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Early Hum Dev. Author manuscript; available in PMC 2021 December 09.

Published in final edited form as:

Early Hum Dev. 2018 June ; 121: 21–26. doi:10.1016/j.earlhumdev.2018.04.018.

Relationship between Mother-Infant Mutual Dyadic Responsiveness and Premature Infant Development as Measured by the Bayley III at 6 Weeks Corrected Age

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Abstract

Background: The quality of mother-preterm infant interaction has been identified as a key factor in influencing the infant's later development and language acquisition. The relationship between mother-infant responsiveness and later development may be evident early in infancy, a time period which has been understudied.

Aim: Describe the relationship between mother-infant mutual dyadic responsiveness and premature infant development.

Design: This study employed a secondary analysis of data from the 6-week CA follow-up visit of the Hospital-Home Transition: Optimizing Prematures' Environment (H-HOPE) study, a

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Conflict of Interest Statement

The authors wish to confirm that there are no known conflicts of interest associated with this publication and there has been no significant financial support for this work that could have influenced its outcome.

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randomized clinical trial testing the efficacy of a mother- and infant- focused intervention for improving outcomes among premature infants.

Subjects: Premature infants born between 29 and 34 weeks gestational age and their mothers who had social-environmental risks.

Outcome measures: At 6-weeks corrected age, a play session was coded for the quality of mutual responsiveness (Dyadic Mutuality Code). Development was assessed via the Bayley Scales of Infant and Toddler Development, 3rd edition.

Results: Of 137 mother-infant dyads, high, medium and low mutual responsiveness was observed for 35.8%, 34.3% and 29.9%, respectively. Overall motor, language and cognitive scores were 115.8 (SD = 8.2), 108.0 (7.7) and 109.3 (7.9). Multivariable linear models showed infants in dyads with high versus low mutual responsiveness had higher scores on the motor (β = 3.07, p = 0.06) and language (β = 4.47, p = 0.006) scales.

Conclusion: High mutual responsiveness in mother-premature infant dyads is associated with significantly better language development and marginally better motor development.

Keywords

mother-infant interaction; social responsiveness; premature infants; language development; motor development; premature infant behavior during social interaction

Introduction

At least 50% of infants born prematurely have neurobehavioral impairments such as cognitive deficits, learning disabilities, impaired speech, or emotional-behavioral problems [1-6]. Of particular concern, premature infants are at increased risk for delay in language [7, 8] and motor development [4, 9-11]. Early developmental programs have been shown to improve cognitive outcomes and motor development in preterm infants [12]. The quality of mother-preterm infant interaction has been identified as a key factor in exacerbating or mitigating negative outcomes, particularly those related to the infant's later development [1, 4, 13], including motor development and language acquisition [1, 4]. Specifically, studies of mothers and their formerly full term infants show that the role of maternal verbal stimulation and the sensitivity with which a mother shows while interacting with her infant predicts attachment security [14] and influences social-emotional development and future health [15]. However, establishing high quality mutual dyadic responsiveness is often hampered by the lack of clarity in cues and limited responsiveness frequently demonstrated by preterm infants, as well as the lack of understanding among their mothers about how to read and respond to their infants' subtle cues [16]. Preterm infants tend to vocalize and smile significantly less frequently, are less responsive to their mothers, show less reactivity to social stimuli and have lower clarity of cues compared with full term infants [17].

Maternal Responsiveness

Interactive behaviors of mothers of preterm infants are different than those of mothers of full term infants, perhaps due in part to less responsivity of their infants [14]. Mothers of preterm infants show less positive affect, pause less during play, and over-stimulate their infants

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in an effort to elicit increased responses from their less active infants [18]. As a result, mother-preterm infant dyads often demonstrate a “controlling pattern” of interaction when formerly preterm infants born at less than 34 weeks gestation reach six months CA. While mothers are controlling, the infant becomes “compulsive-compliant.” In contrast, mother-term infant dyads more often exhibit the “cooperative pattern” of interaction in which the mother is sensitive to her infant’s cues and the infant is more cooperative and responsive [1]. Infants experiencing a controlling pattern of interaction demonstrate significantly lower personal-social and hearing-speech scores as measured by the Griffiths developmental scales (0–2 years) [1]. A maladaptive pattern of mother-infant interaction is exacerbated when the mother is an adolescent [19], has low education, and low income [20] but has been shown to be modifiable when maternal behavior interventions such as the Auditory, Tactile, Visual, and Vestibular or H-HOPE interventions are instituted [18, 21].

