Cochlear implants in children: Development in interaction with the social context

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Chapter 3

Influence of Linguistic Environment on Children's Language Development: Flemish versus Dutch Children

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Abstract

In the present study, language development of Dutch children with a cochlear implant (CI) in a bilingual educational setting and Flemish children with a CI in a dominantly monolingual educational setting is compared. In addition, we compared the development of spoken language with the development of sign language in Dutch children. Eighteen children with a CI participated in the study: six Dutch children older than 18 months at implantation and 12 Flemish children, of whom seven were younger than 18 months at implantation and five were older than 18 months. Tests were administered on auditory perception, speech intelligibility, spoken language and sign language (Dutch children). Five assessments were made to monitor language development of the children: a pre-test before implantation and four post-tests at six, 12, 24 and 36 months after implantation. In general, Flemish children showed more progress in spoken language development than Dutch children. Moreover, earlier implanted Flemish children showed more progress than later implanted Flemish children. This applies to auditory perception, speech intelligibility and spoken language. Whereas spoken language of Dutch children improved in the course of time, the development of sign language in Dutch children did not show any progress. Despite possible alternative explanations, such as better residual aided hearing before implantation or more professional support, it is plausible that the differences are partly caused by the linguistic environment. The lack of progress in development of sign language might be explained by the decreasing use of sign language by parents after implantation.

Introduction

A cochlear implant (CI) increases deaf children's access to sound substantially and it is one of the most important technological breakthroughs for deaf people. Studies on the effects of CIs in children show a positive influence on speech recognition, speech intelligibility and other aspects of spoken language development (Schauwers et al., 2004b; Svirsky et al., 2000, 2002b; Thoutenhoofd et al., 2005; Vermeulen et al., 2007). These effects are even stronger in children younger at implantation. Several studies show that spoken language development of these younger children is within the normal range, although often at the lower end (Anderson et al., 2004; Miyamoto et al., 1999; Schauwers et al., 2004a; Spencer, 2004; Svirsky et al., 2004; Tomblin et al., 2005; Zwolan et al., 2004). Further, children who receive their CI before the age of one develop preverbal communication skills to an extent that does not differ a lot from normally hearing children (Tait et al., 2007).

In the Netherlands, the intention is to raise children with a CI in a bilingual environment (i.e. spoken Dutch and Sign Language of the Netherlands (SLN)). However, the question arises whether deaf children with a CI should still be educated bilingually. After all, their spoken language seems to be adequate for participating in a hearing environment. Moreover, most studies on monolingual versus bilingual settings seem to indicate that children with a CI in dominantly monolingual settings have better spoken language development than children in bilingual or total communication settings (Geers et al., 2003; Kirk et al., 2002; Miyamoto et al., 1999; Vieu et al., 1998; Wie et al., 2007). Geers et al. (2003) found that children with a CI educated in monolingual settings exhibited a significant advantage in their use of narratives, the breadth of their vocabulary, in their use of bound morphemes, in the length of utterances and in the complexity of syntax used in their spontaneous language. Miyamoto et al. (1999) reported that children educated through oral communication had significantly better speech perception than did those educated through total communication. Wie et al. (2007) examined 79 of the first 100 children with a CI in Norway and concluded that children educated in mainstream schools, and thus merely used spoken language, had better speech recognition. Kirk et al. (2002) found similar results: spoken word recognition improved at a faster rate in monolingual

children and they also demonstrated more rapid gains in communication abilities than in children who used total communication. Also, Vieu et al. (1998) found that the educational mode of communication appears to influence speech production and language quality. The language level as indicated by correctly organised sentences was higher in both spoken and cued-speech group than in the sign language group.

In contrast with these studies, other studies report no differences between language outcomes of children with CIs enrolled in oral communication or total communication settings. Connor et al. (2000) found no differences between children with a CI, implanted before the age of five years, in an oral communication setting and a total communication setting on consonant production accuracy, whereas children in a total communication setting achieved significantly higher receptive spoken vocabulary scores. Further, Nordqvist and Nelfelt (2004) and Yoshinaga-Itano (2006) found that language development of children with a CI who acquired sign language before implantation was age-appropriate.

There are some difficulties with interpreting the results of studies comparing different educational settings. First, the non-monolingual settings in these studies differ from each other, varying from equal input of sign language and spoken language to total communication (using some form of sign language in addition to spoken language, usually simultaneously) to cued speech (a soundbased visual communication system which uses hand shapes in different locations (cues) in combination with the natural mouth movements of speech to make all the sounds of spoken language look different). Second, a limitation of most of these studies is the small number of participants. Third, it is not possible to compare the results of the studies, because different tests were used.

