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Research Article

Positive Parenting Behaviors: Impact on the Early Vocabulary of Infants/Toddlers With Cochlear Implants

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Purpose: To extend our knowledge about factors influencing early vocabulary development for infants with cochlear implants (CIs), we investigated the impact of positive parenting behaviors (PPBs) from the Indicator of Parent Child Interaction, used in parent–child interactions during everyday activities.
Method: Implantation age for the sample recruited from CI clinics in Australia ranged from 6 to 10 months for 22 children and from 11 to 21 months for 11 children. Three observation sessions at three monthly intervals were coded for use of PPBs. Children's productive vocabulary, based on the MacArthur–Bates Communicative Development Inventories parent checklist, was collected approximately 6 and 9 months later. A repeated-measures negative binomial generalized linear mixed-effects model was used to investigate associations between the total PPBs per session, covariates (maternal education, gender, and time since implant), and the number of words produced. In follow-up analyses with the PPBs entered separately, variable selection was used to retain only those deemed informative, based on the Akaike information criterion.
Results: As early as Session 1, associations between the PPBs and vocabulary were identified. Time since implant had a positive effect. For different sessions, specific PPBs (descriptive language, follows child's lead, and acceptance and warmth) were identified as important contributors.
Conclusions: Complementing previous findings, valuable information was identified about parenting behaviors that are likely to impact positively the early vocabulary of infants with CIs. Of importance is providing parents with information and training in skills that have the potential to help create optimal contexts for promoting their child's early vocabulary development.

In many countries, including Australia, screening for hearing loss is now the standard of care for all newborn children. Earlier identification of severe-to-profound hearing loss following the introduction of the newborn screening programs has led to cochlear implantation occurring at much earlier stages in children's development (Yoshinaga-Itano et al., 2018). There is variability in language outcomes for children with cochlear implants (CIs; e.g., Peterson et al., 2010), but positive outcomes are increased with younger implantation age (Ching et al., 2017; Cuda et al., 2014; Geers & Nicholas, 2013; Houston & Miyamoto, 2010; Leigh et al., 2013; Szagun & Stumper, 2012; Tomblin et al., 2005; Yosinaga-Itano et al., 2018). However, even when controlling for age of implantation, variability in language outcomes is frequently reported (e.g., Duchesne et al., 2009; Geers et al., 2009; Niparko et al., 2010).

Poor language skills have been associated with behavioral, social, and mental health problems (Curtis et al.,

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2018), as well as poorer academic and employment outcomes (Beitchman et al., 2010). It is important, therefore, to have a clear understanding of the factors that impact language development for CI recipients. Identifying variables that are positively associated with early communicative development for children with CIs can provide valuable information for early intervention programs. It can also inform parents about parenting skills that have the potential to help promote positive language outcomes for their children.

Continuity in communicative development is well documented, with prelinguistic development (vocalizations and gesture use) predicting the onset of vocabulary in children with normal hearing (NH; e.g., Goldin-Meadow, 2014) and in children with CIs (Bavin et al., 2020, 2018), with the onset of vocabulary a step on the path to developing a language (E. Bates & Goodman, 1999). Children with NH identify the sounds of the ambient language and cues to segmenting the linguistic input during their first year (e.g., Jusczyk, 2002; Jusczyk et al.,1999; Saffron et al., 1996), and strong correlations have been shown between early speech perception and early vocabulary development (e.g., Tsao et al., 2004).

Features of parent–child interactions influence the development of early vocabulary and language. While the research in this area with children with NH has been extensive and well documented (e.g., see Rowe & Snow, 2020), there is a need for further research with very young children with CIs. Thus, in this article, we report on the associations between four parenting behaviors observed in parent–child interactions and the early spoken vocabulary of the children who were implanted with CIs in infancy. The results will add to the existing data on the early pathways to language for very young children with CIs. The parent behaviors examined are included in the Indicator of Parent Child Interaction (IPCI; Baggett & Carta, 2010), an established tool identifying behaviors that lead to positive outcomes for young children in their early development. We focused on the four positive parenting behaviors (PPBs; caregiver facilitators) included in the IPCI. To date, the IPCI has not been featured in research with children with CIs. Compared to some of the measures used to assess parent behaviors, the IPCI seems more suitable for very young children; the observation times are shorter, and the tasks tap into everyday activities in the home (dressing, playing, and looking at simple books) and so are less intrusive.

As a background to early vocabulary and language development, some findings from past research with children with NH are presented briefly, as well as some from research with children with CIs, particularly those related to parent–child interactions. Differences in both quality and quantity of parental input to young children have been associated with family socioeconomic status (SES) or level of maternal education (one of the factors used to determine SES), with children's vocabulary generally reported to be larger if mothers have a higher education level or are from a higher SES background (e.g., Fernald et al., 2013; Hart & Risley, 1995; Hoff, 2003, 2006; Huttenlocher et al., 2010). Differences identified in maternal input include diversity in vocabulary use and longer utterances (Hoff, 2003; Rowe, 2008) and more topic-continuing replies, indicating more verbal engagement. However, there is also variability "within" SES groups (see Rowe 2018; Rowe & Snow, 2020). Differences across SES and maternal education levels may sometimes be related to the types of activities undertaken. For example, an activity with simple picture books is likely to hold a child's attention, and the adult is likely to use simple language in interacting with the child (Rowe & Snow, 2020). Other factors impacting parental input, both across and within SES and maternal education levels, include parent stress and level of knowledge about child development and parenting (Rowe, 2018).

