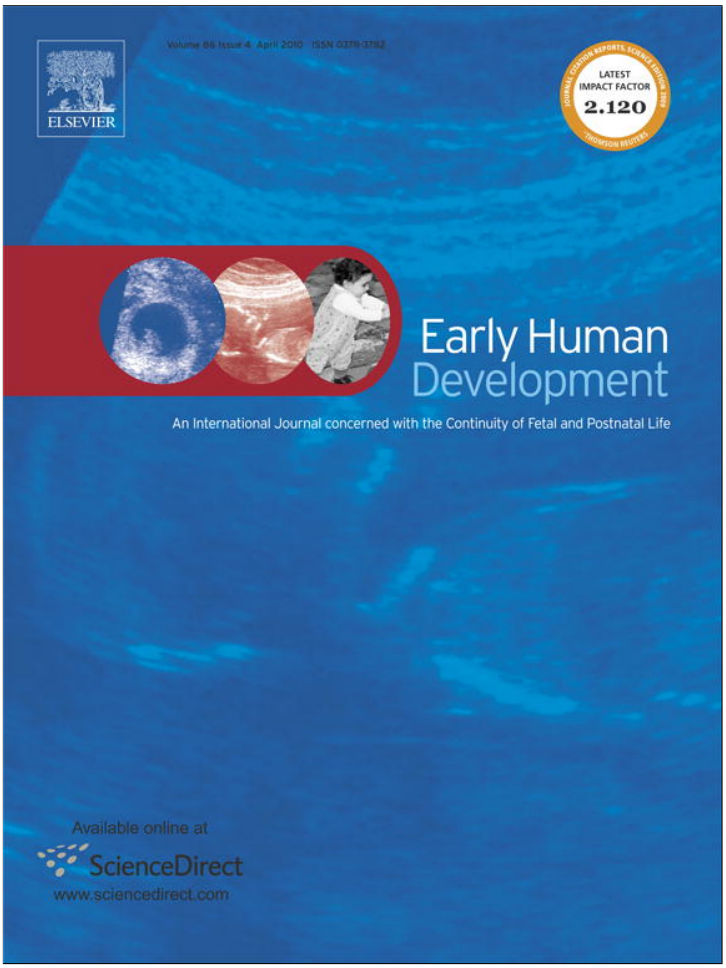

Early Human Development 86 (2010) 255–260

Contents lists available at ScienceDirect

Early Human Development

journal homepage: www.elsevier.com/locate/earlhumdev

Association of maternal communicative behavior with child vocabulary at 18–24 months for children with congenital hearing loss

Betty Vohr *, Lucille St Pierre, Deborah Topol, Julie Jodoin-Krauzyk, Jessica Bloome, Richard Tucker

Women & Infants' Hospital, The Warren Alpert Medical School of Brown University, Providence, RI, United States

ARTICLE INFO

Article history:
Received 18 December 2009
Received in revised form 14 April 2010
Accepted 16 April 2010

Keywords:
Hearing loss
Language
Vocabulary
Maternal communicative behavior

ABSTRACT

Objectives: To identify important maternal and child factors associated with development of vocabulary in a cohort of children with and without permanent hearing loss (HL).
Methods: Children with HL and typical hearing were enrolled after the newborn hearing screen. Mother–child dyads were evaluated at 18–24 months of age. Mothers completed the MacArthur–Bates Communicative Development Inventory (MCDI). Maternal communicative effectiveness was scored using the Parent/Caregiver Involvement Scale (PCIS) from a 10 min play session. Correlations and regression models were run to identify the important predictors of number of child words produced.
Results: Results from 40 children with typical hearing and 31 children with HL are reported. Words produced (134 ± 135 vs. 71 ± 112) and words produced percentile (33 ± 42 vs. 17 ± 23) scores on the MCDI were significantly higher for children with hearing compared to children with HL. Greater maternal stress was associated with decreased verbal involvement, positive regard, availability, and enjoyment. Regression analysis revealed HL, stay in a Neonatal Intensive Care Unit (NICU), and maternal stress were associated with fewer words produced whereas more optimal maternal atmosphere and quality of control and directiveness were associated with more words produced.
Conclusions: Maternal communicative behaviors, maternal stress, child HL, and child stay in the NICU were all associated with number of words produced at 18–24 months.

1. Background

Congenital HL is the most commonly occurring sensory deficit in the United States [1]. HL is identified at a rate of 1–3 per 1000 children, and each year between 8000–12,000 babies are born with congenital HL. Deaf children with deaf parents who use natural signed language usually acquire linguistic competence without signs of delay [2,3]. However, more than 90% of children with HL are born to hearing parents for whom communicative interaction is disrupted, and these children are at risk for language delay [4]. Studies indicate that children who are deaf or hard of hearing who are not identified as newborns and do not receive Early Intervention (EI) and very early language input, steadily fall behind hearing peers in language, cognitive performance, social skills, literacy, and academic skills [4–6]. More recent reports of Yoshinaga–Itano, Moeller and Vohr [7–9] showed improved language outcomes of infants with HL identified early.