However, choosing a linguistic environment for children with a CI probably is not only determined by the effectiveness of the linguistic environment on spoken language development. Other factors might also be important. A factor in favour of a monolingual environment might be children's and their parents' preference for a communication mode. There are indications that most children with a CI for several years prefer spoken language instead of sign language in communication with their hearing environment. In a study on the opinion of deaf young people with CIs, all the young people requested either

spoken language or spoken language supported with signs, while sign language interpretation was available (Wheeler et al., 2007). Spoken language was the preferred mode of communication for 69 per cent, the other 31 per cent preferred sign supported English. Also, parents tend to rely more and more on spoken language the longer their child wears the CI (Archbold et al., 2000; Nordqvist and Nelfelt, 2004; Preisler et al., 2005). Preisler et al. (2005) found that when children started to wear a CI parents asserted the importance of using sign language, saying that this was the basis for communication. After the children started using speech, sign language was only used occasionally: most of the communication in the family was in spoken language. But there are also factors in favour of choosing a bilingual environment. For instance, one factor might be the uncertainty whether children with a CI will be able to adapt themselves fully to spoken language. When wearing the CI, their access to sound might be increased, but they are still not normal hearing. Usually, they encounter the same problems as children who are hard of hearing, such as problems with hearing in noisy environments or understanding spoken language in group communication. In these situations sign language or sign supported spoken language might also be of benefit to children with a CI. Another factor might be that children do not always wear their CI. In a study on the experience of 11 children aged between 8.6 and 10.6 with a CI during 5.0 to 7.6 years, most children considered the implant as a natural part of their life and used their implants daily, but they took it off for special occasions such as sport activities (Preisler et al., 2005). Further, these children thought that in order to reach full understanding when the topic was abstract, complicated, or important, sign language was necessary. A third factor in favour of choosing a bilingual environment might be that it enables children with a CI to be part of the Deaf community.

For deaf children who do not have a CI, there are indications that a bilingual environment has advantages. When comparing Swedish children raised with spoken language (in the 1960s) and children raised with both spoken and sign language (20 years later) the latter had a higher level of academic achievement, particularly in the understanding and use of written Swedish, but also in numerical and mathematical tests (Heiling, 1998). The children raised with both spoken and sign language also had more ‘normal’ family relations, as parents and children had been able to communicate with each other (Heiling,

1994). Preisler and Ahlström (1997) found similar results when they concluded that sign language had positive effects on language development. The improved language skills allowed deaf children to take part in dialogues and to share experiences with others, but also had a positive effect on social and emotional development.

To conclude, whereas a bilingual environment seemed a good option for deaf children without a CI, there is inconclusive evidence from literature whether children with a CI should be raised in a bilingual or monolingual environment. The literature shows that a monolingual environment might be better for spoken language development, whereas a bilingual environment might be better for communication and social and emotional development. This lack of clarity often leads parents to wonder whether they should use sign language when their child has received a CI. The answer of Delore et al. (1999) to this question is 'that as long as we cannot be certain that, thanks to CI, the deaf child will be able to adapt himself fully to oral language we have no right not to propose sign language' (p. 209).

In the present study, language development of Flemish children with a CI and Dutch children with a CI is compared. In the Netherlands, children with a CI are educated in a bilingual setting: schools offer bilingual programmes, with both SLN and spoken language. Moreover, parents are encouraged to use gestures and signs with their deaf child, to attend sign language courses and to use all possible means of communication in order to establish well-functioning communication with their child. Contrarily, in the Dutch speaking part of Belgium (Flanders), most children with a CI are raised in a dominantly monolingual educational setting where spoken language is used, supported by signs and visual communication strategies. Differences and similarities in language development between Flemish children and Dutch children were assessed. Further, we compared the development of spoken language with the development of sign language in Dutch children. Finally, we also compared children who received their CI around their first birthday and children who received their CI around their second birthday.

Method

Design

There were two conditions in this longitudinal study: Dutch children in a bilingual educational setting and Flemish children in a dominantly monolingual educational setting. The most important difference between the two conditions was that in the Netherlands both spoken Dutch and SLN were used in educational settings, whereas in Flanders spoken Dutch, supported by signs and visual communication strategies, was used in educational settings. Another difference is that parents of the Dutch children were educated in SLN: on average, they attended three courses (in total 30 lessons). Parents of Flemish children were not taught sign language, although parents of five Flemish children attended a course on Simultaneous Communication. As a result of the decreasing age at implantation in Flanders, there was great variability in the age of implantation in this group (Table 1). Therefore, the Flemish children were divided into two groups: children who received their CI before the age of 18 months (earlier implanted Flemish children) and children who received their CI after the age of 18 months (later implanted Flemish children). Five assessments were made to monitor the development of the children: a pre-test before implantation and four post-tests at six, 12, 24 and 36 months after implantation.