The "quality" of parental input and its impact on children's linguistic development has been the focus of the more recent research on the early language of children with NH (e.g., Blom & Soderstrom, 2020; Hoff, 2003; Rowe, 2018; Weisleder & Fernald, 2013). In a meta-analysis of 37 studies of children with NH that included either a measure of parent warmth or parent sensitiveness together with a measure of child language (assessed at mean age of 33.5 months, range: 12–71 months), a stronger association was found between parental sensitive responsiveness and children's language than between parental warmth and children's language (Madigan et al., 2019). Parental warmth is indicated by support and comfort during interactions, whereas parental sensitive responsiveness is indicated by prompt and contingent replies to a child's actions (Tamis-LeMonda et al., 2014), indicating that the parent is sharing the focus of attention of the child. However, the factors that influence child language vary according to the age of the child (Rowe & Snow, 2020). For example, for very young children, verbal interactions that relate to the here and now and the child's focus of attention are conceptually supportive, although they would not be for older children (Rowe & Snow, 2020). By naming the objects the young child is attending to, the adult is providing linguistic information, and significant associations have been reported between naming by adults and their young child's early vocabulary development (e.g., Cartmil et al., 2013; Tomasello, 1988; Tomasello & Farrar, 1986). Of importance is that, in addition to providing linguistic input, the adult is modeling social aspects of language use, for example, turn-taking (Carpenter et al., 1998; Tamis-LeMonda et al. 2014). By responding to an infant's response, verbally or a nonverbally, the adult is promoting turn-taking. The adult responses become more linguistically diverse with more complexity as the child acquires more words and starts to combine them, Thus, parental input impacts children's communicative competence, and children's level of language impacts parental input: The influences are bidirectional.

Context can also have an impact (Rowe & Snow, 2020) in that the activity a child is involved in influences parent responsiveness. More parent language input has been reported for book reading than other activities with children with NH (aged 10–16 months; Sosa, 2016), and more attention-getting responses and directives have been reported for shape-sorting play (O'Brien & Nagle, 1987).

Overall, there has been less research to date investigating variables that impact the early vocabulary and language development of very young children with CIs. In the available research, lower SES (e.g., Niparko et al., 2010) and lower level of maternal education (e.g., Geers et al., 2009; Szagun & Stumper, 2012) have been reported to be associated with lower scores on measures of child language. In Szagun and Stumper's (2012) study, the children were implanted between 6 and 42 months of age and assessed every 6 months over 12–30 months postimplantation. The results showed significant associations between mothers' level of education and children's linguistics progress. In addition, features of the linguistic input—specifically parental mean length of utterance (MLU) and their use of expansions (i.e., extensions of the child's utterances)—were positively associated with the children's progress, as measured by their MLU. In expanding children's utterances and in recasting them (i.e., rephrasing the content), a parent provides feedback and in doing so, models communication patterns while providing lexical and grammatical information.

In addition to the use of parent expansions and recasts, Desjardin and Eisenberg (2007) and Cruz et al. (2013) included a measure of "parallel talk" (i.e., talking about what the child is looking at/doing, indicating joint attention) and open-ended questions (i.e., seeking information from a child rather than just a "yes" or "no" answer). These parental behaviors together were referred to as facilitative language techniques (FLT). In Desjardin and Eisenberg's (2007) study, the age of implantation with CIs was 12.5–76 months (M = 34.2 months). The FLTs were identified in videotaped interactions of free-play and storybook activities. Controlling for child age and maternal MLU, two of the FLT measures, recasts and open-ended questions, were found to significantly impact the children's developing language (at age range of 30–86 months, M = 4.8 years). Positive associations were also found between children's developing language and parents' self-reported sense of involvement in their children's speech-language development. In Cruz et al.'s (2013) study, children aged 2 years or younger at preimplantation were assessed 2–4 weeks prior to implantation, which was at mean age of 16.50 months (SD = 4.78), and then six monthly for 3 years post CI activation. Parent–child interactions in structured and unstructured tasks were coded for the use of FLTs. As in Desjardin and Eisenberg's (2007) findings, the frequency in use of parental recasts and open-ended questions (higher level FLTs) predicted growth in the children's expressive language.

Research with CI samples examining the impact of the quality of parent–child interactions on children's language was also reported by Niparko et al. (2010). They used a sample drawn from a large cohort (the Childhood Development After Cochlear Implantation study). Some children were implanted by 18 months, whereas others were implanted at 18–36 months and at over 36 months, but by the age of 5 years. At 3-year follow-up post CI activation, maternal engagement, measured in parent–child interactions, was positively associated with the children's language skills. At a 4-year post CI activation follow-up, with children from the same cohort, Quittner et al. (2013) measured quality of parent–child interactions (using both structured and unstructured tasks). This was rated on a 7-point scale from high to low; the measure, referred to as *maternal sensitivity* (MS), was a composite of four components: sensitivity/responsivity, respect for child's autonomy, positive regard, and hostility. Thus, there was a wider range of behaviors than contained in MS measures used in some past research and as defined by Tamis-LeMonda et al. (2014), described earlier. Age-appropriate tasks were used; they included a problem-solving task and gallery task. In the latter, parents were asked to talk for 5 min about a series of five pictures, mounted at different heights on the wall, and to identify the child's preference. In addition to the composite MS measure, Quittner et al. included measures of linguistic and cognitive stimulation, the latter determined by the quantity of parent instruction or how much they engaged their child in activities that would assist their learning (development) and language growth. Controlling for child and family demographics, the results showed that MS and cognitive stimulation were significantly associated with the children's language growth at 4 years post CI activation. In addition, children of parents with high scores on MS and cognitive stimulation were less delayed in linguistic development. Notably, the two variables together had an impact comparable to that of age of implantation. Linguistic stimulation had a positive association with the children's language growth, but only in the context of high MS scores.