A critical contribution of EI is its role in supporting parents to develop effective communication strategies with their infants, as well as to offer support during a time of increased stress. Parent–child interaction styles are an important influence on child development [10–15], and parental communication and interaction have significant effects on language acquisition. Children at risk for developmental delays may benefit most from positive caregiver interactions. According to McGrath et al [12], "a high quality maternal behavioral style exhibited in positive affect, attitudes, and/or interaction may reduce the impact of the child's biological vulnerability." Baumwell [10] used an overall measure of verbal sensitivity combining mothers' responsiveness, joint attention, and focusing behaviors. The author found that verbal sensitivity significantly predicted language gains between 9–13 months, with the largest effect found for children who had low initial receptive language scores. A study by Pressman et al [14] reported that the maternal sensitivity subscale ratings of the Biringen Emotional Availability Scales [41,42] administered when a cohort of deaf and hard of hearing children were 21–30 months predicted children's expressive language at 33–41 months. Studies of school age children with impairments also have clearly shown benefits derived from higher maternal level of education, socioeconomic status (SES), and interactive styles on child development [12,16,17].

Early language development including the acquisition of vocabulary is also associated with a number of maternal and child factors. Parental stress levels and its impact on the family are often increased

* Corresponding author.
E-mail addresses: bvohr@wihri.org, Betty_Vohr@brown.edu (B. Vohr).

0378-3782/$ – see front matter © 2010 Elsevier Ireland Ltd. All rights reserved.
doi:10.1016/j.earlhumdev.2010.04.002

for families of infants diagnosed with a permanent HL [18–21]. An infant's requirement for a stay in the NICU is also known to be associated with increased maternal stress [22].

The relative contributions of maternal communicative involvement, maternal stress, stay in a NICU, and HL on early vocabulary are unknown in a population of early identified children with HL. The objectives of this study were to assess the effects of two maternal factors (maternal communicative effectiveness and maternal stress) and two child factors (HL and stay in the NICU) on number of words produced at 18–24 months for a cohort of children with and without HL.

The following hypotheses were proposed:

1. More optimal parent/caregiver involvement will be associated with more words produced. Specifically, higher maternal verbal involvement and more optimal availability, atmosphere, and sensitivity, will be associated with more words produced.
2. Higher maternal stress will be associated with fewer words produced.
3. Child HL and NICU stay will be associated with fewer words produced.

2. Methods

The study subjects include children with and without HL who were screened for HL in Rhode Island between 10/15/02–1/31/05. Inclusion criteria for the HL group included a positive screen result and subsequent diagnosis of permanent congenital HL. Eligible controls were infants with typical hearing who had completed the newborn hearing screen. The controls for this paper were identified as the best-matched to the infants with HL, and represent a subset of the total cohort of enrolled controls. Matches were based on hierarchical matching procedures for sex, date of birth, hospital of birth, Well Baby Nursery vs. NICU, maternal education, race/ethnicity, and health insurance. The Hollingshead Four Factor Index of Social Status [23], a weighted combination of parental occupation and education, was used to calculate scores of SES based on parental education and occupation.

Maternal and infant demographic data were collected and assessments were completed during home visits at 6, 12–16, and 18–24 months of age. This paper reports on the 18–24 month assessments. A 10 minute mother–child free play session was videotaped during the home visit and subsequently coded according to the PCIS [24]. The PCIS assesses adult behaviors in interactions with the child. It has been determined to have concurrent validity for mothers with children from infancy to toddlerhood [12,24,25]. Coders were trained to reliability by participation in a workshop conducted by experienced coders followed by coding of teaching videos until the examiner was certified as reliable. Four of six research assistants achieved reliability above .80 in this process and were given responsibility for coding all videos. Six items were coded for both amount and quality displayed by the parent: Verbal Involvement, Responsiveness (reactions to child initiations), Play Involvement (caregiver–parent play), Control and Directiveness (structure and directives the caregiver imposes), Positive Regard (caregiver positive vs. negative attitude), and Negative Regard (negative emotions and statements). Amount refers to the amount of time a behavior is observed without regard to its quality and ranges from Not Observed (1) to Throughout the Session (5), whereas quality refers to the degree of warmth, sensitivity, acceptance, and matching of caregiver behavior shows and to what degree the behavior matches with their child's level of development. Four items exhibited by the parent were scored on amount as overall indicators: Availability (accessible and responsive to child needs), Acceptance (acceptance and approval of child as he/she is), Atmosphere (harmony or synchrony between the parent and child), and Enjoyment (pleasurable periods between parent and child). Five items displayed by the parent were generally rated on independent scales: Sensitivity (degree of positive and congruent interest and pleasure with child), Scaffolding (amount of positive control used in interactions allowing the child to be successful), Intrusiveness (behavior that prevents child autonomy), Structuring/Intrusiveness (degree of appropriately or not appropriately structuring child play), and Hostility (degree of overt facial or vocal hostile behavior toward child). All items have a range of scores of 1–5 except Sensitivity (1–9) and Structuring/Intrusiveness (1–7). Higher scores represent a higher frequency of the designated behavior. Items that showed significant or borderline significant correlations with maternal characteristics or child language outcomes were included in this analysis.