Participants

Eighteen children with a CI were selected: six Dutch children and 12 Flemish children (Table 1). Four out of six Dutch and 11 out of 12 Flemish children received a Nucleus device, two Dutch children an Advanced Bionics implant and one Flemish child a Digisonic implant. All children were deaf from birth, the implants were fully inserted and there were no complications during surgery. They all had a non-verbal intelligence within the normal range and none of them had any other serious impairments. All children were from Dutch or Flemish origin and the native spoken language at home was Dutch. The Flemish children had significant better residual aided hearing than the Dutch children (Mann-Whitney, $U (N = 18) = 14$, $p = 0.04$). Two Dutch children and one Flemish child had problems wearing the device for a short period of time. The first year after implantation, parents of the Dutch children communicated in both sign language

Table 1. Characteristics of children

	Gender Male (M)/ Female(F)	Average residual aided hearing at 500, 1000, 2000 en 4000 Hz in dB	Age at start family support	Age at onset wearing hearing aid(months)	Age at implant (months)	Non-verbal IQ
Bilingual						
Max	M	74	11	12	25	92
Tim	M	91	13	24	25	108
Thomas	M	115	14	16	23	104
Sanne	F	95	14	15	20	101
Lars	M	96	28	19	27	98
Fleur	F	100	14	15	24	86
Monolingual, > 18						
Bram						
Iris	M	81	5	6	22	91
Luuk	F	76	3	5	33	108
Anouk	M	68	3	4	22	91
Bart	F	80	3	3	20	110
	M	63	2	3	19	105
Monolingual, < 18						
Job						
Lotte						
Rick	M	74	6	6	15	98
Niels	F	98	9	9	13	95
Nick	M	58	3	4	8	110
Thijs	M	49	3	3	12	95
Jesse	M	80	3	3	9	110
	M	100	3	3	9	90
	M	90	3	4	15	110

and spoken language with their child, whereas parents of the Flemish children used spoken language, in five cases supported with signs. After one year, parents of the Dutch children started using more spoken language and less sign language, comparable with parents of the Flemish children. Family involvement of 15 of the 18 children was average to good (Moeller, 2000). Parents of three Flemish children were involved below average. The first year after implantation, all Dutch children in this study went to preschools where both spoken and sign language were used (half/half). After one year, five children went to a school where spoken Dutch was the instruction language and SLN was taught as a subject. One child went to a school were SLN was the instruction language and spoken Dutch a subject.

Testing materials

The children in this longitudinal study were administered tests on auditory perception, speech intelligibility, spoken language and sign language (Dutch children) to assess their language development.

Auditory perception

Auditory perception was assessed using the Categories of Auditory Performance (CAP) and the Meaningful Auditory Integration Scale (MAIS). The CAP is a rating scale of eight performance categories arranged in order of increasing difficulty and was administered by the speech therapist (Archbold et al., 1995). The MAIS was completed by parents and was developed as a face valid measure of speech understanding in everyday situations. It provides information about response to sound in everyday listening situations (Robbins et al., 1991b).

Speech intelligibility

The intelligibility of children's speech was evaluated using the Speech Intelligibility Rating Scale (SIR) and the Meaningful Use of Speech Scale (MUSS). The SIR was administered by the speech therapist and was designed to classify children's global speech production according to one of six hierarchical categories (McDaniel and Cox, 1992; Wilkinson and Brinton, 2003). The MUSS

was completed by parents and was designed to assess the child's use of speech in different natural contexts (Robbins and Osberger, 1991a).

Spoken language

To assess spoken language development, the Dutch version of the receptive language part of the Reynell Developmental Language Scale and the Schlichting Scale for language production were used at 24 and 36 months after implantation (Lutje Spelberg et al., 2001; Van Eldik, 1998). The Reynell and Schlichting scales were chosen because norm scores were available for children with normal hearing. The Reynell scale has 87 items which the child has to carry out assignments. The Schlichting scale assesses syntax development and vocabulary.