In summary, research with young children with CIs that has focused on parental input and interaction style has used a variety of measures, and the age of implantation for the samples included in past research has varied, with a wide age range in some studies. Age and experience affect children's development, and given that universal newborn hearing screening has led to implantation at younger ages, it is important to extend this research to young recipients of CIs. This has the potential to advance our understanding about optimal environments for promoting their very early linguistic development. Thus, the objective of the current study was to investigate the impact of specific parent behaviors observed in parent–child interactions on the early vocabulary of children implanted with CIs in infancy. Covariates that might moderate the associations between parent behaviors and children's early vocabulary, based on past results from research with children with NH and some research with children with CIs, were included. These were maternal education, gender, and time since implant. Gender was included given that gender differences in vocabulary have been reported for children with NH, for example, in the manual of the MacArthur–Bates Communicative Development Inventories (CDI; Fenson et al., 2007). Time since implant has been reported as an influencing factor on language development in previous research (e.g., Cruz et al., 2013; Szagun & Stumper, 2012). Because there was some variability in the time of cochlear implantation relative to the first observation session in the current study, it was also included. Age was not included because of the very young age and narrow age range of the children in the sample.

Our specific aims were to identify in a sample of children implanted in infancy: (a) associations between the number of PPBs used in each of three observation sessions and the number of words the children were reported to produce at the time of two data collection points (approximately 6 and 9 months following the third observation session); (b) the extent to which gender, maternal education, and time since implant moderated the number of words produced; and (c) which of the PPBs had more impact on the number of words produced.

Method

Participants

Thirty-six children were recruited from five CI clinics across four states in Australia. All study procedures were reviewed and approved by the university human ethics committee and by the ethics committees responsible for the five clinics. All parents signed informed consent forms prior to the start of the study procedures.

Information about the study was provided to the CI clinics, which served families from urban, regional, and remote communities. Clinic staff handed out an information leaflet to all families who came to the clinic to have their children assessed for CIs and who met the following criteria: (a) had severe-to-profound hearing loss and were already scheduled to be implanted, (b) used English as the main language spoken in the home, and (c) had no other identified developmental delays or disabilities. Families who registered their interest were subsequently contacted and provided with further information about the study. After parents had given signed consent to participate, an initial session was arranged. Two families withdrew after the first session because of time limitations and other commitments. Data from a third family were not included in the analyses because the child was identified with developmental delay during the first year of involvement in the study. For the final sample of 33 children (16 girls, 17 boys), the implantation age was in the range 6–21 months (M = 10.17 months, Mdn = 9 months). All but two of the sample received their implants between 6 and 16 months; two thirds of the total sample were implanted by 10 months. In the sample, 85% had bilateral implants, and the remaining 15% had unilateral implants and a hearing aid in the contralateral ear. The mean switch-on time postimplantation was 15.9 days (SD = 4.6 days). In all cases, spoken language was used in the home, and the families had chosen to educate their child in spoken English. However, during the period of data collection, some parents used a few Auslan signs (e.g., "cat," "bird"), which they had learned from available sources. Parents reported their use of signs diminished as their child started to produce spoken words.

Measures

PPBs

The four PPBs included in the IPCI are viewed as facilitators. They are conveys acceptance and warmth (AW), descriptive language (DL), follows child's lead (FCL), and maintains or extends child's focus (MF). Three of the four daily activities that comprise the IPCI were included: free-play (4 min), dressing (2 min), and looking at books (2 min). The fourth task, a distractor task, investigates how parents (or a familiar adult) restrict their child in reaching a specific object, but this was not included in the current study because it is appropriate only for children aged 12 months or older, and very few of the sample had reached the age of 12 months at the start of data collection. Age-appropriate books for the book task are included in the IPCI kit (e.g., one from the Touch and Feel series). Parents are asked to use familiar items for free-play, and for the dressing task, suggested activities are taking off and putting back on the child's shoes and socks or a shirt, or different items could be used.

Vocabulary

The CDI Words and Gestures form (Fenson et al., 2007) was used to obtain a parent report measure of words produced at two time points. The form includes a total of 396 words and has been shown to be a reliable measure of language development in children with CIs (Thal et al., 2007). Permission was obtained from the authors and publishers to change 13 words to be more appropriate for the Australian context (e.g., *nappy* instead of *diaper*). The CDI form was mailed out a week ahead of a scheduled home visit and, at that visit, was returned to the researcher. The completed form was then copied before the next visit. To reduce the burden of completing a new form each time, a week before a scheduled visit, the previously completed form was mailed out, and the parent asked to use a different colored ink/pencil to mark any additional words. The children's vocabulary scores at two time points (approximately 6 and 9 months after the third IPCI observation) were included in the current study.