At the other end of the spectrum, positive maternal responsiveness plays an important role in reversing some of the adverse developmental effects common among preterm infants [1, 22]. A high level of maternal responsiveness is demonstrated when a mother responds consistently to the infant’s behavior, reinforces desired behavior, and communicates and uses words and actions that support social, emotional, and cognitive development [3, 16, 23].

Language and Cognitive Development

Investigators have found that preterm children exhibit lower levels of language development than full term children [4-8, 16, 24]. Landry et al. [22], reported that when mothers were more responsive to the infant’s interests during structured play, their infants had more advanced language skills and faster language development. Expressive and receptive language abilities play a vital role in school and their social competence and social relationships, the acquisition of numeracy, and emergent literacy skills [25]. Several investigators have reported a positive relationship between sensitive parenting and cognitive development [1, 2, 16, 26]. Additionally, family social risk at birth and parent-child synchrony are key predictors of a child’s overall language development at 4 years of age [25].

Purpose

This relationship between mother-infant responsiveness and later development may be evident much earlier in infancy, a time period that has been understudied. This study describes the relationship between the quality of mutual dyadic responsiveness and infant cognitive, language and motor development at 6-weeks corrected age (CA) for infants born preterm to women at high social-environmental risk.

Materials and Methods

Design

This secondary analysis employed a cross-sectional design using data from the 6-week CA follow-up visit of the Hospital-Home Transition: Optimizing Prematures’ Environment (H-HOPE) study, a randomized clinical trial testing the efficacy of a mother- and infant-focused intervention for improving outcomes among premature infants.

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Setting and Sample

The H-HOPE study (n = 198) was conducted at two inner city community hospitals, one with a Level II and one with a Level III neonatal intensive care unit (NICU). The infants were eligible if they were born between 29 and 34 weeks gestational age (GA), had no other major health problems (e.g. oxygen dependence or current infection requiring treatment), and were clinically stable at enrollment. Infant exclusion criteria included congenital anomalies, necrotizing enterocolitis, brain injury, chronic lung disease, HIV, and prenatal drug exposure. Infants from multiple gestations were eligible, but only one infant of each multiple gestation was randomly selected to participate in the research. Mothers were eligible if they had at least two social-environmental risk factors: self-identified as African-American or Latina, less than high school education, less than 18 years old, history of current mental illness, depression, family income less than 185% of federal poverty level (FPL), more than one child under 24 months, 4 or more children under 4 in the household, or resided in a disadvantaged neighborhood. Mothers were excluded if their medical charts indicated a positive screen for illicit drug use or if they had lost legal guardianship of their infants.

Of the 198 eligible mother-infant dyads enrolled, 149 (75.3%) were retained for the 6-week CA visit. The only difference between dyads who returned and did not return for the 6-week CA follow-up visit was GA, with those returning born at a significantly younger GA on average compared to those not returning. Eight infants had missing data for mother-infant interaction and an additional four infants were missing developmental assessment data due to infant fatigue, fussiness or unavailability of the developmental evaluator. Thus, we had a final sample of 137 dyads for this secondary analysis. While in the H-HOPE study we previously found a significant intervention effect on mother-infant interaction [18], there were no significant differences in Bayley III composite scores for infant development between intervention and control infants. Therefore, we combined the intervention and control groups for this secondary analysis.