The Family Support Scale [26] which measures the helpfulness of sources of support to families raising a young child (range of scores 18–90), the Family Resources Scale [27] which measures resources (range of scores 31–155), the Impact on the Family [28], a measure of the effect of the child's condition in producing change in the family (range of scores 14–56), and the Parenting Stress Index [29] which identifies stressful areas in mother–child interactions (range of scores 36–180) were administered. Mothers of multiples completed interviews for each child individually.

Child vocabulary was measured at 18–24 months using the MCDI [30]. The MCDI prompts parents to report their child's understanding and use of early vocabulary items separated into word categories. Parents of both children with hearing and HL are asked to identify the words or signs they have observed their child using. The MCDI has been normed and validated, and was designed to minimize limitations of parental report by asking questions about current and emerging language through a recognition format. Studies on the validity of the MCDI for children with language impairments and children with HL have found that parent reports show high concurrent validity with other measures of early language. [31,32]. We previously administered the MCDI: Words and Gestures at 12–16 months [33]. At 18–24 months the MCDI: Words and Sentences which consists of two parts, “Part I: Words Children Use” includes a 680 word vocabulary list, and “Part II: Sentences & Grammar” includes questions on word endings, word forms, word combinations, and sentence complexity was administered. The MCDI was administered to all English speaking families and a normed Spanish version was administered and scored for native Spanish speakers. If signed vocabulary was understood or used, it was counted accordingly. The American Sign Language (ASL) version was used with the one family that used ASL at home. Scores are reported separately for this family, since ASL norms and percentiles are still in development.

3. Statistical analyses

This was a matched cohort study. Between-group analyses (HL vs. control) were performed using t-tests on continuous variables and chi-square on categorical variables. Variables that demonstrated significant skew and/or sufficiently differing between-group variances were log-transformed to normalize the data for parametric analyses. Correlations were run between maternal and child predictors and child MCDI vocabulary scores. Multiple regression models were constructed for the outcome of total words produced at 18–24 months. Independent variables include PCIS communicative behaviors, maternal stress, child hearing status (HL vs. hearing), and newborn nursery (NICU vs. Well Baby Nursery) as an indicator of neonatal illness severity.

4. Results

Results from a total of 31 infants with HL and 40 children with typical hearing are reported. Characteristics are shown in Table 1. Mothers in the hearing and HL groups had similar age, marital status,

Table 1
Mother and infant characteristics.

	HL	Control	*p* value
Mothers *N*	28	30	–
Maternal age, mean (SD)	32 (6)	35 (5)	.0987
Married	23 (82)	27 (90)	.3859
Level of education			.0857
<High school	2 (7)	1 (3)	
Completed high school	4 (14)	0	
Partial college	12 (43)	11 (37)	
Completed college	10 (36)	18 (60)	
Primary home language			.1001
English	24 (86)	30 (100)	
Spanish	3 (11)	0	
ASL	1 (4)	0	
Health insurance type			.6902
Private	22 (79)	26 (87)	
Medicaid/HMO	4 (14)	3 (10)	
Medicaid/Public assist.	2 (7)	1 (3)	
Hollingshead SES score, mean (SD)	34 (14)	48 (10)	.0104
Infants ***N***	31	40	–
Parent–child communication			
Sign language use	24	1	
ASL	1	0	
Extensive use of sign	3	0	–
Use of inconsistent/minimal sign	20	1	
Oral	7	39	
Multiples	9 (29)	16 (40)	.3372
Female sex	12 (39)	16 (40)	.9121
Age at 18 month visit, mean (SD)	22 (2)	22 (3)	.1636
White race	28 (90)	39 (98)	.1917
NICU stay	19 (61)	26 (65)	.7476
Gestational age <37 weeks	20 (65)	21 (53)	.3093
Birth weight <1500 g	15 (48)	8 (20)	.0112
EI referral	30 (97)	14 (35)	<.001
Degree of HL			
Unilateral or mild bilateral	13 (42)	–	–
Bilateral–moderate to profound	18 (58)	–	–