Spontaneous language

Spontaneous language was assessed in all six Dutch children at 12, 24 and 36 months after implantation. The spontaneous language of spoken Dutch was assessed with a hearing adult who used spoken language whereas spontaneous language of SLN was assessed with a deaf adult who used SLN. Transcriptions were made according to CHAT (Codes for the Human Analysis of Transcripts) conventions in Child Language Data Exchange System (CHILDES) and analysed using Computerised Language Analysis tools (Gilis, 1998; MacWhinney, 1984). Mean Length of Utterance (MLU) was calculated to measure complexity of syntax and was defined as the mean number of morphemes per utterance. Further, communication mode was coded in six categories: (1) fully spoken: a completely spoken utterance without signs; (2) fully signed: a completely signed utterance without spoken language; (3) fully signed, complementary spoken: a fully signed utterance of which a part is also expressed in spoken language; (4) complementary signed, fully spoken: a fully spoken utterance of which a part is also expressed in sign language; (5) supplementary signed, supplementary spoken: a partly spoken and partly signed utterance in which the spoken and signed part complement each other; (6) fully spoken, fully signed: the utterance is both fully spoken and fully signed (Van den Bogaerde, 2000).

Analyses

Auditory perception, speech intelligibility and spoken language development of Dutch children, earlier implanted Flemish children and later implanted Flemish children were compared using the Kruskal-Wallis test. When there was a significant difference, pair wise comparisons were made with Mann-Whitney U test. Pair wise comparisons between two variables were conducted with the Wilcoxon Signed Rank test.

Results

Auditory perception

Before and shortly after implantation, auditory perception was significantly better in the later implanted Flemish children (before CI MAIS: $p = 0.02$; 6 months after CI CAP: $p = 0.04$) compared to the other two groups. According to the CAP, 11 out of 18 children showed awareness of environmental sounds before implantation of whom six also responded to speech sounds. All children, except for one Dutch child, improved to the level that they could discriminate some speech sounds without lip-reading (n = 9), could understand conversations without lip-reading (n = 4) or could use the telephone with a known speaker (n = 4). Responses to sound in everyday listening situations also improved: before implantation the earlier implanted Flemish and the Dutch children hardly responded to sound in everyday listening situations. This is in contrast with the later implanted Flemish children who already had a 40 per cent of maximum score on the MAIS before implantation. Three years after implantation, most children reached the 90th per cent score of the MAIS.

Speech intelligibility

Speech intelligibility improved after children received their CI (see Figure 1). Before implantation, children mostly communicated with signs and gestures and if they used spoken language, their speech was hardly intelligible. Improvement tended to be faster in the Flemish children than in the Dutch children ($p = 0.10$). Three years after implantation, the Flemish children produced language that was

intelligible for everyone, whereas the Dutch children were understandable if the listeners concentrate and lip-read.

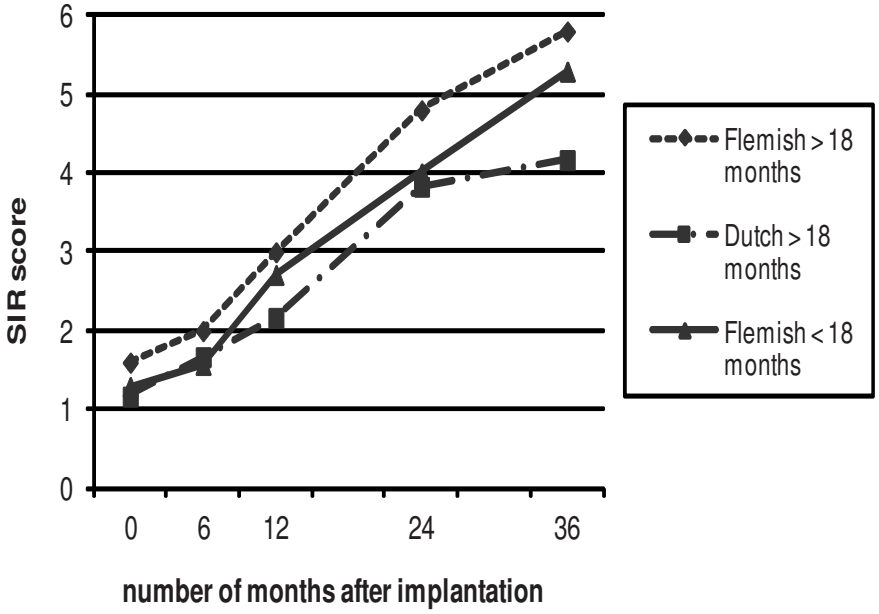

Figure 1. Speech Intelligibility Rating Scale (range 1-6)

Daily use of speech also improved: according to the parents (MUSS), children hardly made use of speech in daily communication before implantation, whereas most children reached the 90th per cent score three years after implantation. There were no significant differences between the three groups on the MUSS.