Mothers in the sample were African American (49.6%) and Latina (50.4%). Mean maternal age was 26.1 years (SD = 6.5). There were 72 male infants and 65 female infants. Mean infant GA at birth was 32.6 weeks (SD = 1.5) and mean infant birth weight was 1822 grams (SD = 402). The mean chronological age of the infants at the 6-week follow-up was 13.4 weeks (SD = 1.9). See Table 1 for sample characteristics.

Measures

Mother-Infant Interaction—The independent variable in this secondary analysis was mutual dyadic responsiveness during play, as measured by the Dyadic Mutuality Code (DMC) at 6-weeks CA [18, 27]. The DMC measures levels of mutual dyadic responsiveness in infant-adult interaction. The DMC consists of six items that represent key components of mutuality: mutual attention, positive affect, mutual turn-taking, maternal pauses, infant clarity of cues, and maternal sensitivity to cues and responsiveness. The items are added for a total score (range 6-12). High mutual dyadic responsiveness is defined for this study as a score of 11-12, moderate as 9-10 and low as 6-8. Mutual attention was rated based on the total amount of time the mother-infant pair simultaneously exhibited face-to-face attention.

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Joint positive affect measured how pleasurable the interaction appeared to both partners and was determined by observing facial expression (smiles, grimaces, frowns, raising eyebrows, making an “o” shape with their mouth) and vocalizations (laughing, cooing, crying). Mutual turn-taking was indicated by the presence of cycles of reciprocal behavior, either imitation or play in which one partner elicits and the other responds (such as mother talks and the child mouths or verbalizes a sound in return) that repeated. The presence of maternal pauses was rated when the mother waited and ceased all stimulating behaviors in order to provide time for the infant to respond. Clarity of cues was scored based on how clearly the infant indicated by behavior, a desire for the stimulation to continue or cease. Maternal sensitivity to cues and responsiveness was rated when the mother read the infant's behavior appropriately and adjusted stimulation accordingly. Scoring was completed following the scoring instructions [16]. DMC reliability and construct and concurrent validity have been demonstrated using healthy term and preterm infants and in high risk infants [16]. For this study, inter-rater reliability of DMC scores from videotaped play sessions remained above 98% agreement between the primary and a secondary coder.

Motor, Cognitive, and Language Development.—The outcome variables in this secondary analysis were composite scores on the infant motor, language and cognitive subscales of the Bayley Scales of Infant Development Third Edition (Bayley III). While the Bayley III measures five domains: motor, cognitive, language, social-emotional, and adaptive behavior, the social-emotional and adaptive scales are quantified in quarterly or monthly increments, whereas the motor, cognitive, and language subscales are quantified in 10 day increments [28]. Because we were testing at 6-weeks CA and needed high resolution measures, we chose the motor, cognitive, and language scales. At 6-weeks CA, the Motor Scale assesses hands fisted, eye movements left to right following a moving person and a ring (horizontal and vertical movement), and purposeful attempts to bring hand to mouth. For this age, the language scale evaluates the beginnings of verbal communication such as undifferentiated throaty sound, social smile in response to the caregiver’s attention, expressive vocalizations including vocalizing of mood (e.g. cry), and social vocalizing or laughing in response to the caregiver’s attention. At 6-weeks CA, the cognitive scale assesses sensory-perceptual acuities, discriminations, and the ability to respond to these, including calming when picked up by the caregiver, responding to surroundings by freely turning eyes or head to visually explore surroundings, gazing continuously at an object for at least three seconds, orienting to the rattle followed by habituating to the rattle, discriminating between objects by exhibiting a behavioral change to a new sound, and recognizing caregiver. The technical manual for the Bayley III reports reliability coefficients for the motor composite (.86), language composite (.82) and cognitive scale (.89) and high internal consistency among nine diagnostic groups of infants for the scales [28]. Test-retest stability of the scales has also been documented from 2 months through 42 months [29, 30].