N (%).

and health insurance type; control mothers had higher Hollingshead SES scores. Children in the two groups had similar gender, race, NICU stay, and gestational age. The infants with HL were more likely to have a birth weight below 1500 g. As expected, significantly more children with HL were referred to EI. Among infants with HL, 13 had unilateral or mild bilateral and 18 had bilateral moderate to profound conditions. In addition, 24/31 (77%) used some sign for communication. Six of the children with HL were diagnosed with cerebral palsy (CP) by 18 months of age.

Scores for the Family Support Scale, Family Resources Scale, and Parenting Stress Index did not differ between the HL and control groups (see Table 2). Total Impact on the Family scores were higher for mothers of children with HL compared to mothers of hearing children.

As shown in Table 3, number of words produced (134 ± 135 vs. 71 ± 112) and words produced percentile scores (33 ± 42 vs. 17 ± 23) were significantly higher for children with hearing compared to children with HL for the entire study sample. To adjust for illness severity at birth, the analyses were repeated excluding children who

Table 2
Support, stress, resources, and impact on the family.

M ± SD	HL	Control	*p* value
Number of infants	31	40	
Total family support scale score	37 ± 11	37 ± 9	.6888
Total family resources score	121 ± 13	125 ± 14	.2030
Total impact on the family score	27 ± 5	24 ± 4	.0324*
Total parenting stress index	67 ± 10	70 ± 17	.3832

Scores are expressed as mean (SD).

Table 3
MCDI words produced at 18–24 months.

	Sample including NICU infants			Sample excluding NICU infants		
N	HL 29	Control 40	*p*[a]	HL 11	Control 14	*p*[a]
Words produced	70.6 ± 112 (median 38.0)	133.6 ± 135 (median 89.5)	0.0048	137.6 ± 159 (median 58.0)	174.1 ± 141 (median 141)	0.2545
Percentile	16.8 ± 23 (median 7.5)	32.8 ± 27 (median 30.0)	0.0033	30.8 ± 32 (median 22.5)	40.4 ± 27 (median 37.5)	0.2514
<10th %	20 (69%)	13 (33%)	0.01	5 (45%)	2 (14%)	0.0849

[a] *p* values for means reflect analysis of transformed variables to adjust for skewness.

were cared for in the NICU from both the HL and hearing groups. Although words produced and words produced percentile were both higher for controls than children with HL, the differences were no longer significant. In addition, (not shown in table) for the HL group alone, children enrolled in EI by 3 months of age compared to infants enrolled after 3 months of age had higher words produced percentile (27 ± 29 vs. 7 ± 6, $p = 0.01$) respectively. Data on two infants are not included in the table. The mother of the child who communicated with ASL reported 354 words understood and 256 words signed. In addition, for one child who spoke Spanish only, the administration of the MCDI was stopped due to maternal reluctance to continue a prolonged visit.

The mean scores of the PCIS domains were similar for the mothers of children with hearing and HL and the mothers of NICU and Well Baby Nursery infants (not shown). Correlation analyses were run to examine the associations between maternal and child factors and maternal communicative effectiveness (PCIS) scores (see Table 4). Greater maternal stress was associated with decreased verbal involvement, positive regard, availability, and enjoyment with a trend for decreased sensitivity. Higher maternal resources were associated with greater maternal availability and enjoyment and higher SES was associated with decreased negative regard and intrusiveness and increased quality of control and directiveness.

Correlations were run between maternal communicative effectiveness scores, resources, impact and stress scores, child HL, and NICU stay with words produced at 18–24 months. Increased maternal atmosphere, availability, quality of control and directiveness, and maternal resources were associated with more words produced. In contrast greater maternal stress, greater impact on the family, child HL, and stay in the NICU were all associated with decreased words produced. Increased maternal sensitivity had a borderline association with more words produced ($p = 0.08$). Maternal verbal involvement was not associated with number of child words produced (Table 5).

Regression analyses incorporating our two maternal independent factors (PCIS scores and maternal stress scores) and two infant independent variables (HL and NICU stay) were run to predict words produced as shown in Table 6. The child factors of HL and stay in the NICU both provided independent contributions to fewer words produced. Child NICU stay was found to have significant effects for six out of seven models and was associated with 56–70 fewer words produced, whereas HL was associated with 64–74 fewer words produced in all seven models. Maternal stress scores were a consistent independent predictor resulting in approximately 20 fewer words produced for every 10 point increase of the stress score. Greater maternal atmosphere during mother–child interaction contributed to 36 more words produced and quality of control and directiveness with 45 more words produced for each increase of one point in the PCIS. Trends for negative effects of increased maternal intrusiveness and amount of control and directiveness during the play interaction

Table 4
Correlations of maternal and child characteristics with maternal involvement (PCIS) scores.