Maternal Level of Education

Maternal education was coded into four categories: (a) did not complete high school (n = 5), (b) completed high school (n = 9), (c) undertook some additional training (n = 7), and (d) completed a university degree (n = 12).

Time Since CI Surgery

Time since cochlear implantation was determined from the date of surgery to the time of the first of the two vocabulary collections (Mdn = 12 months, M = 11.62 months, SD = 2.402 months, range: 6.50–19.25 months).

Procedure

The first of three IPCI observation sessions was planned to occur just prior to the child's planned surgery date; this occurred for 23 of the families. However, due to some unexpected changes in surgery dates, for 10 children, the first session followed CI surgery. All IPCI sessions were administered by certified assistants. Training in the protocol is required in order to obtain certification. The training and certification process is explained in detail in the IPCI manual (see Baggett et al., 2011). The assistants in our study were trained by a certified administrator with extensive experience in training others in its use. The standard procedure for administering the IPCI was followed. General information about the tasks to be included was given to the parent at the beginning of the first session. It was indicated that our interest was in the way the parent and the child usually interacted and the things they normally did. Before each task, more specific details about the task were provided (e.g., instructions in the manual for "book reading" include: "You and your child can spend a few minutes with these books" and "However you want to use the books with your child is fine"). Each session was timed and video-recorded for later scoring. The IPCI manual provides detailed and clear descriptions of each of the PPBs with specific examples of what counts and what does not count. AW behaviors include, for example, smiling at the child; confirming what the child has just said; and providing gentle, affectionate touch. DL requires either a comment that labels and connects objects/people and actions (e.g., "The wheels go round") or a complete sentence that connects objects and adjectives (e.g., "The car is red"). FCL indicates that the parent/caregiver is focusing on what the child is doing. This can be indicated in a number of ways, including turn-taking and commenting on the child's focus of interest. MF is indicated when the parent/caregiver builds on what the child is doing, that is, responds to the interest of the child, leading to continued child engagement. New items/activities can be involved, as well as the use of scaffolding language that the child will be able to understand, or tone of voice, facial expression, or gesture, but it does need to extend the focus of attention of the child in an interesting way rather than disrupting it. Thus, MF is more than FCL; for example, if a child reaches for her toy phone and vocalizes and then the parent not only pushes the phone to the child but also suggests phoning someone known to the child.

The three observation sessions were scored by a trained and certified scorer for use of the four PPBs. One point is given per example rather than a rating on a scale, as used in some other parental behavioral measures (e.g., a 7-point scale was used by Quittner et al., 2013). Interrater reliability with a second certified scorer on 15% of the recordings from Session 1 was over 90%. For each type of PPB, the mean of the total number used across the activities in each session was calculated, and from those, the total mean score was calculated.

Analysis

A Spearman correlation analysis was conducted on the PPBs from each observation session to examine the associations within and across the three sessions. R Version 3.6.1 (R Core Team, 2019) was used for the statistical analyses to address Aims 1 and 2. A repeated-measures negative binomial generalized linear mixed-effects model using the lme4 package (D. Bates et al., 2015) was used to model words produced. The model was fitted with a random intercept for the individual. Covariates included in the model were gender, maternal education, time since implant, words (indicating the number of words at Time 1 and Time 2), and total PPBs per observation session. Interaction between words and PPBs was also considered and was insignificant, suggesting little association between PPBs and the time between word totals at Time 1 and Time 2 other than what was already explained by PPBs alone. The interaction term was therefore excluded for the analyses. Three models were fitted, one each with total PPBs at observation Sessions 1, 2, and 3. The models were fitted for log count, and coefficients were then exponentiated to provide incidence ratios (IRs) and their respective confidence interval estimates.

A follow-up analysis with the separate PPBs from each session was conducted to identify which PPBs at each session contributed more to the number of words produced. To avoid multicollinearity and difficulty in interpreting complicated models, variable selection of the negative binomial generalized linear mixed-effects models was used in order to retain only the PPBs and covariates that were deemed informative based on the Akaike information criterion (AIC). The AIC is a bias-corrected estimator of the Kullback–Leibler divergence between the distribution implied by a statistical model and that estimated by the data (Akaike, 1974; Claeskens & Hjort 2008). To correct for potential overfitting that can occur when sample sizes are not large, we used the AIC, which adjusts for smaller samples. Consequently, only those variables that are deemed to contribute above and beyond what is being contributed by the other variables in the model are retained. Model selection was carried out using the MuMIn package (Barton, 2019).

Results

The number of words reported to be produced at Time 1 ranged from 0 to 309 (M = 43.07, SD = 63.61), and at Time 2, 3 months later, the range was 1–382 (M = 82.3, SD = 104.13). For one participant, PPB data were missing for the third observation session, and to help reduce bias, the average of the nonmissing data was calculated. Shown in Table 1 is the group mean for each PPB type, and the standard error for each of the three observation sessions. Table 2 shows the correlations and significance levels for each PPB across the three sessions, as well as the correlations.