Covariates

Maternal demographic characteristics consisted of: age in years; race and ethnicity (Latina or African American), interview language preference (English or Spanish), education appropriate for age, parity (primiparous versus multiparous), co-habitant of the mother (baby’s father, her mother or another adult or single), and income as a percentage of the

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federal poverty level (FPL) (<185% of the federal poverty level, or ≥185% of the federal poverty level). Education was categorized as appropriate for age if women were 20 years and older and had finished high school or a GED or women were younger than 20 and had finished high school or were still in school right before the delivery. Infant characteristics consisted of the child's sex, GA in weeks, birth weight in grams, five minute Apgar score, infant morbidity during hospitalization according to the Problem-Oriented Perinatal Risk Assessment System (POPRAS) score [31], and plurality (singleton or twin/triplet). Intervention group (Attention Control and H-HOPE) was also included in the analysis as a covariate.

Procedure

The Institutional Review Boards of the university and the two clinical sites approved the H-HOPE study. Informed consent was obtained at enrollment in the hospital, shortly after the infant's birth. The H-HOPE intervention was offered twice daily and began in the hospital when the infant reached 32 weeks PMA and continued in the home until the infant reached 44 weeks PMA, two weeks prior to the 6-week CA assessment. Mothers assigned to the Attention Control Group received information about infant care, e.g. "Back to Sleep," and infant bathing by a member of the team. For the H-HOPE study, maternal sociodemographic characteristics were collected via a maternal interview at enrollment, infant characteristics were obtained from the medical record, and mother-infant interaction and infant development were assessed at a 6-week CA follow-up visit at the university. This H-HOPE follow-up visit lasted approximately 2.5 – 3 hours for each mother-infant dyad and included infant measurements, a maternal interview and a videotaped feeding session, in addition to the assessment of mother-infant interaction and infant development. The progression/order of the evaluation sessions occurred based on the infant's needs for feeding and sleep.

For the assessment of the DMC, mothers were given standard instructions for a 5 minute play session with their infants. The observer instructed the mother to place the infant in the infant seat so that the mother and infant were on the same eye-level and had a full view of each other's face. Mothers placed their infants in the same infant seat used for all play sessions. All infants remained in their infant seats for the duration of the play session. The mother was instructed to play with the infant as she usually does but without a toy or pacifier. All assessments were conducted/recorded in the same private, quiet room that had a door and was free from distractions. The session was video recorded by a research assistant while the mother and infant were face to face. No other individuals were in the room. The video camera was positioned on a tripod facing away from the window. This session was later coded by a member of the research team who was blinded to group assignment and DMC scores. A second rater coded 25% of the video recordings. Inter-rater agreement was maintained at greater than 90%.

During the evaluation visit, The Bayley III assessment was conducted by a trained physical therapist who was blinded to group assignment. We assessed inter-rater reliability for a randomly selected 25% of the Bayley assessments from a video recording of the original administration of the tests. An experienced Developmental Psychologist and Bayley III

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examiner, blinded to group assignment and the scores given by the original raters, re-scored the motor, language and cognitive scales of the test. Inter-rater reliability was determined using the intraclass correlation coefficient (ICC) and can be interpreted as very good to excellent when the ICC is 0.75 or higher, and moderate to good with ICCs between 0.50 and 0.75 [32]. The ICC was 0.75 (95% CI = 0.46, 0.88) for the motor scale, 0.75 (0.51, 0.87) for the language scale, and 0.73 (95% CI = 0.46, 0.86) for the cognitive scale.

The order of the evaluation components at the 6-week CA visit varied depending on the infant's physical needs and infant behavioral state which required the infant to be alert for the play session. Typically, the developmental assessments were performed first, and the DMC was evaluated near the end of the visit.

Statistical Methods

The maternal and infant characteristics, and the raw, scaled and composite scores of the Bayley-III Scales of Infant Development, were analyzed using descriptive statistics. Analysis of variance (ANOVA) was used to examine differences in the mean Bayley motor, language and cognitive subscale composite scores for high, medium and low levels of mutual dyadic responsiveness according to the DMC. Multivariable linear regression was implemented to examine the relationship between level of mutual dyadic responsiveness and the composite scores on the Bayley-III Scales of Infant Development. The maternal and infant characteristics and intervention group were examined as potential covariates for each of the models and manual backward selection was used to choose covariates for each model. Alpha was set at 0.05; marginal significant results (trends) were noted for $p < 0.10$. These analyses were performed using IBM SPSS Statistics software Version 19.