	Verbal involvement	Positive regard	Availability	Enjoyment	Sensitivity	Negative regard	Intrusiveness	Control directive quality
Maternal stress	−0.2878 0.01	−0.2852 0.02	−0.2950 0.01	−0.2325 0.05	−0.2169 0.07	NS	NS	NS
Resources	NS	NS	0.3117 0.0008	0.2541 0.03	NS	NS	NS	NS
SES	NS	NS	NS	NS	NS	−0.249 0.03	−0.248 0.04	0.281 0.01

Impact, Support, HL, and NICU stay were not related to PCIS factors.

on words produced were observed. When the models were rerun excluding infants with CP the models remained significant, the independent effects of atmosphere and quality of control and directiveness remained significant but the independent effects of NICU and HL were attenuated and non-significant.

5. Discussion

Our findings support the concept that multiple maternal and child factors contribute to child vocabulary at 18–24 months. Our first hypothesis exploring the effects of maternal communicative effectiveness on early vocabulary was supported. Although there were no significant differences in mean PCIS scores across the two study groups, there were significant associations between higher positive maternal communicative behavior scores including atmosphere, availability, and quality of control and directiveness, and more child words produced for the total study cohort. Our regression analyses identified significant independent effects of atmosphere, reflecting increased synchrony between the mother and child and quality of control and directiveness on more words produced after controlling for independent effects of NICU, HL, and maternal stress. In addition, there was a trend for increased amount of control and directiveness and increased intrusiveness behaviors to be associated with fewer words produced. Increased rates of controlling and intrusive behavior have previously been reported for hearing mothers of children with HL by Spencer [6] and Brinich [34].

Our second hypothesis was that maternal stress would be associated with decreased words produced. Maternal stress was found to be an important mediator of maternal behaviors for both groups during mother–child interaction and with child language outcomes at 18–24 months. Increased maternal stress was negatively correlated with a number of PCIS domains including verbal involvement, positive regard, availability, and enjoyment. Lower resources were associated with decreased availability and enjoyment. Although we identified no associations between support and PCIS scores, the importance of support for families of children with HL has been cited in other studies. Meadow–Orlans [35] found that hearing mothers of 18 month old deaf children with low support were significantly more intrusive, less sensitive, and less reciprocal than mothers of hearing children. Our findings suggest that maternal stress is an important factor inhibiting optimal communication among mother–infant dyads.

Table 5
Correlations between maternal and child factors and MCDI words produced.

Predictors	Words produced	
Maternal factors	*r*	*p*
PCIS verbal involvement	0.092	0.45
PCIS availability	0.283	0.01
PCIS sensitivity	0.213	0.08
PCIS atmosphere	0.296	0.01
PCIS quality of control and directiveness	0.333	0.005
↑ stress scores	−0.3308	0.005
↑ resources scores	0.3775	<0.0001
↑ impact scores	−0.3961	<0.0001
Child factors	*r*	*p*
Child HL	−0.244	0.01
NICU stay	−0.301	0.01

Our correlation analyses reinforce the concept that both parent and child characteristics are associated with language development. Higher maternal resources and SES were associated with more optimal mother–infant interactions. Calderon [36] reported that mother's communication skills with 4–7 year old deaf children were significantly correlated with SES. Within our cohort of children with varying degrees of HL and typical hearing, SES was associated with greater quality of control and directiveness, which in turn, was associated with more words produced. Maternal report of greater resources was significantly related to greater overall enjoyment and increased availability during play, and more words produced. Maternal perceived resources may capture aspects beyond the SES score, such as time and personal networks.

As proposed in our third hypothesis, the number of words produced at 18–24 months of age was significantly lower for the children with HL compared with children with typical hearing. This is consistent with studies examining language skills among deaf children with hearing parents compared to hearing peers [37–39]. In addition, we identified significant independent effects of NICU stay on decreased words produced. Prior studies have shown that approximately 50–60% of infants identified with HL have a history of neonatal illness severity requiring care in a NICU. This is consistent with our findings. Although children with HL in the study had significantly fewer words produced than the hearing children, the group differences in words produced was lessened when we excluded infants who required NICU care from the analyses.

In the regression models, two PCIS domains contributed significantly to language outcomes: atmosphere and quality of control and directiveness. Even when the models were rerun excluding infants with co-morbidities (CP) the models remained significant, the independent effects of atmosphere and quality of control and directiveness remained significant, but the independent effects of NICU and HL were attenuated and non-significant.

