Language Evolution in Children with Cochlear Implants

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The capacity to incorporate significant words into the existing vocabulary and to use these words to form sentences with more mature syntactic structures emerges over a considerable time course in young deaf children who have undergone a cochlear implantation. The purpose of this follow-up study is to document the nature and time span of language production—in morphosyntactic and lexical skills—when a child’s first experience with language sounds is provided artificially through electrical stimulation. To examine the development of these two aspects of linguistic processing, five deaf French children, all enrolled in similar postimplantation educational settings, were individually assessed at 6-month intervals over a period of 18 months. Computerized analyses were derived from their spontaneous speech in a 20-min standardized play session. Results for mean length of utterance and vocabulary revealed gradually improving performance for most children, in spite of the generally low starting point. Both measures of production nevertheless remained well below the norms established for normally hearing children. Although the achievement of higher production scores, which underlies more effective interpersonal exchanges, is evident after only 1 year of device use, it is clear that improvement does not always occur at the same pace, as shown by two of the children. This emphasizes the importance of longitudinal studies in documenting intersubject variability and intrasubject stability throughout the experience with an implant.

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Introduction

Children who are born deaf or who become deaf before 3 years of age lack one of the essential forces that make normal language acquisition possible: interaction with their auditory environment. When the hair cell function of the inner ear is impaired, there is no acoustic processing, which prevents young deaf children from segmenting speech sounds into phonemes and putting these phonemes together to form new words and sentences. However, in some cases, a relatively new technology, cochlear implantation, permits better perception of speech sounds and increases access to the segmental features of speech (Miyamoto, Robbins, et al., 1997); this, in turn, improves spoken linguistic performance. Implanted children can actually acquire a more mature vocabulary and the syntactic structures necessary for communicating through spoken language, characteristic of the development of normally hearing children (Geers & Moog, 1994).

Coerts and Mills (1995) found a marked development in the morphosyntactic abilities of prelingually deaf children over an 18-month period, with different rates of improvement. In another study, the rate of language acquisition and growth following an implantation was found to match that of hearing peers, even though expressive language skills remained below those of the hearing peers at all ages (Miyamoto, Svirsky, & Robbins, 1997). Rapid improvements from day 1 to days 30 and 120 suggest that cochlear implants produce immediate gains in specific aspects of speech production, possibly with slower progress, or even a decline, later on (Te et al., 1996). However, the real effects of a cochlear implant on expressive language development may be hard to determine because the groups studied vary across a large number of factors relevant for language development—age at onset of deafness, duration of deafness, type of language input received by deaf children, and so on—which produce large intersubject and interstudy differences. Hence, the nature and course of these
changes require further definition. The purpose of this longitudinal study is to shed light on the expressive language abilities of implanted children over time, focusing on the evolution of their lexical and syntactic skills in spontaneous language production in comparison to normal subjects.

Methods

Subjects. Speech production was assessed on five French children—two boys and three girls—who had received a multichannel cochlear implant (CI). The characteristics of the deaf children are presented in Table 1. They underwent neurological, audiological, and linguistic evaluations at two different hospitals located in Paris and Lyon. All children are enrolled in speech therapy sessions three times a week and their home language environment is predominantly oral. Their results are compared to reference norms established for French hearing children of comparable ages.

Procedures. Evaluations were conducted at 6-month intervals over a period of 18 months. A 20-min standardized play session (Le Normand, 1986) with Fisher-Price toys (house, furniture, and figurines), as part of a more extensive examination protocol, was used to examine the children’s spontaneous speech production. Children were tested individually, in interaction with an experimenter. The entire symbolic play session was videotaped, transcribed, and analyzed according to the Child Language Data Exchange System (CHILDES; MacWhinney & Snow, 1985, 1991) rules for automated analysis of language transcripts. The verbal interactions, digitized on a Macintosh computer and transcribed by two researchers, reached an interrater agreement of >90%. Normative data for normally hearing children are found in Le Normand (1996).

Linguistic analyses. Two specific measures of production were derived from the computerized analyses. Morphosyntactic maturation was investigated in terms of mean length of utterance (MLU)—the ratio of total number of words over number of utterances. MLU allows one to observe the progressive lengthening of children’s utterances according to their age and linguistic development and is an approximation of the child’s “linguistic age.” Lexical skills were measured in terms of vocabulary—number of different words uttered. This measure represents the active lexicon of the child, in a structured context, at a particular moment of his or her development.

