2008

Language skills of profoundly deaf children who received cochlear implants under 12 months of age: a preliminary study

Richard T. Miyamoto

Marcia J. Hay-McCutcheon

Karen Iler Kirk

Derek M. Houston

Tonya Bergeson-Dana
Butler University, tbergeso@butler.edu

Recommended Citation

Miyamoto, R. T., Hay-McCutcheon, M. J., Kirk, K. I., Houston, D. M., Bergeson-Dana, T. R. (2008). Speech and language skills of profoundly deaf children implanted under 12 months of age: Preliminary results. Acta Oto-Laryngologica, 128, 373-377.

Published in final edited form as:
Acta Otolaryngol. 2008 April ; 128(4): 373. doi:10.1080/00016480701785012.

Language Skills of Profoundly Deaf Children who Received Cochlear Implants under 12-months of Age: A Preliminary Study

Richard T. Miyamoto[1], **Marcia J. Hay-McCutcheon**[1], **Karen Iler Kirk**[1,2], **Derek M. Houston**[1], and **Tonya Bergeson-Dana**[1]

[1] Department of Otolaryngology, Head and Neck Surgery, Indiana University School of Medicine

[2] Department of Speech, Language and Hearing Sciences, Purdue University

Abstract

Conclusion—This study demonstrated that children who receive a cochlear implant below the age of 2 years old obtain higher mean receptive and expressive language scores than children implanted over the age of 2 years.

Objective—The purpose of this study was to compare the receptive and expressive language skills of children who received a cochlear implant before 1 year of age to the language skills of children who received an implant between 1 and 3 years of age.

Method—Standardized language measures, the Reynell Developmental Language Scale (RDLS) and the Preschool Language Scale (PLS), were used to assess the receptive and expressive language skills of ninety-one children who received an implant before their third birthday.

Results—The mean receptive and expressive language scores for the RDLS and the PLS were slightly higher for the children who were implanted below the age of 2 years compared to the children who were implanted over 2 years old. For the PLS, both the receptive and expressive mean standard scores decrease with increasing age at implantation.

Keywords

cochlear implants; Reynell Developmental Language Scales; Preschool Language Scale; receptive language; expressive language

INTRODUCTION

Evidence has suggested that profoundly deaf children who receive cochlear implants under the age of 2 years old more successfully develop speech and language skills than children who receive a cochlear implant over the age of 2 years [1–3]. Additionally, there is a growing body of literature suggesting that children who are implanted under the age of 12 months might develop speech and language skills more comparable to their normal-hearing age-matched peers [4–8]. It is generally thought that deaf children can more easily develop speech and language with early implantation because they have increased access to sound during a sensitive period of development [9].

Objectively evaluating the auditory skill development of very young children is challenging due to their limited response capabilities with traditional assessments of development. Specific

Address for correspondence: Richard T. Miyamoto, MD, Department of Otolaryngology—Head and Neck Surgery, Indiana University School of Medicine, 702 Barnhill Drive, Suite 0806, Indianapolis, Indiana 46202, USA, Tel: 317-274-3556, Fax: 317-278-3743, rmiyamot@iupui.edu.

measurement tools, therefore, need to be employed to accurately assess the speech and language skills of infants who receive a cochlear implant. Some studies have elected to use questionnaires or rating scales of auditory development, such as the Category of Auditory Performance (CAP) [4] or the Infant-Toddler Meaningful Auditory Integration Scale (IT-MAIS) [8]. Other studies have used head-turn procedures and/or visual looking preferences to assess auditory discrimination abilities [6]. Although the methodologies varied, the findings from these studies generally revealed that children who are implanted under the age of 12 months can successfully develop auditory discrimination abilities.

Examination of language development for these children also has been performed. Again, due to the young age of these children it is necessary to select developmentally-appropriate language assessment tools in order to accurately measure early-acquired language skills. Studies have either used video recordings of communication behavior to assess turn-taking skills and auditory awareness [7] or have used language rating scales [5]. For example, Tait et al. [7] demonstrated through the use of video recordings that children who received implants under 1 year of age might be developing pre-communicative behaviors (e.g., vocal autonomy from a caregiver's direction of play) similarly to their normal-hearing age-matched peers. Later, Dettman et al. [5] used the Rossetti Infant-Toddler Language Scale (RI-TLS) over a period of 2 to 3 years to demonstrate that the rates of expressive and receptive language growth for children who received implants before the age of 1 year old were significantly greater than the rates of language growth for children implanted between 12 and 24 months of age. The RI-TLS is a non-standardized rating scale that assesses the language skills of children from birth to 36 months of age. Observed or elicited behaviors, in addition to clinician or caregiver report, are used to complete the scale [10].