Spoken language

Figure 2 shows that receptive spoken language was better in the Flemish children than in the Dutch children, both at 24 and 36 months after implantation (Kruskal Wallis: 24 months, $\chi 2$ (2, N = 18) = 10.71, $p < 0.01$; 36 months, $\chi 2$ (2, N = 18) = 7.89, $p = 0.02$). Follow-up tests showed that both groups of Flemish children did significantly better than the Dutch children. Further, within the group of Flemish children, the earlier implanted children seemed to do better

than the later implanted children, but the differences were not significant. Also, there was a significant difference in complexity of syntax (Kruskal Wallis: 24 months, $\chi 2$ (2, N = 18) = 9.61, $p < 0.01$; 36 months, $\chi 2$ (2, N = 18) = 7.08, $p = 0.03$). Follow-up tests showed that the earlier implanted Flemish children used more complex syntax than the Dutch children. The later implanted Flemish children did not differ significantly from both other groups. The same was true for active lexicon, where also only differences between the earlier implanted Flemish and the Dutch children were significant. Language development of the earlier implanted Flemish children seemed to be congruent with normal language development, whereas the Dutch children performed very poorly compared to their normal hearing peers.

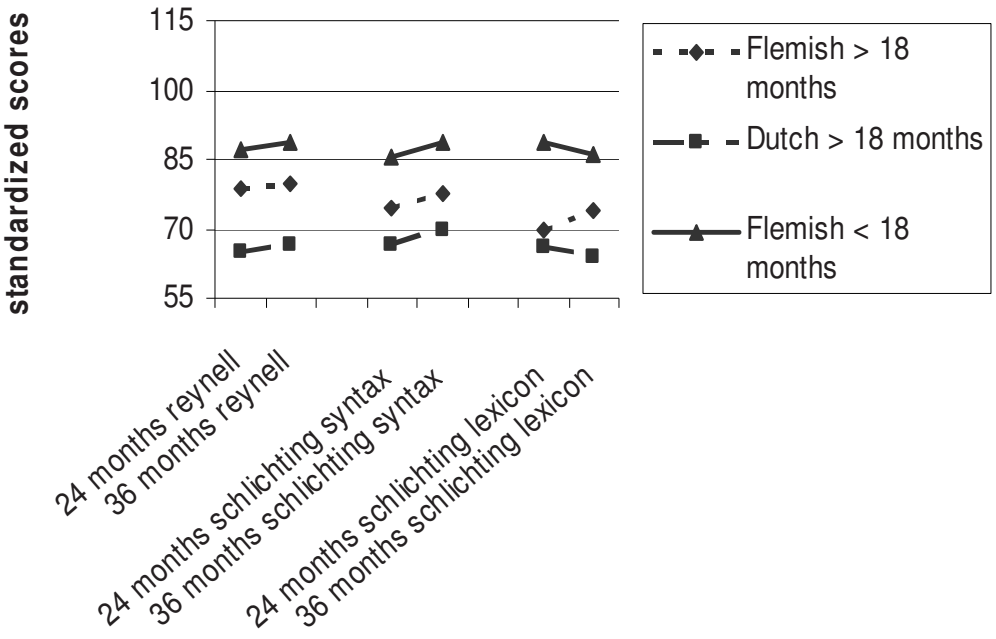

Figure 2. Receptive and expressive (syntax, lexicon) language (range 55-145)

Spoken language versus sign language in Dutch children

The Dutch children in this study showed progress in the MLUs in spoken language and thus in the complexity of syntax (Figure 3). Four out of six children showed great progress between the first and the third year after implantation, varying from 1.3 to 2.0. This means that these children used up to two more morphemes per utterance three years after implantation compared to one year after implantation. The other two children hardly made any progress. In contrast with this, the MLUs in sign language was stable during the three years of the project for all six children: none of the children made progress greater than 0.5. This implies that the complexity of syntax of sign language did not progress.