<p>| TABLE 1 |
|---|---|---|---|
| Characteristics of Implanted Children | | | |</p>
<table>
<thead>
<tr>
<th>Sex</th>
<th>Cause of deafness</th>
<th>Age at onset of deafness</th>
<th>Age at implantation</th>
<th>Duration of deafness</th>
</tr>
</thead>
<tbody>
<tr>
<td>Child 1</td>
<td>F</td>
<td>Meningitis</td>
<td>1 year, 11 months</td>
<td>2 years, 11 months</td>
</tr>
<tr>
<td>Child 2</td>
<td>F</td>
<td>Unknown</td>
<td>4 years, 10 months</td>
<td>4 years, 10 months</td>
</tr>
<tr>
<td>Child 3</td>
<td>M</td>
<td>Unknown</td>
<td>2 years</td>
<td>4 years, 10 months</td>
</tr>
<tr>
<td>Child 4</td>
<td>M</td>
<td>Wardenburg syndrome (hereditary)</td>
<td>3 years, 9 months</td>
<td>3 years, 9 months</td>
</tr>
<tr>
<td>Child 5</td>
<td>F</td>
<td>Hereditary origin</td>
<td>2 years, 4 months</td>
<td>2 years, 4 months</td>
</tr>
</tbody>
</table>
Results

Morphosyntactic maturation. Individual MLU scores for the five implanted children, taken at three different times following implantation, as well as mean scores and standard deviations for the control group at different chronological ages, are illustrated in Fig. 1. The five curves representing implanted subjects' development indicate that, although all children performed at an equivalent level when they were first tested, they did not all progress in the same way and at the same rate. Two children in particular (Child 3 and Child 5) did not show any signs of improvement during the entire 18-month period. The other three children, on the other hand, improved steadily. When compared to the normally hearing group, however, all CI users are well below the mean score and the first standard deviation and generally below the second one. This demonstrates the abridged speech and less complex syntax in implanted children following a relatively short postimplantation period. However, this ability is expected to improve with further experience with the device, as shown by three of the five curves.

Lexical skills. Individual vocabulary scores for the same five children, taken at the same three postimplantation periods, as well as mean scores and standard deviations for the control group at different chronological ages, are presented in Fig. 2. This figure illustrates the low number of words used by implanted children compared to normally hearing children of the same age. All CI users are well below the mean score and the first standard deviation of their hearing counterparts and even below the second standard deviation. Taken individually, the five different curves indicate variability in the rate and nature of improvements. While three of the five implanted children made marked progress between each test, the other two subjects only started to improve 12 months after implantation. Until they had that much experience with the device, they were unable to expand their vocabulary.

Discussion

The results of this study demonstrate that cochlear implantation provides an opportunity to achieve substantial improvements in language production in a relatively short time following the surgical operation. From a relatively low starting point, im-
planted children can gradually increase their vocabulary and rearrange the components of this enlarged vocabulary to build more and more complex sentences. They then acquire more mature syntactic structures and a larger lexicon, although the expressive lexical spurt observed in normal linguistic development at about 18 months is not so clear in the atypical language development that follows a cochlear implantation.

Moreover, the difference in nature and time span characterizing the development of morphosyntactic and lexical skills by the five CI users indicates that implanted devices give rise to heterogeneous language production profiles. The exact course of language production is hard to predict, partly because it is based on a variety of factors, the most influential being the cause and diagnosis of deafness, the age at which deafness occurred, the duration of deafness, and the age at implantation.

Finally, the poor progress demonstrated by Child 3 and Child 5 for both measures of language production could be explained by the nature of their diagnosis; these two children suffered from more severe deafness than the other three subjects. The prognosis may nevertheless be optimistic, because expressive language performance is expected to improve with experience with the device, as seems to be the case with most children. It is, however, interesting to note that the scores of even the best performers remained below the mean scores of chronologically younger normally hearing children. They actually present significant deficits in general language production even with the implanted hearing device and are expected to remain delayed at subsequent evaluations in comparison to both age-matched hearing children and younger ones. This supports the notion that only through longitudinal studies can the full consequences of such a surgical intervention be assessed.

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REFERENCES


Short-Term Memory Impairment and Unilateral Dichotic Listening Extinction in a Child with Landau–Kleffner Syndrome: Auditory or Phonological Disorder?

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The neuropsychological profile of a child with a Landau–Kleffner syndrome is presented here. The observed cognitive difficulties included verbal short-term memory and seemed partially compensated for when the experimental assessments bypassed the auditory channel. This case study is especially challenging since the child, whose phonological skills were quite efficient and who exhibited a dichotic listening unilateral extinction, had developed average reading and spelling abilities. The fact that B.E.’s performance on memory tasks was quite poor when the stimuli were presented auditorily and more efficient when the stimuli were presented visually, strongly suggests that the observed memory impairment was due to a deficit at the level of cortical auditory processing. B.E.’s phonological skills were efficient, suggesting a neuropsychological dissociation between phonological ability and auditory processing. The fact that B.E. dramatically recovered language and easily acquired reading and spelling accounts for the hypothesis that compensatory strategies allowed him to develop phonological skills from predominantly visual input. © 2001 Academic Press

Introduction

In the acute phases of Landau–Kleffner syndrome (LKS), children generally exhibit a frank auditory agnosia. This agnosia is concomitant with the expressive language impairment and with the abnormal EEG readings seen in these children. A principal question is to know whether the primary deficit is a generalized auditory agnosia or whether it specifically concerns phonological decoding. Korkman, Granström, Appelqvist, and Liukkonen (1998) suggest that the primary deficit in LKS