Impact of Total PPBs and Covariates on Words Produced

To investigate the association between total PPBs and the four-level variable indicating maternal education, preliminary analysis was conducted using Kendall's tau, with asymptotic confidence intervals and as a sensitivity analysis due to sample size, bootstrap intervals (see Section 8.3 of Hollander et al., 1993). Results were similar, and so the asymptotic intervals were used. There were significant positive correlations between maternal education and PPBs at each session: Session 1 (tau = 0.338, CI [0.199, 0.477], p < .001), Session 2 (tau = 0.198, CI [0.043, 0.354], p = .039) and

Table 1. Mean and standard error (*SE*) for each positive parenting behavior for each observation session.

Sess.	DL	*SE*	FCL	*SE*	AW	*SE*	MF	*SE*
1	8.291667	0.707399	2.989583	0.248116	7.125	0.354759	0.46875	0.07187
2	9.546875	0.76337	3.692708	0.246342	6.640625	0.449319	0.34375	0.058911
3	8.752688	0.647256	3.709677	0.275045	4.924731	0.340175	0.505376	0.114659

Note. Sess. = session; DL = descriptive language; FCL = follows child's lead; AW = conveys acceptance and warmth; MF = maintains and extends child's focus.

Session 3 (tau = 0.266, CI [0.106, 0.427], p = .006). Further analysis was conducted with words included in the repeated-measures negative binomial analysis. Maternal education was insignificant for each analysis. However, when the total PPBs variable was removed, there was an increase in words for Maternal Education Level 4 (p = .068), suggesting that the highest level of maternal education was associated with an increase in the number of words produced. Subsequently, to reduce model complexity and to avoid overfitting, we collapsed the levels to create a two-level maternal education variable. Levels 1, 2, and 3 were collapsed (no university degree), and Level 4 (university degree) became the second level.

The interaction analyses between words and PPBs for each session showed the following results: Session 1, p = .77; Session 2, p = .664; Session 3, p = .378. The results of the repeated-measures negative binomial generalized linear mixed-effects model used to determine the impact of the PPBs and covariates maternal education, gender, and time since implant on the outcome measure are reported in Table 3 (for Session 1 PPB data), Table 4 (for Session 2 PPB data), and Table 5 (for Session 3 PPB data). The tables show the IR for each variable, the IR confidence interval, and the p value. An IR of > 1 indicates an increase in the variable related to an increase in the number of words produced. As shown, maternal education did not have a significant effect on the number of words produced. The total PPBs at Session 1 were positively associated with Words – Time 1 (IR = 1.089, 95% CI [1.028, 1.154], p = .004), with a further significant increase in Words – Time 2 (IR = 2.074, 95% CI [1.675, 2.568], p < .001). Total PPBs were positively associated with Words – Time 2 (Spearman rho = 0.461, p = .027).

As shown in Table 4, there was a positive association between total PPBs at Session 2 and Words – Time 1 (IR = 1.046, 95% CI [0.997, 1.097], p = .067). A significant increase in Words – Time 2 was found (IR= 2.069, 95% CI [1.670, 2.563], p < .001). As found for Session 1, total PPBs was positively associated with Words – Time 2 (Spearman rho = 0.495, p = .016). For Session 3, there was a positive association between total PPBs and Words – Time 1 (IR = 1.046, 95% CI [0.991, 1.107], p = .100; see Table 5), and a significant increase in words produced at Time 2 (IR = 2.076, 95% CI [1.675, 2.573], p < .001). Again, total PPBs was positively associated with Words – Time 2 (Spearman rho = 0.340, p = .113).

For all three models, gender had no significant effect. In contrast, time since implant did, with p = .002 for the analyses including Session 1 PPBs and also Session 2 PPBs and p = .002 for the analysis with Session 3 PPBs.

Impact of Each Type of PPB

Using the mean number for each PPB in each session, analysis was conducted to determine which PPBs were identified by the model as important contributors to the output

Table 2. Correlations of positive parenting behaviors within and across sessions.

Variable	DL.1	AW.1	FCL.1	MF.1	DL.2	AW.2	FCL.2	MF.2	DL.3	AW.3	FCL.3
DL.1											
AW.1	.137										
FCL.1	.523**	–.102									
MF.1	.558**	–.166	.552**								
DL.2	.674***	.059	.514**	.429*							
AW.2	.257	.437*	.099	.191	.376*						
FCL.2	.512**	.173	.319	.131	.587***	.238					
MF.2	.372*	–.177	.367*	.463**	.348	.167	.389*				
DL.3	.672***	–.071	.428*	.302	.677***	.148	.565**	.282			
AW.3	.361*	.498**	.217	.04	.11	.345	.288	.142	.24		
FCL.3	.478**	.088	.67***	.133	.384*	.14	.405*	.047	.683***	.426*	
MF.3	.247	.166	.465**	.021	.196	.085	.087	–.099	.333	.344	.598***

Note. DL = descriptive Language; AW = conveys acceptance and warmth; FCL = follows child's lead; MF = maintains or extends child's focus.

*p < .05. **p < .01. ***p < .001.

Table 3. Impact of positive parenting behaviors (PPBs) used in Session 1 on number of words produced.

Variable	IR	CI	*p*
(Intercept)	0.109	[0.008, 1.570]	.103
Words-2	2.074	[1.675, 2.568]	< .001
Total PPBs	1.089	[1.028, 1.154]	.004
Maternal education	1.321	[0.516, 3.381]	.562
Time since implant (months)	1.392	[1.128, 1.719]	.002
Gender (male)	0.482	[0.211, 1.099]	.083

Note. IR = incidence ratio; CI = confidence interval.