Results

Overall, the sample consisted of 41 (29.9%) dyads in the low mutual dyadic responsiveness group, 47 (34.3%) in the moderate group, and 49 (35.8%) in the high mutual dyadic responsiveness group. Mean raw, scaled and composite scores for the Bayley-III subscales are presented in Table 2. The mean composite score for the Motor subscale was 115.8 (SD = 8.2), for the Language subscale was 108.0 ($SD = 7.7$) and for the Cognitive subscale was 109.3 ($SD = 7.9$).

Mean composite scores for the Bayley-III language subscale were significantly different across the three levels of mutual dyadic responsiveness. Although mean Bayley scores appear similar, there was a significant difference between the low and high DMC groups (a difference of 4.5 points $p = 0.006$). The mean scores for the Bayley-III motor subscale and cognitive subscale were higher for infants in dyads with high mutual dyadic responsiveness, but differences were not significant (Table 3).

Results from multivariable linear regression models, shown in Table 4, indicate that mutual dyadic responsiveness has a significant positive relationship with the composite language scale of the Bayley-III Scales of Infant Development and that no other maternal or infant factors were significantly associated with language development. Compared to the low mutual dyadic responsiveness group, the high mutual dyadic responsiveness group scored

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4.5 points ($p = 0.006$) higher on average and the moderate mutual dyadic responsiveness group scored 2.3 points ($p = 0.16$) higher on average on the Bayley-III Language subscale. High mutual responsiveness indicates a trend towards a positive relationship with the motor scale composite of the Bayley-III ($p = 0.06$), after adjusting for significant covariates. The results do not indicate that there is any significant relationship between mutual dyadic responsiveness and the composite cognitive scale of the Bayley-III Scales of Infant Development (Table 4).

Of the covariates, race/ethnicity and infant morbidity were significantly associated with motor development, with infants of Latina mothers demonstrating significantly lower Bayley-III motor scores than infants of African-American mothers, and infants with higher morbidity (according to the POPRAS) demonstrating significantly lower motor scores. For the Bayley-III cognitive subscale, infants of mothers who did not live with the baby's father had significantly lower scores than infants of mothers who lived with the baby's father, and infants from multiple births had lower scores than singletons.

Discussion

In this study, premature infants who demonstrated high mutual dyadic responsiveness during a play session with their mothers had better language development than infants in dyads with low levels of responsiveness. In addition, marginally higher motor development scores were observed for infants in dyads with high versus low mutual dyadic responsiveness. Cognitive scores did not differ by level of responsiveness.

Our findings are consistent with previous research suggesting there is a correlation between the quality of mother/infant responsiveness and language development [2, 16, 22, 24-26, 33]. Previously, little research was available about the relationship between level of mother/preterm infant responsiveness and language development during early infancy [4]. These findings also support the publication by Caskey et al. that showed reciprocal interactions of mothers and high risk infants involving maternal response to infant vocalizations in the NICU [34] improves infant language function at 18-22 months of age. Our findings are the first to identify a significant relationship between high levels of mutual dyadic responsiveness and improved language development as measured by the Bayley III scale at an early age (6-weeks CA). Early interventions that teach mothers how to be more responsive to their infants' attentive behavior and how to reinforce infant vocalizations are likely to improve infant language development among preterm infants [35, 36]. If improved mother-infant mutual dyadic responsiveness can enhance early language development among premature infants, this suggests a potential target for intervention.

In this study, we found a trend toward improved motor composite score in the infants from the dyads with strong mutual dyadic responsiveness. Many of the motor subscale items require good head control in order to succeed. A possible explanation for our finding is that the social interactions between the mother and infant facilitate the development of head control. The more the infant lifts the head in an attempt to locate the mother for social interaction, the more head control is achieved. Alternatively, infants who demonstrate better head control might be better able to locate the sound of their mothers' voices and thus

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achieve better responsiveness scores. Given the cross-sectional nature of this analysis, the direction of the relationship between head control and mutual responsiveness is not clear and warrants further study.