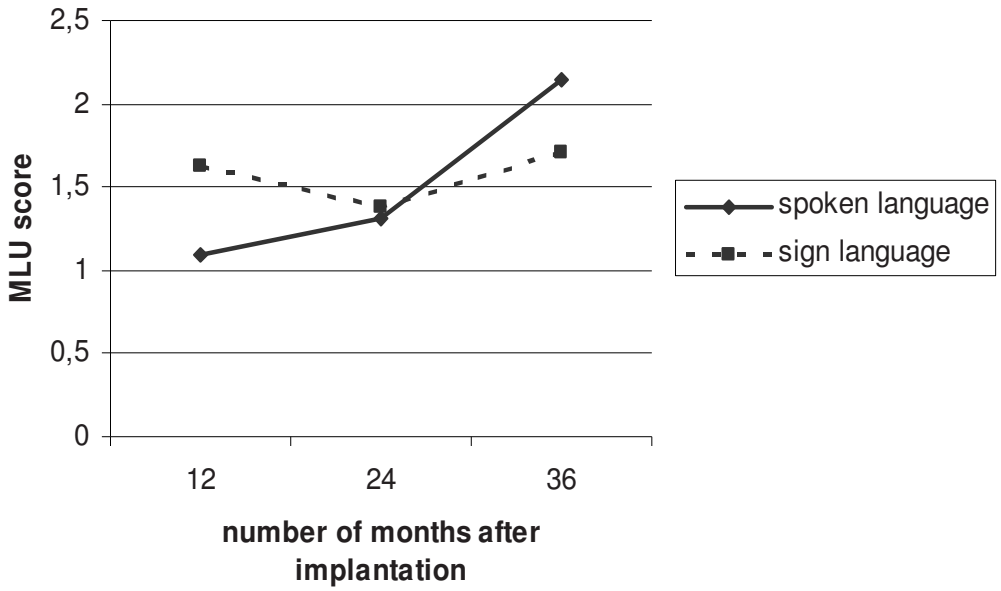

Figure 3. Mean Length of Utterance (MLU) in spoken language and in SLN in Dutch children (n=6).

Figures 4 and 5 show the communication mode used by the Dutch children when they were exposed to spoken language only (Figure 4) and sign language only (Figure 5). Only the categories 'fully spoken', 'fully signed' and

'fully spoken, fully signed' are represented in the figures, because the other three categories were rarely used by the children. This means that the Dutch children in this study hardly used supplementary and complementary modes to make themselves clear. Most utterances they used are fully spoken and/or fully signed. If children were exposed to spoken language only they merely used spoken language themselves and hardly used sign language. If they were exposed to sign language, they used more sign language than spoken language one year after implantation. In the course of time, they also used more and more spoken language even when the adult used sign language. They still used sign language, but more and more in combination with spoken language.

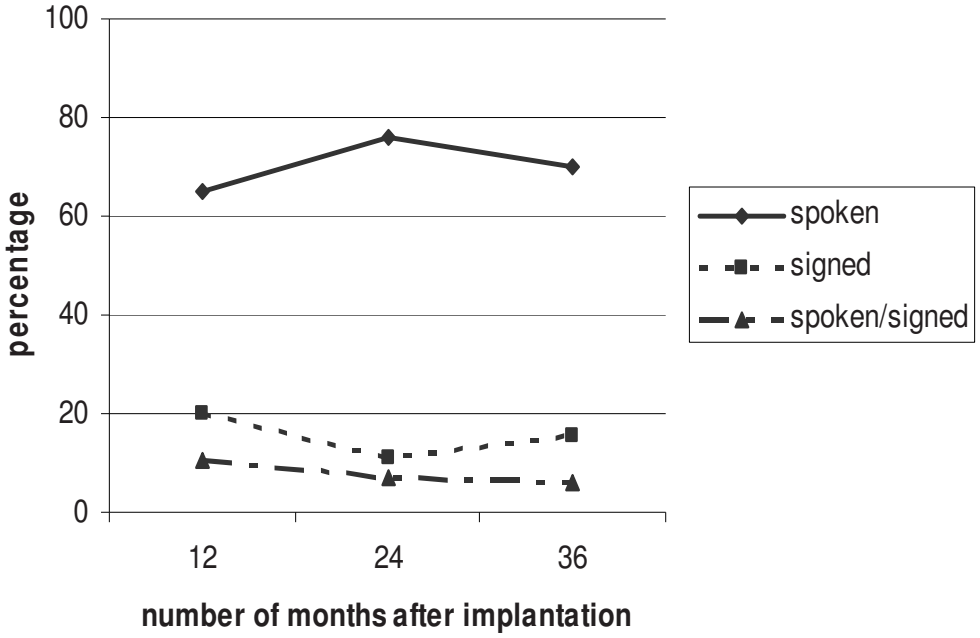

Figure 4. Communication mode in spoken language situation in Dutch children (n=6)