Atmosphere is a global rating of dyadic mother–child interactions, reflecting a harmonious environment and shared positive emotions [24]. Previous studies of both preterm and deaf children have demonstrated the importance of a positive affective environment for language development. Greenberg, et al [40] found that developmental and language outcomes for preterm children at two years of age were highly dependent on maternal attitude. Pressman et al [14] reported that the maternal sensitivity predicted children's expressive language at 33–41 months. It should be noted that their cohort included no children with known medical conditions or handicaps other than HL. Although sensitivity did not reach statistical significance in our models, independent effects of atmosphere and quality of control and directiveness, however, on words produced support the importance of overall quality of mother–infant interactions in facilitating language development.

The control and directiveness measure assesses the extent to which mothers physically manipulate their children and direct their activities during the play activity. For this cohort, while quality of control and

Table 6
Regression models to assess association of PCIS domains with words produced at 18–24 months.

	PCIS domains in regression models													
	Verbal involvement		Availability		Sensitivity		Atmosphere		Intrusiveness		Control directiveness		Control directiveness quality	
Predictors	*b*	*p*	*b*	*p*	*b*	*p*	*b*	*p*	*b*	*p*	*b*	*p*	*b*	*p*
NICU	−67.8	0.024	−68.2	0.022	−67.3	0.024	−63.7	0.029	−70.8	0.016	−55.9	0.066	−63.1	0.030
HL	−70.2	0.015	−63.5	0.028	−68.9	0.016	−65.0	0.021	−70.8	0.012	−72.1	0.012	−74.4	0.008
Total stress[a]	−20.5	0.021	−20.3	0.033	−20.5	0.018	−20.5	0.013	−20.8	0.006	−20.9	0.004	−20.4	0.017
PCIS domain	15.6	0.404	26.5	0.160	15.0	0.225	36.3	0.046	−38.7	0.056	−30.4	0.097	45.3	0.006
Total R^2	0.25	0.0008	0.27	0.0005	0.26	0.0006	0.29	0.0002	0.29	0.0002	0.27	0.0004	0.32	0.0001

[a] *b* value for total stress score is equivalent of 10 points on the stress scale.

directiveness was associated with more words produced, there was a trend for amount of control and directiveness to be associated with fewer words produced. Our findings are consistent with observations that mothers whose hearing status (hearing or deaf) does not match their child's use adaptive ways to control and direct interaction that rely on other modalities rather than hearing alone [34,43,44].

Verbal involvement is an important influence on child development. Specific features of verbal involvement that have been shown to facilitate language development include responsiveness to children's communicative attempts, promoting joint attention, and expansion of children's utterances [4,5]. Contingent responsiveness to the child's behaviors and cognitive level have been linked in several studies to increased receptive language, speech, and higher cognitive scores among toddlers [6]. In the present study, maternal verbal involvement did not provide an independent contribution to the regression model. This measure assesses the extent to which mothers are linguistically engaged with their children throughout the play session [24]. Prior studies have shown differential effects of maternal verbal input on deaf children's language development. Studies of deaf children ages 12–36 months have shown no significant correlation between frequency of spoken language by their hearing mothers and language gains [38,45], although frequency of signing has been shown to correlate with infants' production of signs [46]. The results of these studies indicate that the quality and type of language output by mothers may be equally if not more important than frequency of spoken language both for children with HL and hearing. Characteristics of maternal language that are known to specifically promote vocabulary and words produced rather than just general language development are joint attention, mapping new words to objects, repetition, and contingent responsiveness. These specific behaviors need to be studied in depth in the population of early identified children with HL.

There are additional factors which are difficult to measure that can contribute to language development. In a study of deaf children at 22–36 months, Lederberg [38] found that toddlers did not see a quarter to half of their hearing mothers' utterances, even though mothers were generally successful at gaining joint visual attention. Even when mothers have their child's attention, hearing mothers of deaf children produced less complex language and had less frequent remodeling of deaf children's speech and language compared to mothers of hearing children [47]. A number of maternal behaviors have been shown to promote language development among at risk populations and specifically among children with HL. In a study among developmentally delayed children 17–36 months, Fey [48] found that high maternal responsivity in play sessions predicted more intentional communication in the children. A study of prematurely born preschool-age children found that maternal responsivity was a significant predictor of child receptive language scores and cognitive competence even after controlling for medical risk and maternal education [12]. In conclusion, our study identified that specific maternal communicative behaviors, maternal stress, child HL, and child stay in the NICU were all associated with words produced at 18–24 months of age.