Although it is important to use appropriate tools to assess the language abilities of infants shortly after implantation, it is also important to continue to assess their language skills with increasing duration of implant use. In order to compare these infants with their normal-hearing age-matched peers it is necessary to use more standardized measurement tools than previously have been used. This study assessed the receptive and expressive language skills of children who received their implants below the age of 1 year old and compared them to the language skills of children implanted between 1 and 3 years of age using standardized language assessment tools.

MATERIAL AND METHODS

Participants

Based on their ages at implantation, the children included in this cross-sectional study were divided into three different groups. Eight children received their implant under the age of 12 months, 38 children received their implant between 12 months and 23 months of age, and 45 children received their implant between the ages of 24 and 36 months. The children were implanted between the years of 1994 and 2007 and used SAS, CIS, SPEAK or ACE speech processing strategies. They were all native speakers of English and had no additional disabilities.

Procedures and Language Tests

The children were administered one of two language measures, the Reynell Developmental Language Scales (RDLS) or the Preschool Language Scale (PLS) in a quiet testing room. The data presented in this study were generated from one testing session. All of the children had 2–3 years of implant experience prior to the testing session. The RDLS has been standardized on a large group of normal hearing children and is designed to be administered to children between the ages of 1 and 7 years of age. It consists of both a verbal comprehension scale and

an expressive language scale [11]. At the beginning level of the receptive language subtest, the verbal comprehension scale evaluates the child's ability to distinguish among a few word sounds, and at the most advanced level, this scale evaluates the child's ability to use vocabulary for conceptual reasoning. The expressive language scale evaluates the use of vocal language structure, the use of vocabulary to name and describe word meanings, and the use of language to express ideas. This test has been used extensively with deaf children.

The second language measure that was used, the PLS, also has been standardized on a large group of normal hearing children and is designed to be administered to children from birth to 6 years of age [12]. It consists of two subscales that assess auditory comprehension and expressive communication skills. The auditory comprehension subscale assesses how well a child understands language, and the expressive communication subscale measures are designed to determine how well infants and toddlers develop and use their oral communication skills. The children who received this test had 6 months to 1 year of implant use when the test was administered.

RESULTS

The results for the RDLS and the PLS are displayed in Figures 1 and 2, respectively. Figure 1 is a box plot that shows the language quotient scores (i.e., age equivalent score obtained on the test divided by the child's chronological age) of the RDLS expressive and receptive subtests as a function of age of implantation. The upper edge of each box represents the 75^{th} percentile and the lower edge of the box represents the 25^{th} percentile. The solid and dot-dashed horizontal lines in the middle of the plot represent the median and mean values, respectively. The vertical lines, or "whiskers" are extended to a maximum of 1.5 times the inter-quartile range and the points outside of the whiskers are considered to be outliers. The mean language quotient score for normal-hearing children is indicated with the dashed line through the 1.0 mark, and the number of children tested for each age at implantation group is shown.

Although the majority of the language quotient scores fall below the average language quotient for normal hearing children, there are some children with implants who perform at or above the average level for both the expressive and receptive tests. In addition, for both of these test results, there appears to be a trend where the children who were implanted over the age of 2 perform more poorly than the children implanted under 2 years of age. The mean language quotient scores for the receptive and expressive subtests of the RDLS are provided in Table 1. The mean receptive scores are slightly higher for the children who were implanted below the age of 2 years (i.e., 0.64 and 0.69) compared to the children who were implanted over 2 years old (i.e., 0.59). The mean expressive language quotient scores are also displayed in Table 1. Again, the trend is for the mean expressive language quotient scores to be higher for the children implanted under 2 years of age (i.e., 0.70 and 0.68) compared to the children implanted over the age of 2 years old (i.e., 0.56). The differences in scores across the three age-at-implantation groups for both the receptive and expressive language quotient scores, however, were not significantly different as determined using a one-way ANOVA. Due to the limited number of children included in the under 12-month age-at-implantation category, this finding should be cautiously interpreted. Also, the present analyses did not consider the possible influence of confounding variables.

Our lab has only recently used the PLS to assess the receptive and expressive language skills of children with cochlear implants and these results are presented in Figure 2. The standard scores obtained for the expressive communication and auditory comprehension subtests are presented as a function of the age at implantation. The mean standard score for normal-hearing children (i.e., 100) is indicated using the dashed line in both panels. Each open circle represents the data obtained for one child and the number of children included in each group is shown in

the bottom panel. Ideally, it is hoped that children with cochlear implants would be able to perform similarly to their normal-hearing peers on these language measures.

