<i>M (SD)</i>	<i>M (SD)</i>	<i>M (SD)</i>	<i>M (SD)</i>
Age (years)	23.21 (4.93)	21.27 (2.02)	22.34 (4.33)	22.27 (3.95)
BMI	32.96 (8.97)	26.20 (6.17)	30.95 (5.71)	30.04 (7.5)
High School Grad	68.8%	46.7%	53.8% (n = 13)	58.1% (n = 43)
Single	93.8%	93.3%	80%	88.9%
Currently working	43.8%	53.3%	40%	44.4%
Infant				
Sex (Female)	46.7%	60%	26.7%	44.4%
Breastfed	13.3%	26.7%	20%	20%
Formula Fed	100%	93.3%	86.7%	93.3%
Solids	100%	66.7%	73.3%	80%

Note. Maternal and infant characteristics are based on baseline data at 3 months of infant age.