We found little evidence that infant cognitive development was correlated to mutual dyadic responsiveness score at 6-weeks CA, but this may be too early to assess this outcome and differences may emerge later in the infant's development. Past studies have assessed children born preterm at later developmental ages and have found significant relationships between quality of parent-child interactions and cognitive development [3].

Limitations

This study has many strengths, including the systematic assessment of mother-infant mutual dyadic responsiveness and infant development by trained and blinded study personnel. In addition, this study targeted and enrolled a population of mothers at high social-environmental risk who delivered preterm infants, a vulnerable population that is understudied. As in any study, there were also some limitations. Infant development measurements were limited to a one-time assessment at 6-weeks CA via the Bayley III scale. Future research might better supplement these findings by using an additional measure such as the Fagan test of infant intelligence or other measures to provide more comprehensive results [37]. The Bayley III may not have as high a level of specificity in measurement for this age group as other measures have [29, 38]. Additionally, the Bayley III has received much scrutiny in the literature recently for tending to overestimate developmental outcomes compared to previous versions of the Bayley [29, 39]. Our findings are in agreement with other researchers in that the means for the infants in this study were considerably above the published means in the normative study for the Bayley III. While it remains unclear whether the Bayley III at 6-weeks CA is a valid measure of language skills, these results are the first to evaluate the link between dyadic responsivity and language at this age. Another limitation of this study was the loss to follow-up before the 6-week CA visit due to some mothers moving out of the area or discontinuing their telephone services. Finally, while this study provides important new information about low income African- American and Latina mother-premature infant dyads, generalizability is limited for other groups.

Conclusion

The findings reported in this study are significant because parenting style is a potentially modifiable influence that may promote improved developmental outcomes in children born preterm [1]. Low income mothers of preterm infants, many of whom also have minority status and low levels of education, are at increased risk of experiencing poor outcomes with respect to mother-infant interaction and infant development [4, 20, 40]. The results suggest that interventions during infancy to improve mutual dyadic responsiveness of mothers and preterm infants at high social-environmental risk may contribute to better infant language and motor development. Interventions that encourage maternal sensitivity to cues, responsiveness, and positive affect, ultimately increasing levels of mutual dyadic responsiveness between mother/infant dyads, could promote optimal developmental outcomes for preterm infants already at high risk for delays. Future studies of

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preterm infants should target interventions that facilitate positive mother-infant interaction, especially mutual responsiveness, and assess its effects on infant development.

Acknowledgements

This study was funded by the National Institute of Child Health and Development and the National Institute of Nursing Research, Grant 1 R01 HD050738-01A2 and the Harris Foundation. We thank all the mothers and infants who have participated in this project.

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Highlights

- Establishing high quality mutual dyadic responsiveness is often hampered by the lack of clarity in cues and limited responsiveness frequently demonstrated by preterm infants, as well as the lack of understanding among their mothers about how to read and respond to their infants' subtle cues.
- Family social risk at birth and parent-child synchrony are key predictors of a child's overall language development at 4 years of age.
- This secondary analysis employed a cross-sectional design using data from the 6-week CA follow-up visit of the Hospital-Home Transition: Optimizing Prematures' Environment (H-HOPE) study, a randomized clinical trial testing outcomes for premature infants of a mother- and infant- focused intervention.
- Mutual dyadic responsiveness at 6-weeks corrected age has a significant positive relationship with the composite language scale of the Bayley-III Scales of Infant Development.
- Race/ethnicity and infant morbidity were significantly associated with motor development, with infants of Latina mothers demonstrating significantly lower Bayley-III motor scores than infants of African-American mothers, and infants with higher morbidity demonstrated significantly lower motor scores.
- The findings are significant because parenting style is a potentially modifiable influence that may promote improved developmental outcomes in children born preterm.