Acknowledgements

This work is funded by cooperative agreements between the Rhode Island Department of Health and the Early Hearing Detection and Intervention Program at the Centers for Disease Control & Prevention and the Association of University Centers on Disabilities. Grant UR3/CCU120033-01 AUCD-RTOI 2006-06-07-1.

References

[1] White K. National Center for Hearing Assessment & Management (NCHAM). http://www.infanthearing.org/summary/prevalence.html2006.
[2] Newport EL, Meier RP. In: Slobin DI, editor. The Crosslingistic Study of Language Acquisition. The acquisition of American sign language. Hillsdale, NJ: Erlbaum; 1985.
[3] Meadow KP. Early manual communication in relation to the deaf child's intellectual, social, and communicative functioning. J Deaf Stud Deaf Educ 2005;10(4):321–9 Fall.
[4] Calderon R, Bargones J, Sidman S. Characteristics of hearing families and their young deaf and hard of hearing children. Early intervention follow-up. Am Ann Deaf 1998 Oct;143(4):347–62.
[5] Fletcher P, German M. Language Acquisition: Studies in First Language Development. Cambridge: Cambridge University Press; 1986.
[6] Spencer PE. Parent–Child Interaction: Implications for Intervention and Development. In: Bodner-Johnson B, Sass-Lehrer M, editors. Early education for deaf and hard-of-hearing toddlers and their families: Integrating best practices and future perspectives. Baltimore: Paul Brookes; 2004.
[7] Moeller MP. Early intervention and language development in children who are deaf and hard of hearing. Pediatrics 2000 Sep;106(3):E43.
[8] Vohr BR, Jodoin-Krauzyk J, Tucker R, Johnson MJ, Topol D, Ahlgren M. Results of newborn screening for hearing loss: effects on the family in the first 2 years of life. Arch Pediatr Adolesc Med 2008 Mar;162(3):205–11.
[9] Yoshinaga-Itano C, Sedey AL, Coulter DK, Mehl AL. Language of early- and later-identified children with hearing loss. Pediatrics 1998 Nov;102(5):1161–71.
[10] Baumwell L, Baumwell CS. Maternal verbal sensitivity and child language comprehension. Infant Behav Dev April–June 1997;20(2):247–58.
[11] Snow CE. Mothers' speech to children learning language. Child Dev 1972;32: 549–65.
[12] McGrath MM, Sullivan MC, Seifer R. Maternal interaction patterns and preschool competence in high-risk children. Nurs Res Nov–Dec 1998;47(6):309–17.
[13] Olson SL, Bayles K, Bates JE. Mother–Child Interaction and Children's Speech Progress: A Longitudinal Study of the First Two Years. Merrill–Palmer Quarterly Jan 1986;32(1)(1):1–20.
[14] Pressman L, Pipp-Siegel S, Yoshinaga-Itano C, Deas A. Maternal sensitivity predicts language gain in preschool children who are deaf and hard of hearing. J Deaf Stud Deaf Educ 1999;4(4):294–304 Fall.
[15] Tamis-LeMonda CS, Bornstein MH. Habituation and maternal encouragement of attention in infancy as predictors of toddler language, play, and representational competence. Child Dev 1989 Jun;60(3):738–51.
[16] Luu TM, Vohr BR, Schneider KC, Katz KH, Tucker R, Allan WC, et al. Trajectories of receptive language development from 3 to 12 years of age for very preterm children. Pediatrics 2009 Jul;124(1):333–41.
[17] Vohr BR, Allan WC, Westerveld M, Schneider KC, Katz KH, Makuch RW, et al. School-age outcomes of very low birth weight infants in the indomethacin intraventricular hemorrhage prevention trial. Pediatrics 2003 Apr;111(4 Pt 1): e340–6.