Table 5. Impact of positive parenting behaviors (PPBs) used in Session 3 on number of words produced.

Variable	IR	CI	*p*
(Intercept)	0.101	[0.004, 2.352]	.154
Words-2	2.076	[1.675, 2.573]	< .001
Total PPBs	1.047	[0.991, 1.107]	.100
Maternal education	1.846	[0.686, 4.968]	.225
Time since implant (months)	1.486	[1.175, 1.878]	.001
Gender (male)	0.526	[0.210, 1.315]	.170

Note. IR = incidence ratio; CI = confidence interval.

measure (children's vocabulary scores). To reduce the number of variables included in the models given the small sample size and the addition in this analysis of four variables for PPB rather than one, maternal education and gender were not included as they had not contributed significantly in the analyses using the total PPB scores. The PPBs and covariates deemed to be informative were selected with the variable procedure. Retained in all three models were time since implant and words (see Tables 6, 7, and 8). Time since implant was a significant contributor to the number of words produced, and consistent with the results using the total number of PPBs, significantly more words were produced at Time 2 than 3 months earlier. Of the four PPBs, two (DL and FCL) were selected by the model for Session 1 (see Table 6), DL for Model 2 (see Table 7), and AW for Model 3 (see Table 8).

Discussion

Impact of PPBs and Covariates on Words Produced

The main aims of the current study were to determine the associations between the use by parents of four PPBs (from the IPCI measure) in interactions with their child in three daily activities over three observation sessions and words reported to be produced by their child approximately 6 and 9 months after the third observation session, and the impact of possible influencing covariates. We first discuss the results concerning the association between PPBs and maternal education, followed by the results with the other variables included.

Table 4. Impact of positive parenting behaviors (PPBs) used in Session 2 on number of words produced.

Variable	IR	CI	*p*
(Intercept)	0.151	[0.008, 2.760]	.202
Words-2	2.069	[1.670, 2.563]	< .001
Total PPBs	1.046	[0.997, 1.097]	.067
Maternal education	1.752	[0.652, 4.704]	.266
Time since implant (months)	1.429	[1.137, 1.795]	.002
Gender (male)	0.479	[0.195, 1.176]	.108

Note. IR = incidence ratio; CI = confidence interval.

As discussed in the introduction, higher levels of maternal education have been associated in previous research with children's higher vocabulary/language levels. One factor proposed to be influencing the association is that the quality of the interaction between parent and child may be related to education level. Thus, in an initial analysis, we investigated the association between maternal education (four levels) and number of PPBs used at each of the three observation sessions. A significant association found for each session suggested it was likely that more PPBs would be used by a mother with higher education. When both maternal education and total PPBs were included in a repeated-measures negative binomial analysis together with our output measure (the number of words at each of two data collection points), maternal education was not a significant factor. However, removing the total PPB variable from the analysis gave a *p* value of .068, suggesting some association with the number of words produced.

Based on these preliminary results, in our subsequent analyses, we reduced the number of levels of maternal education to two by collapsing the variable into "no degree" versus "having a degree." Including this new maternal education variable with total PPBs, words, gender, and time since implant in our models, no significant association between maternal education and words produced was found. Differences attributed to family characteristics might become evident in the future as the children's vocabulary and language abilities develop and different growth patterns become evident, although, as has been shown previously (Rowe, 2018; Rowe & Snow, 2020; Sperry et al., 2019), there is variability within maternal education levels. Mothers who are motivated to assist in their children's language development, regardless of education level, are likely to seek relevant information (Rowe & Snow, 2020). For mothers of young children with CIs, while information about strategies may be available from the CI clinics at follow-up sessions and through early intervention programs, some parents may be more willing to take in the information and more motivated to use it.

A positive and significant association was found between the total number of PPBs per session and the number of words produced at Time 1 and the number of words produced at Time 2. As might be anticipated with a 3-month

Table 6. Impact on words produced of positive parenting behaviors in Session 1.

				After variable selection		
Variable	**IR**	**CI**	***p***	**IR**	**CI**	***p***
factor(Words)Time2	2.036	[1.674, 2.477]	< .001	2.045	[1.681, 2.487]	< .001
DL.1	1.046	[0.956, 1.144]	.325	1.077	[0.988, 1.174]	.093
AW.1	1.092	[0.949, 1.256]	.218	—	—	—
FCL.1	1.287	[1.013, 1.636]	.039	1.29	[1.019, 1.633]	.034
MF.1	1.677	[0.716, 3.925]	.234	—	—	—
Time since implant	1.484	[1.195, 1.842]	< .001	1.456	[1.164, 1.82]	.001

Note. Em dashes indicate that that variable was not selected by the model in the variable selection procedure. IR = incidence ratio; CI = confidence interval; DL = descriptive language; AW = conveys acceptance and warmth; FCL = follows child's lead; MF = maintains and extends child's focus.

gap between the 2 times for vocabulary collection, more words were produced at Time 2 than Time 1. However, no significant interaction between total PPBs and words was found. The results indicate that quality of the mother–child interaction (demonstrated in their use of PPBs) impacted the vocabulary development of the children, supporting findings from past research on the impact of quality in parent–child interactions on early language development. Previous research with children with CIs, covering a wider age range than in the current study and following up for longer periods, has used different measures of quality, including, as discussed above, some measures referred to as facilitative language techniques and others referred to as MS. Measures may vary across studies. As discussed earlier, the IPCI has shorter observation times than some measures, and the tasks are less intrusive, tapping into everyday activities in the home that involve interactions between the child and the parent. This has an advantage over introducing new activities when aiming to capture typical parent behavior. The structured task in Quittner et al.'s (2013) study, in contrast, asks parents to talk for 5 min about a series of five pictures on the wall, a task more suitable for older children than in the current study. The activities included in the current study captured both nonverbal and verbal interactional features of communication. Communication is a two-way process, with turn-taking as a parent/caregiver responds to what the child is doing/attending to, either verbally or nonverbally, and the child's behavioral response will determine/influence further parental responses. As the children's vocabulary develops and with more experience, their verbal responses will develop.