As shown in this figure and across all of the implant groups, some of the children are able to obtain age-appropriate language skills and even exceed the mean standard scores obtained by their age-matched normal-hearing peers. However, the majority of the scores fall below the 100 standard score level. The mean standard scores for the PLS are also provided in Table 1. Both the receptive (i.e., 101.0, 79.0, 60.2) and expressive (i.e., 104.0, 89.8, 66.0) mean standard scores decrease with increasing age at implantation. With further data collection it will be possible to determine if the trend observed with these mean data (i.e., decreasing standard scores with increasing age at implantation) continues, and in addition it will help to determine if this trend is statistically significant.

DISCUSSION

The mean receptive and expressive language scores for both the Reynell Developmental Language Scales and the Preschool Language Scale tests suggest that the receptive and expressive language skills of children who are implanted at earlier ages are better compared to the scores observed for children who are implanted later in life. In particular, the mean language scores from this study suggest that children implanted below the age of 2 were more proficient with their understanding and use of language compared to children who were implanted over the age of 2 years old. Families in the United States with a child identified as having a profound hearing loss at birth or shortly thereafter, therefore, should more readily have the option of receiving an implant as soon as there are no medical or surgical counter-indications.

Previous data also have suggested that implantation under the age of 2 years old is beneficial for the development of language skills. Specifically, data from Svirsky et al. [3] revealed that when implanted between 16 and 24 months of age, children performed similarly to their normal-hearing age-matched peers on the expressive subtest of the RDLS than did children implanted between the ages of 25 to 36 months. Also, Connor et al. [1] demonstrated that after approximately two years of implant use, oral children implanted before 2.5 years of age had mean vocabulary skills that were age appropriate, compared to children who were implanted when they were older than 2.5 years old.

It is possible that even earlier implantation would promote the development of receptive and expressive language skills such that profoundly deaf children could achieve skills comparable to their normal-hearing age-matched peers. It will be necessary, however, to continue to follow this group of children who received implants before 12 months of age to examine their skills across time. Additionally, it will be necessary to recruit a larger population of children in our studies who have received a cochlear implant before their first birthday to provide statistical significance to our current findings.

Acknowledgments

Funding for this work was provided through NIH-NIDCD R01 DC00064 and the Psi Iota Xi National Sorority.

References

1. Connor CM, Craig HK, Raudenbush SW, Heavner K, Zwolan TA. The age at which young deaf children receive cochlear implants and their vocabulary and speech-production growth: is there an added value for early implantation? Ear Hear 2006;27:628–44. [PubMed: 17086075]
2. Waltzman SB, Cohen NL. Cochlear implantation in children younger than 2 years old. Am J Otol 1998;19:158–62. [PubMed: 9520051]

3. Svirsky MA, Teoh SW, Neuburger H. Development of language and speech perception in congenitally, profoundly deaf children as a function of age at cochlear implantation. Audiology & Neuro-Otology 2004;9:224–33. [PubMed: 15205550]

4. Colletti V, Carner M, Miorelli V, Guida M, Colletti L, Fiorino FG. Cochlear implantation at under 12 months: Report on 10 patients. The Laryngoscope 2005;115:445–9. [PubMed: 15744155]

5. Dettman SJ, Pinder D, Briggs RJS, Dowell RC, Leigh JR. Communication development in children who receive the cochlear implant younger than 12 months: Risks versus benefits. Ear Hear 2007;28:11S–8S. [PubMed: 17496638]

6. Miyamoto RT, Houston DM, Bergeson T. Cochlear implantation in deaf infants. The Laryngoscope 2005;115:1376–80. [PubMed: 16094108]

7. Tait M, De Raeve L, Nikolopoulos TP. Deaf children with cochlear implants before the age of 1 year: Comparison of preverbal communication with normally hearing children. International Journal of Pediatric Otorhinolaryngology. in press.

8. Waltzman SB, Roland JT Jr. Cochlear implantation in children younger than 12 months. Pediatrics 2005;116:e487–e93. [PubMed: 16199675]

9. Kral A, Hartmann R, Tillein J, Heid S, Klinke R. Delayed maturation and sensitive periods in the auditory cortex. Audiology & Neuro-Otology 2001;6:346–62. [PubMed: 11847463]

10. Rossetti, LM. The Rossetti Infant-Toddler Language Scale. East Moline, IL: LinguiSystems; 1990.

11. Reynell, JK.; Huntley, M. Reynell Developmental Language Scales: Second Revision. Windsor, England: NFER-NELSON; 1985.

