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Early language outcomes of children with cochlear implants: Interim findings of the NAL study on longitudinal outcomes of children with hearing impairment*

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Abstract

This paper reports interim findings of a prospective study that examines longitudinal outcomes of early- and later-identified children with hearing impairment in Australia. Eighty-seven children with cochlear implants were assessed using the Preschool Language Scale at one or more intervals. Results demonstrated that children who received a cochlear implant before 12 months of age developed normal language skills and at a rate that is comparable to normal-hearing children. Children who received later implantation performed at two standard deviations below the normative mean. These results are preliminary, as there are currently insufficient data to examine the effect of multiple factors on language outcomes and the rate of language development.

Keywords

early intervention; implant age; language development; children; cochlear implants

Introduction

In Australia, one to two children in every thousand children under the age of three years have a permanent bilateral hearing loss of greater than 40 dB HL and are fitted with hearing aids (Ching et al., 2006). Of these children, 40 per cent have bilateral hearing loss greater than 70 dB HL. Permanent childhood hearing loss impacts negatively on the development of auditory skills, speech and language, psycho-social abilities and educational attainment of children.

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Several retrospective studies have established an association between intervention before six or nine months of age and better language skills measured at three and five years of age (e.g. Moeller, 2000; Yoshinaga-Itano et al., 1998). These studies have provided the driving force for implementing universal newborn hearing programmes around the world. Emerging data have shown that early detection results in early intervention (Ching et al., 2006; Uus and Bamford, 2006), but the evidence on whether early intervention leads to better outcomes remains inconclusive because of design limitations in existing studies (Thompson et al., 2001; US Preventative Services Task Force, 2001). The Task Force stated that there were 'no prospective controlled studies that directly examine whether newborn hearing screening and earlier intervention result in improved speech, language or educational development'.

In Australia, different states are at different stages of implementing universal newborn hearing screening programmes. This provides a narrow time window during which it would be possible to find sufficiently large numbers of early- and later-identified children for direct comparison in a prospective manner. All children receive consistent intervention services from the sole national hearing service provider, Australia Hearing (AH). As the research arm of AH, the National Acoustic Laboratories (NAL) have captured this unique opportunity to conduct research that will provide the most definitive evidence yet regarding the effectiveness of early detection and intervention for improving outcomes of children. In collaboration with multiple early intervention agencies, we commenced a prospective controlled study in 2005 to compare the outcomes of early- and later-identified children.

The aims of the study are 1) to establish an evidence base for the development of speech, language, functional and psychosocial skills, and educational attainment of children with hearing aids and/or cochlear implants; and 2) to identify the extent to which outcomes in each dimension are affected by a range of child- and device-related factors, including age of intervention (The Outcomes study website, 2007). The performance of 400 children in a range of dimensions is evaluated at multiple intervals over a five year period using standardised or custom-designed tests. In this paper, we report interim findings on early language development of children with cochlear implants.

Method

We invited all families with children under the age of three years who first presented with hearing loss at an AH hearing centre in New South Wales (NSW), Victoria and Queensland to participate in this population-based study. All children received hearing aids, some subsequently received cochlear implants. Our current enrolment of children with cochlear implants is 87. The mean age of implantation was 15.4 months (SD = 8.6) in NSW, 19.1 months (SD = 9.3) in Queensland and 20.9 months (SD = 9.2) in Victoria.

Evaluations are carried out at six, 12 and 24 months after first fitting, and at chronological ages of three and five years. We expect to assess these children when they turn eight and 11 years of age in the second phase of the study. Here, we report only language results as measured using the Preschool Language Scale (PLS-4, Zimmerman et al., 2002). The number of measurement points for each child differed, depending on the time of enrolment, age at fitting or implantation and chronological age of the child. The effect of age of first fitting and age of implantation was examined using analyses of variance with repeated measures.

Results and discussion

Table 1 shows the mean auditory comprehension and expressive communication scores for children who received cochlear implants before or after 12 months of age.

On average, children who received a cochlear implant before 12 months of age developed skills of auditory comprehension and expressive communication at six and 12 months after implantation the same as their normal-hearing peers. On the other hand, children who received cochlear implants at a later age performed at two standard deviations below the normative mean. Because age at implantation is likely to be confounded by age at first fitting, the analysis was repeated with age at first fitting as a continuous covariate. The results revealed that age of implantation was significant ($p = 0.009$) after accounting for the effect of age of first fitting.

The rate of growth for 31 children who had assessment results at two or three intervals was examined. Age-appropriate rate of development is indicated by unity (1.0). For children who were implanted before 12 months of age ($n = 10$), the mean rate for development of auditory comprehension was 1.25 (SD = 1.07; range = 0.17 to 3.75); and the mean rate for development of expressive communication was 1.06 (SD = 0.83; range = 0 to 2.75). For children who received later implantation ($n = 21$), the mean rate for auditory comprehension was 0.89 (SD = 0.63; range = 0 to 2.14) and the mean rate for expressive communication was 0.80 (SD = 0.45; range = 0 to 1.5). On average, children who received an implant before 12 months of age developed language at a rate that is comparable with normal-hearing children of the same age. The inter-subject variability in growth rate is large possibly because of measurement errors in having only two data points over a relatively short time interval.

Conclusion

Although these interim findings support early implantation, there are currently insufficient data to examine the effect of multiple factors and to better define growth rates over a longer period of time. When all data become available, it will be possible to examine the relative contribution of different factors to predict the rate of growth and levels of attainment for different outcome measures. Furthermore, it must not be assumed that the advantage associated with early intervention measured at this early stage will be maintained in the longer term. Examination of the longer term acquisition of more complex auditory, linguistic and literacy skills is a critically important component of this study.

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Table 1

Mean standard scores for the auditory comprehension and expressive communication subscales of the Preschool Language Scale, fourth edition (PLS-4)

		<u>Auditory comprehension</u>		<u>Expressive communication</u>	
		<u>6 months after implantation</u>	<u>12 months after implantation</u>	<u>6 months after implantation</u>	<u>12 months after implantation</u>
Implanted before	Mean	93.8	86.6	96.1	98.0
12 months of age	SD	23.5	13.1	18.8	10.9
(n = 16)	Range	51.0 to 139.0	67.0 to 111.0	57.0 to 128.0	78.0 to 114.0
Implanted at or after	Mean	63.9	66.5	70.0	72.9
12 months of age	SD	15.9	20.5	15.3	18.0
(n = 23)	Range	50.0 to 120.0	50.0 to 106.0	50.0 to 109.0	50.0 to 119.0