[18] Brand HJ, Coetzer MA. Parental response to their child's hearing impairment. Psychol Rep 1994 Dec;75(3 Pt 1):1363–8.
[19] Kurtzer-White E, Luterman D. Families and children with hearing loss: grief and coping. Ment Retard Dev Disabil Res Rev 2003;9(4):232–5.
[20] Meadow-Orlans KP. The impact of childhood hearing loss on the family. In: Moores DF, Meadow-Orlans KP, editors. Educational & Developmental Aspects of Deafness. Washington, DC: Gallaudet University Press; 1990. p. 11–23.
[21] Meadow-Orlans KP. Sources of stress for mothers and fathers of deaf and hard of hearing infants. Am Ann Deaf 1995 Oct;140(4):352–7.
[22] Shaw RJ, Bernard RS, Deblois T, Ikuta LM, Ginzburg K, Koopman C. The relationship between acute stress disorder and posttraumatic stress disorder in the neonatal intensive care unit. Psychosomatics Mar–Apr 2009;50(2):131–7.
[23] Hollingshead A. Four Factor Index of Social Status. New Haven, CT: University Press; 1975.
[24] Farran D, Kasari C, Comfort M, Jay S. Parent/Caregiver Involvement Scale. Department of Teaching and Learning. Vanderbilt University; 1986.
[25] Munson LJ, Odom SL. Review of rating scales that measure parent–infant interaction. Top Early Child Spec Educ 1996;16:1–25.
[26] Dunst CH, Trivette CM, Jenkins V. Family Support Scale. Cambridge, MA: Bookline Books, Inc.; 1988.
[27] Dunst CJ, Leet HE. Family Resource Scale. Child: Care, Health and Development-Blackwell Publishing; 1987. p. 111–25.
[28] Stein REK, Reissman CK. The development of an impact on family scale: Preliminary findings. Med Care 1980;18:465–72.
[29] Abidin RR. In: Lutz FL, editor. Parenting Stress Index (PSI). Third Edition. Psychological Assessment Resources, Inc; 1995.
[30] Fenson L, Dale PS, Resnick JS, Thal D, Bates E, Hartung JP, Pethick S, Reilly JS. MacArthur Communicative Development Inventories (CDI). San Diego, CA: Singular Publishing; 1993.
[31] Thal D, Desjardin JL, Eisenberg LS. Validity of the MacArthur–Bates Communicative Development Inventories for measuring language abilities in children with cochlear implants. Am J Speech Lang Pathol 2007 Feb;16(1):54–64.
[32] Thal DJ, O'Hanlon L, Clemmons M, Fralin L. Validity of a parent report measure of vocabulary and syntax for preschool children with language impairment. J Speech Lang Hear Res 1999 Apr;42(2):482–96.
[33] Vohr B, Jodoin-Krauzyk J, Tucker R, Johnson MJ, Topol D, Ahlgren M. Early language outcomes of early-identified infants with permanent hearing loss at 12 to 16 months of age. Pediatrics 2008 Sep;122(3):535–44.
[34] Brinich PM. Childhood deafness and maternal control. J Commun Disord 1980 Jan;13(1):75–81.
[35] Meadow-Orlans KP, Steinberg AG. Effects of infant hearing loss and maternal support on mother infant-interaction at 18 months. J Appl Dev Psychol 1993;14(3):407–26.
[36] Calderon R. Parental involvement in deaf children's education programs as a predictor of child's language, early reading, and social-emotional development. J Deaf Stud Deaf Educ 2000;5(2):140–55 Spring.
[37] Meadow-Orlans KP, Spencer PE, Koester LS. The World of Deaf Infants: A Longitudinal Study. New York, NY: Oxford University Press; 2004.
[38] Lederberg AR, Everhart VS. Communication between deaf children and their hearing mothers: the role of language, gesture, and vocalizations. J Speech Lang Hear Res 1998 Aug;41(4):887–99.
[39] Power DJ, Wood DJ, Wood HA. Maternal control over conversations with hearing and deaf infants and young children. First Lang 1990;10(28):19–35.
[40] Greenberg MT, Crnic KA. Longitudinal predictors of developmental status and social interaction in premature and full-term infants at age two. Child Dev 1988 Jun;59(3):554–70.
[41] Biringen Z, Robinson J. Emotional availability in mother–child interactions: a reconceptualization for research. Am J Orthopsychiatry 1991 Apr;61(2):258–71.
[42] Biringen Z, Robinson J. Manual for scoring the emotional availability scales. Unpublished manuscript 1998.
[43] Spencer PE, Gutfreund MK. Directiveness in mother–infant interactions. In: Moores D, Meadow-Orlans K, editors. Educational and Developmental Aspects of Deafness. Washington, DC: Gallaudet University Press; 1990.
[44] Musselman C, Churchill A. Maternal conversational control and the development of deaf children: a test of the stage hypothesis. First Lang 1993;13(39):271–90.
[45] Spencer PE. The World of Deaf Infants: A Longitudinal Study. In: Meadow-Orlans K, Spencer P, Koester L, editors. Language at 12 and 18 months: characteristics and accessibility of linguistic models. New York: Oxford University Press; 2004.
[46] Spencer P. The expressive communication of hearing mother and deaf infants. Am Annals Deaf 1993;138:275–83.
[47] Waxman RP, Spencer PE. What mothers do to support infant visual attention: sensitivies to age and hearing status. J Deaf Stud Deaf Educ 1997;2:104–14.
[48] Fey ME, Warren SF, Brady N, Finestack LH, Bredin-Oja SL, Fairchild M, et al. Early effects of responsivity education/prelinguistic milieu teaching for children with developmental delays and their parents. J Speech Lang Hear Res Apr 2007;50(2):549.