12. Zimmerman, IL.; Steiner, VG.; Pond, RE. Preschool Language Scale. 4. San Antonio, TX: The Psychological Corporation; 2002.

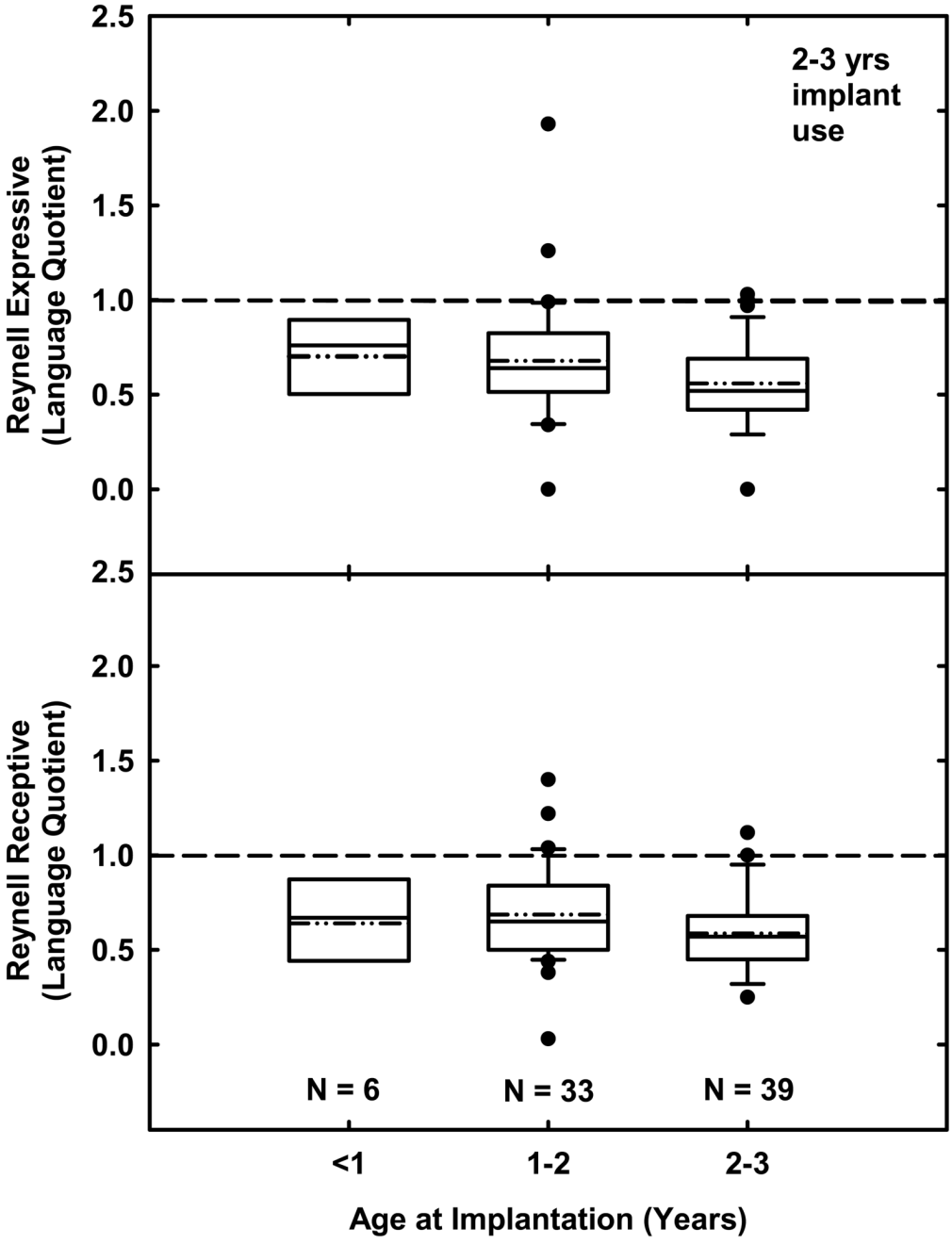

Figure 1.

The expressive and receptive language quotient data from the Reynell Developmental Language scale are presented as a function of age at implantation. Each child had 2–3 years of experience with his or her cochlear implant when these data were collected. The numbers of children who were included in each group are listed in the bottom panel. The solid line within the box plot shows the median score and the dashed-dot-dot line represents the mean score. See text for further explanation of the box plots.

