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Infrequent word classes in the speech of two- to seven-year-old children with cochlear implants and their normally hearing peers: A longitudinal study of adjective use

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ABSTRACT

Objective: Studies investigating language skills of children after cochlear implantation usually use global language proficiency scores and rarely tackle the acquisition of specific language phenomena (word classes, grammatical constructions, etc.). Furthermore, research is largely restricted to frequent word classes (nouns, verbs). The present study targets the acquisition of adjectives (e.g. *big*, *intelligent*) by children implanted before their second birthday. Adjectives constitute a relatively infrequent, but functionally important word class and were shown to be good indicators of language delays and impairments.

Method: Nine cochlear-implanted (CI) children and 60 age-matched normally hearing (NH) controls participated in the study. The CI children were followed longitudinally from ages 2 to 7; control data were collected in a cross-sectional manner (10 children per age group). Samples of children's spontaneous interactions with their caregivers were transcribed and analyzed for adjective use (frequency, lexical diversity, complexity of syntactic constructions, and morphological correctness).

Results: The performance of the CI subjects was not significantly different from that of NH peers on adjective frequency and lexical diversity. On these measures, both groups reached adult levels by age 3. However, the CI group had a significant delay in the acquisition of complex syntactic constructions. The NH subjects produced adjectives in adult-like grammatical constructions from age 3 onwards, whereas their CI peers lagged behind until age 5. The speech of the CI participants also featured morphological errors that are not characteristic of typical development (inflection of predicative adjectives). However, the overall error rate was low.

Conclusions: The findings suggest that CI children have particular difficulty with grammatical items (bound morphemes, copulas) that are less salient in the flow of speech than content words. Nevertheless, children implanted before their second birthday are able to catch up with their hearing peers by age 5, even in the use of relatively infrequent word classes.

1. Introduction

1.1. Language development after cochlear implantation

The advent of cochlear implantation made it possible for deaf children to develop speech and language skills that often surpass those of children using hearing aids [1,2]. It is, however, not surprising that cochlear-implanted (CI) children often display significant delays in the acquisition of both vocabulary [3–8] and grammar [9–13] compared to their normally hearing (NH) peers. Complex syntax appears to be more demanding for CI children than lexical diversity [13–16]. The acquisition of spoken language grammar by CI users was shown to be significantly delayed, especially in the domain of bound morphemes and function words, such as determiners, copulas and modal verbs [7,9,13,14]. These elements are less stressed and, therefore, less easily identifiable for children with a hearing impairment. As a result, CI children tend to produce less complex syntactic structures and often fail to mark syntactic relations [12].

Most studies thus far have presented a very broad picture of language development in the CI population, presenting general measures of expressive/receptive vocabulary and grammar [1,15,17–23]. There have been relatively few attempts to trace the development of specific language phenomena, such as the acquisition of noun [7,9,12,13] and verb morphology [9,13,24,25]. Notice that nouns and verbs are the most frequent lexical

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categories in parental input [26]. Hardly any research has so far targeted the acquisition of less frequent lexical categories, such as adjectives and adverbs, by children with cochlear implants. Le Normand et al. [27] examined the frequencies of words from 36 lexical categories in the longitudinal speech samples of 17 French-speaking CI children implanted between 22 and 76 months of age. They found that three years post implantation the frequencies of adjectives, determiners, nouns, lexical verbs and auxiliaries in the speech of CI children were not significantly different from the distributions in the control group matched for MLU. However, significant differences between the two groups were found on negation adverbs, place adverbs, communicators, possessives, prepositions and pronouns, as well as on infinitive, modal and existence verbs.

1.2. The acquisition of adjectives by hearing-impaired children

In this study, we focus on the development of the adjective category in the speech of CI children. Although adjectives constitute a third most important content word class after nouns and verbs, their acquisition by CI users has barely been investigated. The only exception is Herzberg's study [9] that compared the production of nouns, verbs and adjectives by Hebrew-speaking children with cochlear implants. In this paper, we target adjective production in spontaneous speech of CI children acquiring Dutch.