In all three models used to analyze the data, there was a significant impact of time since implant on the number of words produced. An implication of this finding is that early implantation and switch-on of the CIs can benefit children with severe-to-profound hearing loss in catching up to those with NH of an equivalent age, although other factors will impact vocabulary development. Early vocabulary marks progress in identifying the patterns of the ambient language, and there are strong correlations between early speech perception and developing vocabulary. The likelihood, then, is that the earlier children become attuned to the sound patterns of the language and their speech perception abilities develop, the sooner their vocabulary will develop. Some past research supports this in that better linguistic outcomes have been reported for children implanted in their first year of life (e.g., Ching et al., 2017; Leigh et al., 2013).

Gender did not impact the total number of words produced. Some past research has shown gender differences in children's early vocabulary (Fenson et al., 2007), although gender has been reported in some research to have less impact on later language for samples with NH (Rowe et al., 2012). However, significant gender differences in a CI sample at the mean age of 5;10 (years;months) were reported by Geers et al. (2009); gender differences might develop within

Table 7. Impact on words produced of positive parenting behaviors in Session 2.

				After variable selection		
Variable	**IR**	**CI**	***p***	**IR**	**CI**	***p***
factor(Words)Time2	2.042	[1.678, 2.486]	< .001	2.042	[1.678, 2.485]	< .001
DL.2	1.049	[0.954, 1.153]	.322	1.072	[0.99, 1.161]	.085
AW.2	1.075	[0.937, 1.235]	.303	—	—	—
FCL.2	1.018	[0.774, 1.338]	.899	—	—	—
MF.2	1.166	[0.381, 3.561]	.788	—	—	—
Time since implant	1.42	[1.083, 1.863]	.011	1.431	[1.104, 1.855]	.007

Note. Em dashes indicate that that variable was not selected by the model in the variable selection procedure. IR = incidence ratio; CI = confidence interval; DL = descriptive language; AW = conveys acceptance and warmth; FCL = follows child's lead; MF = maintains and extends child's focus.

Table 8. Impact on words produced of positive parenting behaviors in Session 3.

				After variable selection		
Variable	IR	CI	*p*	IR	CI	*p*
factor(Words)Time2	2.03	[1.667, 2.472]	< .001	2.043	[1.678, 2.487]	< .001
DL.3	1.014	[0.907, 1.133]	.809	—	—	—
AW.3	1.186	[1.005, 1.401]	.044	1.239	[1.044, 1.469]	.014
FCL.3	1.239	[0.912, 1.683]	.17	—	—	—
MF.3	0.629	[0.336, 1.178]	.148	—	—	—
Time since implant	1.389	[1.066, 1.81]	.015	1.481	[1.154, 1.902]	.002

Note. Em dashes indicate that that variable was not selected by the model in the variable selection procedure. IR = incidence ratio; CI = confidence interval; DL = descriptive language; AW = conveys acceptance and warmth; FCL = follows child's lead; MF = maintains and extends child's focus.

the current sample as their language progresses into the school years.

Which PPBs Were Selected in Each Session as Important Contributors to Words Produced?

In our follow-up analyses, differences were found across sessions as to which PPBs were selected by the model as important contributors to the number of words produced. We can expect variability in the use of PPBs depending on the child's behaviors/responses, as well as the activity involved. DL was retained for Session 1 in the model variable selection procedure. FCL was also selected for Session 1. FCL is demonstrated in an action that indicates the adult has noticed what the child is doing (e.g., by joining in with the activity), indicating joint attention; it can also be shown verbally, for example, by commenting specifically on the child's focus of attention. If the comment meets the criteria, it would also be scored as an example of DL. Joint attention is associated with the here and now and has been shown to be important in promoting communicative development in young children (e.g., Carpenter et al., 1998). By responding to an infant's focus of attention, a parent is providing interactional and conceptual support (see Rowe & Snow, 2020). Weisleder and Fernald (2013) have proposed that early language experience strengthens a child's processing skills and so helps build vocabulary. While acquiring words, a young child frequently hears them in a context that suggests a potential meaning. For example, naming an object in the context of joint attention provides the child with a clue as to what the name refers to. However, DL examples provide the child with more than a label for an object; there is a linguistic context: a noun and attribute or noun and action. The finding that DL use as early as Sessions 1 and 2 had an impact on the children's vocabulary development, measured some months later, reinforces the importance of parents talking to their young child during their activities. Moderately strong correlations were found for DL across sessions, as shown in Table 2, indicating some consistency in its use across sessions, so parents who used DL more frequently in Session 1 were likely to continue using DL in their interactions with their child in the later sessions. In the analysis for Session 2 PPBs, DL was again selected; although the *p* value was .085, this does not indicate a lack of a strong association between DL and vocabulary size.