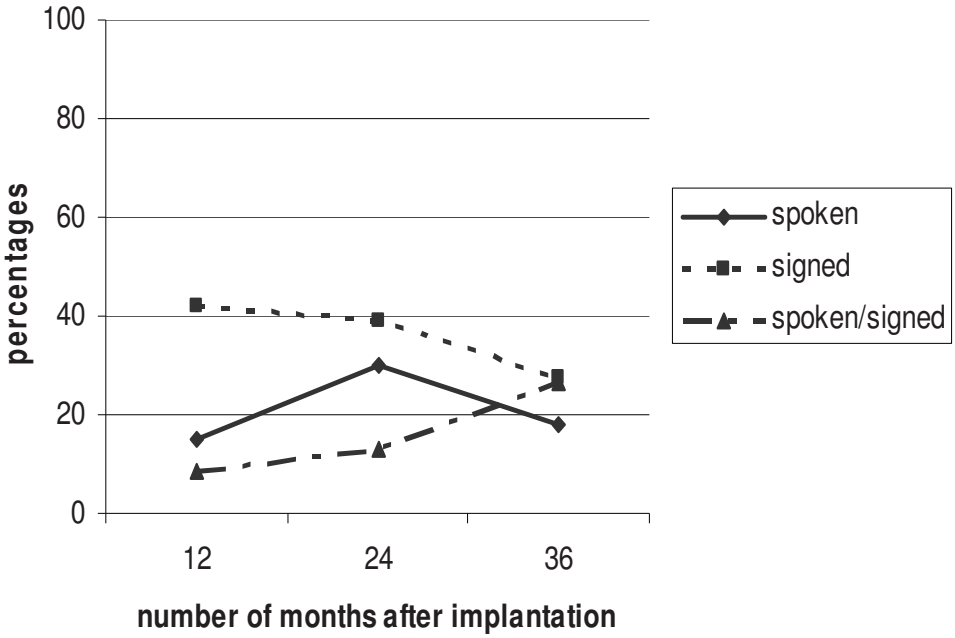

Figure 5. Communication mode in sign language situation in Dutch children (n=6)

Discussion

Auditory perception increased in all children: whereas most children hardly had any auditory perception before implantation, 36 months after implantation most children were able to understand daily conversations without lip-reading. Good auditory perception is a prerequisite for the development of spoken language. In general, the Flemish children in this study showed more progress in spoken language development than the Dutch children. Moreover, the earlier implanted Flemish children showed more progress than the later implanted Flemish children. This applies to auditory perception, speech intelligibility and spoken language. Whereas spoken language of the Dutch children improved in the course of time, the development of sign language in Dutch children did not show any progress. The results in the present study are consistent with earlier studies on the effects of CI on auditory perception and speech intelligibility (Anderson

et al., 2004; McKinley and Warren, 2000; Thoutenhoofd et al., 2005) and on the effects of CI on spoken language development (Schauwers et al., 2004b; Svirsky et al., 2000, 2002b). The findings in the present study concerning spoken language are also consistent with earlier studies on differences of the effect of CI between monolingual and bilingual children (Geers et al., 2003; Kirk et al., 2002; Wie et al., 2007). Children in a dominantly monolingual educational setting seem to have better spoken language development than children in a bilingual educational setting.

Can the differences between the Flemish and the Dutch children in the development of spoken language be explained by the different language environment or by other factors?

One alternative explanation for the differences between the Flemish and the Dutch children in this study might be better aided hearing in Flemish children before implantation than in Dutch children. Correlational analyses showed that the level of aided hearing is associated with auditory perception and speech intelligibility after implantation: the more aided hearing before CI, the better auditory perception and speech intelligibility after implantation (CAP: $r = -0.51$; SIR: $r = -0.45$). The influence of aided hearing still seemed present three years after implantation: a significant correlation between the aided hearing before implantation and receptive and expressive spoken language three years after implantation was found (Reynell: $r = -0.50$; Schlichting syntax: $r = -0.48$). The findings in the present study are consistent with other studies. Svirsky et al. (2002a) showed that speech intelligibility of deaf children is associated with the level of aided hearing: children with more aided hearing had higher speech intelligibility. Further, Spencer (2004) found that better auditory perception before implantation was associated with the development of more complex syntax. Moreover, pre-operative hearing seems to be a better predictor of subsequent linguistic growth than age at implantation (Szagun, 2001).

Another explanation for the differences between the Flemish and the Dutch children in this study might be the received care and professional support. For instance, the Flemish children were diagnosed at a younger age (1–3 months) than the Dutch children (about 9–12 months) and therefore received a hearing aid at a younger age. Further, the Flemish children got professional support at a younger age than the Dutch children: at an average age of three

months versus past the age of one year. The positive effect of early identification and early intervention has been indicated in several studies (Moeller, 2000; Yoshinaga-Itano, 2006). The Flemish children in this study not only received earlier intervention than the Dutch children, they also attended special daycare centres for at least six hours a day two or three days a week, whereas the Dutch children in this study went to preschool classes for three hours a day two days a week. After the age of 2.5 year, there were no differences in professional support: all children went to a special nursery school. Also, the Flemish children received immediate technical support when there was something wrong with their CI. This was not always the case for the Dutch children.