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Table 1

Characteristics of Mothers and Infants in Sample, H-HOPE Study (n = 137 dyads)

Characteristic	%	mean (SD)
Maternal Characteristics		
Age		26.1 (6.5)
Race/Ethnicity		
African-American	49.6	
Latina	50.4	
Language Preference		
Spanish	33.6	
English	66.4	
Education for Age [a]		
Appropriate	78.7	
Low	21.3	
Parity		
Primiparous	42.3	
Multiparous	57.7	
Living Situation		
With Baby's Father	58.8	
With Mother or Other Adult	27.2	
Single	14.0	
Income as a % of the FPL		
≥185%	11.9	
<185%	88.1	
Infant Characteristics		
Gestational age at birth		32.6 (1.5)
Birthweight		1822 (402)
Apgar score (5 min)		8.2 (1.1)
Infant Morbidity During Initial Hospitalization (POPRAS)		71.5 (19.9)
Sex		
Female	47.4	
Male	52.6	
Plurality		
Singleton	90.5	
Twin/Triplet	9.5	

[a] Education is considered appropriate for age if woman is 20 or older and has a high school degree or GED, or if a women is younger and has a high school degree or is still enrolled in school

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Table 2

Raw, Scaled and Composite Bayley-III Scores at Six-Weeks Corrected Age for Infants born Preterm (29-34 weeks), H-HOPE Study (n = 137)

Bayley-III Scale	Mean	SD	Minimum	Maximum
Motor				
Raw Score	16.55	3.35	6	24
Scaled Score	25.54	5.24	18	77
Composite Score	115.76	8.22	94	136
Language				
Raw Score	10.53	2.78	7	15
Scaled Score	22.74	2.69	18	32
Composite Score	108.00	7.74	94	129
Cognitive				
Raw Score	9.59	2.15	5	24
Scaled Score	11.85	1.60	7	17
Composite Score	109.26	7.94	85	135

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Table 3

Mean Composite Scores for Bayley-III Scales of Infant Development Relationship by Level of Mother-Infant Mutual Dyadic Responsiveness, H-HOPE Study (n = 137 dyads)

Mutual Dyadic Responsiveness	Bayley-III Scales of Infant Development		
	Motor Scale mean (sd)	Language Scale* mean (sd)	Cognitive Scale mean (sd)
High (n = 49)	117.2 (8.4)	110.1 (8.1)	110.6 (9.1)
Moderate (n = 47)	115.7 (7.9)	107.9 (7.7)	108.4 (7.6)
Low (n = 41)	114.2 (8.3)	105.6 (6.7)	108.6 (6.7)

* $p < 0.05$ tor ANOVA

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Table 4

Linear Regression Results for the Relationship between Level of Mutual Dyadic Responsiveness and Composite Scores on the Bayley-III Scales of Infant Development, adjusting for covariates, H-HOPE Study

	Bayley-III Scales of Infant Development								
	Motor Scale (R^2 = 0.14, *n* = 134)			Language Scale (R^2 = 0.08, *n* = 137)			Cognitive Scale (R^2 = 0.16, *n* = 136)		
	Beta	**SE**	***p***	**Beta**	**SE**	***p***	**Beta**	**SE**	***p***
Intercept	121.2	2.73	--	106.6	1.26	--	114.1	2.89	--
High vs Low Responsiveness	2.80	1.64	0.09	4.94	1.58	0.002	2.34	1.63	0.15
Moderate vs Low Responsiveness	1.73	1.63	0.29	2.51	1.58	0.11	−0.73	1.62	0.65
H-HOPE intervention	1.53	1.33	0.25	−2.61	1.28	0.04	0.82	1.32	0.53
Latina vs African-American	−3.92	1.33	0.004						
POPRAS score	−0.08	0.03	0.02						
English vs Spanish							3.60	1.53	0.02
Mother Lives with Her Mother/Other Adult vs with Infant's Father							−4.18	1.63	0.01
Mother Lives Alone vs with Infant's Father							−7.63	2.02	0.0002
Multiple birth vs Singleton							−5.53	2.19	0.01