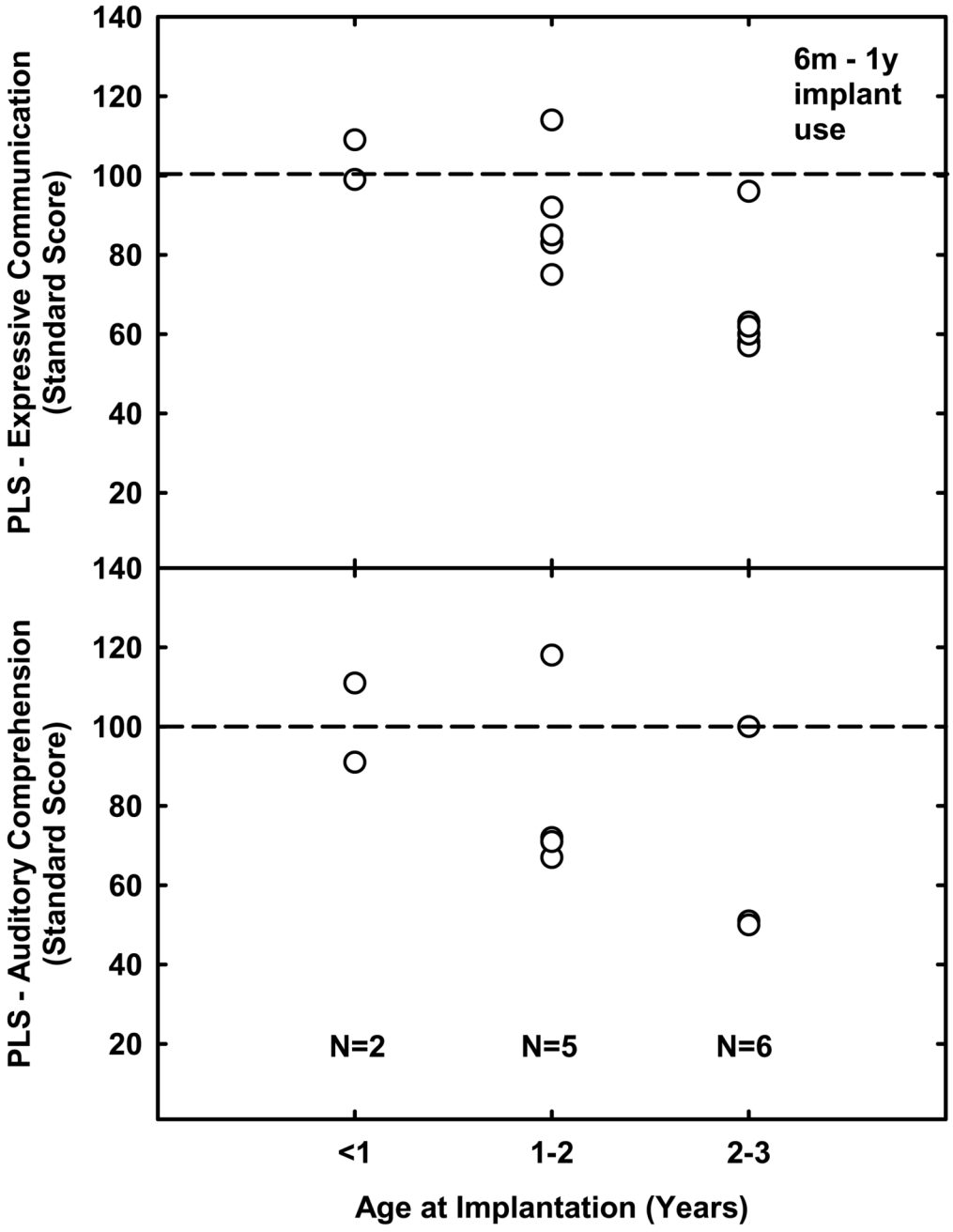

Figure 2.

The auditory comprehension and expressive communication standard score data from the Preschool Language Scale are shown as a function of age at implantation. The numbers of children included in each group are displayed in the bottom panel. Each open circle represents one data point from one child. The children had used their devices for 6 months to 1 year prior to administration of the PLS.

Table 1

Mean Receptive and Expressive Language Scores for the Three Age-at-Implantation Groups

	Receptive			Expressive		
	<1 years	**1–2 years**	**2–3 years**	**<1 years**	**1–2 years**	**2–3 years**
RDLS LQ	0.64 (0.37)	0.69 (0.26)	0.59 (0.20)	0.70 (0.24)	0.68 (0.34)	0.56 (0.22)
PLS SS	101.0 (14.1)	79.0 (21.9)	60.2 (22.3)	104.0 (7.1)	89.8 (14.8)	66.0 (14.9)

Note: RDLS LQ (Reynell Developmental Language Scales Language Quotient), PLS SS (Preschool Language Scale Standard Score); Standard deviations are provided in parentheses.