In the variable selection for Session 3, AW was selected as contributing to the number of words produced. Nonverbal behaviors (smiling, touching affectionately) and verbal (positive comments) indicate AW; they reflect parental warmth. Recall, in the meta-analysis of research with children with NH conducted by Madigan et al. (2019) discussed in the introduction, parental warmth was identified as a factor impacting children's language development, although the impact of parental sensitive responsiveness was stronger. However, the children in the current study were still at the early stage of developing vocabulary. Parent behavior is modified by the child's behavior, and AW may have a greater impact as the children produce more words and start combining them, and in different activities, there may be more opportunities for the use of AW. That is something to consider for future research.

MF was the least frequently used PPB (see Table 1) and was not identified as a major contributor to the children's word count. MF is indicated if a parent/caregiver extends what a child is already doing without detracting from it so that their interest is maintained. It can be achieved by adding an item, a new theme, or a novel approach. Thus, MF takes FCL to a higher level and so would not be expected to occur as frequently with very young children as when the children get a little older.

Summary and Future Research

Innovative features of the current research were the young ages and narrow range of the children in the sample and the use of the IPCI measure for identifying the use of PPBs in parent–child interactions in the home during three daily activities, thus providing opportunities for a range of behaviors. The parent behaviors measured in the IPCI relate to shared attention (i.e., contingency) between parent and child, as well as parental warmth and sensitivity. These areas have previously been reported as supportive of early language development.

Given the size of the sample, we were limited in how many variables could be added in the statistical models, but with a larger sample, additional variables could be examined, including, for example, the use of the different PPBs in the different activities. In past research with infants with NH, Sosa (2016) found that, in a book reading with children aged 10–16 months, there was more parental language input than when playing with toys, and Clemens and Kegel (2020) reported that book sharing between parent and infant (9–18 months of age) provided a richer environment for language use than other activities. Examination of the use of PPBs in each activity included in the current research would help identify which activities with infants with CIs are more likely to provide an optimal context for encouraging behaviors that might impact positively on infant's vocabulary. This would provide valuable information for parent guidance and personnel working in early intervention programs.

Language outcomes are influenced by a number of factors, and for children with CIs, even when they have had the advantage of being implanted at an early age (Duchesne & Marschark, 2019). An important direction for future researchers will be to study larger samples than in the current study to investigate interactions between PPBs and variables previously identified as influencing the language outcomes. Those variables include child characteristics, memory (e.g., Kronenberger et al., 2020), family demographics, and linguistic features of the input. In addition, children's early vocabulary may vary depending on their experiences. In Jung et al.'s (2020) study, differences were found in word types produced by children with CIs (M_{age} = 23.99 months, 8.89 months after receiving CIs) compared to younger children with NH matched on receptive vocabulary. The word types reported on the CDI were not considered in the current research, but the topic is one for further research as the children's vocabulary develops. A priority for future research would be determining whether parents' early use of the PPBs, together with variables that provide linguistic and conceptual support at an older age, has implications for the children's linguistic development over the preschool years.

Conclusions

This study has added to current knowledge about features of parent behaviors that are associated with the early vocabulary development of children implanted with CIs at a very young age. A strength of the study is the use of the PPBs included in the IPCI, an established observation tool for tracking the development of young children with NH that has not previously been used in research with children with CIs. The IPCI emphasizes behaviors between children and their caregiver/parent that indicate quality. Our observations were every 3 months, but the IPCI can be used more frequently, and therefore, it is valuable for documenting individual development. The observations were conducted in the home, a familiar location with familiar toys easily accessible, making it convenient for mothers to handle their children's needs. The tasks included in the IPCI cover daily interactions that occur between the infant and the parent, an advantage over introducing new activities when attempting to capture typical parent behavior.

Together, the four parent behaviors (DL, FCL, AW, and MF) were positively associated with the number of words the children produced at 6 and 9 months following the observation sessions. Individually, from the first and second sessions, DL was shown to impact the number of words, FCL from the second, and AW from the third. The fourth PPB (MF) would be anticipated to contribute more as the children get older, given it is an extension of FCL.

The findings indicate the potential value of the IPCI measure to clinicians monitoring the development of infants with CIs. Furthermore, if the findings of the current study are incorporated into the information provided to parents of young children with CIs by early intervention services, there are clear potential benefits for them and their children's language development.

Author Contributions

Edith L. Bavin: Conceptualization (Lead), Funding acquisition (Equal), Methodology (Lead), Project administration (Lead), Investigation (Lead), Supervision (Lead), Writing – Original draft (lead), Writing – Review & editing (Lead). **Julia Sarant:** Conceptualization (Supporting), Funding acquisition (Equal), Methodology (Supporting), Writing – review & editing (Supporting). **Luke Prendergast:** Formal analysis (Lead), Writing – review & editing (Supporting). **Peter Busby:** Funding acquisition (Equal), Investigation (Supporting), Writing – review & editing (Supporting). **Greg Leigh:** Funding acquisition (Supporting), Investigation (Supporting), Writing – review & editing (Supporting). **Candida Peterson:** Funding acquisition (Supporting), Investigation (Supporting), Writing – review & editing (Supporting).

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