Adjectives are not a universal category, as some languages map properties to nouns and some to verbs [28,29]. Dutch adjectives constitute an open word class denoting various properties of objects, people and events (e.g. *rood* 'red', *droog* 'dry', *intelligent* 'intelligent'). Syntactically, adjectives are dependent on nouns, as indicated by the two syntactic positions they typically occupy in the world's languages – predicatives (e.g. *Jack is* **smart**) and attributives (e.g. *a* **smart** *boy*) [30,31]. In many languages adjectives agree with head nouns in inflectional properties (number, gender, case, and definiteness), particularly as modifiers within a noun-phrase. For example, the Dutch adjective *klein* 'small' is inflected with *–e* when modifying plural nouns (e.g. *klein***e** *huizen* 'small houses'), singular nouns of common gender (e.g. *een/de klein***e** *muis* 'a/the small mouse') and definite nouns of neuter gender (e.g. *het klein***e** *paard* 'the small horse'). Agreement inflections, like other bounded morphemes, are unstressed and, therefore, less easily identifiable in the flow of speech. Hence, their acquisition might be problematic for children with a hearing impairment. Furthermore, even in typical language development adjectives were shown to be acquired relatively late because they are conceptually complex [32]. In order to understand what an adjective such as *red* means, children need to be able to attend selectively to one particular dimension such as colour [33] and to determine which of a whole range of attributes displayed by the object is meant [34]. Furthermore, adjectives are relatively infrequent compared to nouns and verbs. Naturalistic studies of spontaneous speech show that adjectives account for only about 5% of word tokens in child-directed speech [27,35]. Therefore, it is not surprising that adjective production was shown to be a good indicator of language proficiency [36] and language impairments [37–39].

For hearing-impaired children, evidence in the literature is scarce and somewhat controversial. Heward and Eachus [40] found that school-age children with a hearing impairment avoid using adjectives and adverbs in their writing. As against this, Herzberg [9] reports that Hebrew-speaking CI children use more adjective tokens than NH children matched for chronological age. However, adjectives in the speech of CI patients appear to be less diverse and used in a more restricted range of syntactic environments compared to adjective production by NH controls. In order to determine to what extent these results can be generalized to other languages, more research is clearly warranted. It is also important to target other aspects of adjective production, such as complexity of syntactic frames in which adjectives are used and the acquisition of adjective agreement morphology.

The study reported in this paper will compare the use of adjectives in the longitudinal transcripts of nine CI children acquiring Dutch with adjective production by NH children matched for chronological age. The following aspects of adjective use will be addressed: frequency, lexical diversity, complexity of syntactic frames and morphological correctness. Another goal of this investigation is to compare the patterns in child speech to distributions in the parental input.

2. Method

2.1. Subjects

In this study, we used a longitudinal corpus of nine CI children, all monolingual speakers of Belgian Dutch. The children were about 2 years of age at the outset of the study and 7 years of age at the end of the data collection, with the exception of two participants who left the study earlier (S2 at age 6 and S9 at age 5). All of them received a Nucleus 24 cochlear implant before their second birthday. The data were collected longitudinally around the children's birthdays. More detailed information on each subject is presented in Table 1.

At each datapoint, the performance of CI participants was compared to that of NH peers matched for chronological age. The control data were collected in a cross-sectional manner (10 by age group). All participants were native speakers of Belgian Dutch, with no patent cognitive or health deficits. Six comparison groups were included in the study: ten 2-year-olds (age range: 1;11–2;3, mean age: 2;1), ten 3-year-olds (age range: 2;10 – 3;2, mean age: 3;0), ten 4-year-olds (age range: 3;10–4;3, mean age: 4;0), ten 5-year-olds (age range: 4;11–5;3, mean age: 5;1), ten 6-year-olds (age range: 5;10–6;3, mean age: 6;1) and ten 7-year-olds (age

Table 1
Individual child characteristics of the CI group.

ID	Gender	Age at implantation first CI	Age at implantation second CI	Unaided hearing loss	Aided hearing loss	Age at first recording	Age at last recording
S1	F	1;01.15	6;03	120	38	2;01.01	7;01.09
S2	F	0;06.21	4;08	120	30	1;11.24	6;00.15
S3	F	0;10.00	5;10	115	25	1;11.22	7;00.27
S4	M	1;06.05	–	113	25	1;11.23	7;01.14
S5	M	1;04.27	6;04	93	35	2;00.25	7;00.18
S6	M	0;08.23	–	120	38	1;11.25	7;02.08
S7	F	0;05.05	1;03	117	23	2;00.06	7;00.19
S8	F	1;07.14	–	112	55	1;11.23	7;00.07
S9	F	0;08.21	1;11	103	42	1;11.22	5;00.07