Despite these confounding factors, it is plausible that the differences between the Flemish and Dutch children in this study are partly caused by the linguistic environment. Because the Dutch children in this study learned two languages at the same time, it is normal that they show a different pattern of language development than the Flemish children. As Grosjean (1989) already pointed out, the communicative competence of bilinguals cannot be evaluated through only one language; it must be studied instead through the bilingual's total language repertoire as it is used in his or her everyday life. Because we studied spoken language and SLN separately, we could assess the development of both languages, but it was not possible to assess the communicative competence of the Dutch children.

The results of the present study indicate that spoken language in the bilingual children developed faster than in children using sign language. The complexity of syntax in SLN was stable during the three years of study, whereas progress was expected. This might be explained by the fact that the Dutch children in our study were more exposed to spoken language than to SLN. Although the parents of these children were taught SLN in courses, they were not fluent in it. Therefore, as soon as their children were able to understand spoken language, these parents communicated as much as possible in spoken language with their children, supported with signs when oral communication was not sufficient. Consequently, from one year after implantation, the input of SLN was almost completely restricted to day-care and/or (pre)school. The proportion of spoken language versus sign language changed in time to more spoken language. This might also explain why the Dutch children developed a

preference for spoken language. But to be able to communicate fluently in sign language, as in any language, a child needs to live in an environment where adults and other children use sign language. This means that sign language should play an equally important role as spoken language in the life of CI children (Preisler et al., 2005). Also, it is essential for bilingual programmes that hearing parents and hearing teachers should reach fluency in sign language within a short time frame (Knoors, 2007). In a bilingual setting, there should be equal input of spoken and sign language. Special efforts have to be made for children to become fluent in sign language. It is therefore important to involve parents intensively, by teaching them SLN. If this is not possible, proper input of sign language should be realised within the school system, the family support system and the Deaf community (Nordqvist and Nelfelt, 2004).

Study limitations and strengths

This study yielded some new insights in the development of spoken and sign language in children with a CI. However, the results should be interpreted with some caution. Firstly, the number of children in the study was small. This means that only large differences between groups of children will be significant. Smaller probably relevant differences might not be significant. Still, we believe that the results are reliable because all the results point in the same direction and some of them were significant. Secondly, the children were followed-up for only three years. It is possible that spoken language development of the Dutch children in this study is only delayed at the onset and that they will catch up with the Flemish children in the course of time. But this is not likely, because research shows that children with a CI who show fast progress at an early stage continue to make faster progress as time passes, and those who show slow progress early on continue to progress slowly (Szagun, 2001).

A strength of this study is that we not only used standardised tests, but we also analysed the spontaneous language of children, spoken as well as sign language. Spontaneous language analysis provides information on the use of language in natural settings. Although MLUs may be overstating differences in complexity of syntax in the early stages of language acquisition, the development of the MLUs is consistent among the children. The MLUs for sign

language for all Dutch children show hardly any progress, whereas the MLUs for spoken language improve in four out of six children.

Implications for practice

Considering possible alternative explanations it is not possible to conclude that children with CI should be educated in a bilingual or monolingual environment. Although the results of the study should be interpreted with caution, they are consistent to such an extent that it is possible to reflect on the optimal linguistic environment for children with CI. For parents, it is not possible to decide at an early stage whether the child with a CI should be raised monolingual or bilingual. The use of spoken language, supported by signs and visual communication strategies, offers parents the opportunity to postpone this decision and at the same time to communicate effectively with their young child. At a later stage, when auditory perception of the child is more clear, parents can decide whether their child will be raised in a dominantly monolingual or a bilingual environment. A child with poor auditory perception might be better off in a bilingual environment, whereas a child with good auditory perception might benefit from a monolingual environment. Then, the proportion of spoken language and sign language can be tailored to the chosen environment. In the case of monolingual education, the input of spoken language (supported with signs and visual communication strategies) might be increased. However, in a bilingual environment, with the objective that the child can participate in the hearing community as well as in the Deaf community, there should be equal input of spoken language and sign language. In that case it is also important to involve parents intensively, by teaching them sign language. If this is not possible, proper input of sign language should be realised within the school system, the family support system and the Deaf community (Nordqvist and Nelfelt, 2004).

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