



A comparative study of speech development between deaf children with cochlear implants who have been educated with spoken or spoken + sign language

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Summary

Objective: To compare speech development following unilateral cochlear implant (CI) between a group of prelingually deaf children who have been educated exclusively using spoken language and another group who have used two languages (spoken and sign language).

Design: A simple group quasi-experimental design was used with a control group.

Methods: The sample comprised 7 girls and 11 boys, aged between 4 and 8 years old, who received a CI between the ages of 15 months and 5 years old. The sample was divided into two groups, G1—bilingual and G2—spoken language. In both groups, aspects such as speech intelligibility, receptive vocabulary, psycho-linguistic skills, adaptive behaviour and behavioural problems were measured.

Results: The children in Group 1 (bilingual) had better verbal and manual expression whereas those in Group 2 (spoken) achieved better results in terms of speech intelligibility, auditory reception and grammatical closure. These differences were confirmed statistically using Analysis of Variance. No significant differences were observed in relation to: receptive vocabulary, social and communicative skills, visual reception, auditory and visual association, visual closure and visual or auditory sequential memory.

Conclusion: The development of speech in these children is irrefutable; however, this study contributes a paradoxical element to the discussion: the bilingual group obtained better results in verbal fluency, hence these children should be able to evoke a greater number of words than those educated using just spoken language.

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1. Introduction

A cochlear implant (CI) is a small, complex electronic device that can help to provide a sense of sound to someone who is profoundly deaf or hard of hearing. The implant consists of an external piece that sits behind the ear and a second piece that is surgically placed under the skin. The purpose of cochlear implants is to help deaf individuals to develop their speech when they have been unable to do so through conventional prosthetics.

Although CI are a recent development (in June 1990, the Food and Drug Administration – FDA – definitively approved the application of the nucleus system in children), they have become an effective integration tool for deaf children, decisively contributing to the fact that a high percentage of children who received their CI before the age of 5 are placed in mainstream classes now, with hearing children [1,2].

However, there are still important questions to be answered. It is fundamental to study not just the improvements that CI achieves in oral language but which factors influence these improvements and how. A fundamental aspect to consider is the option of communication and education, before and after CI implantation.

For example, Preisler et al. [3] claim that factors such as the use of sign language and the communication models used by the adults who relate with deaf children who receive a CI, and the content and complexity of the dialogues maintained with them could be the most influential aspects of this process.

Other studies have demonstrated that, when spoken language is developed through this device, the general development and cognitive level of the deaf child is accelerated. Similarly, these studies show that children with these implants display improved attention, concentration, and capacity to accept rules and cultural values, relating these findings with a standardisation of conduct and relations with their parents [4,5].

Another aspect of the problem tackled in the literature is the possible existence of a ceiling in language progress. It has been indicated that children continue to improve in different aspects of oral comprehension and expression 24 months after the procedure [6], and no plateau is observed in the process after 6 months of monitoring [7].

Several other factors have been suggested as aspects that influence the acquisition process of oral linguistic skills after receiving a CI implant, including the age at which the procedure is carried out, the amount of time since the procedure, the length of time the subject was without hearing, the level of parental involvement in the language

rehabilitation process, type of auditory training and amount of time dedicated to this task a week [8–10].

One of the most frequently studied factors is the age at which the children begin using the CI. Numerous studies consider this factor to be a fundamental aspect, indicating the age of 5 as the upper age limit to achieve the best results [6,11]. However, the studies performed by Geers et al. [12] and Geers et al. [13] did not find any significant evidence regarding the age at which the CI is received.

Various studies have shown that these procedures are increasingly being carried out in the first year of the child's life. Zwolan et al. [14] studied a sample of 295 children, divided into 5 age groups, concluding that the children who received their CI at an earlier age displayed better results in language reception skills.

Along these same lines, Tait et al. [15] conducted a study with 99 children between the ages of 1 and 4, finding that the younger ones displayed the best results. Furthermore, Lesinski-Schiedat et al. [16], studied children who had received the implant before their first birthday with no additional risk, finding superior development in their understanding of speech. Furthermore, when studying 6-month-old babies, Schauwers et al. [17], observed that their development in terms of hearing and speech was very similar to that of children with no hearing problems.

In addition to the age at which the implant is received, another important variable that can influence the development of speech is the choice of communicative model used in the home and the education system. Furthermore, numerous articles have been written in relation to subjects who, both prior to and after the CI procedure, were immersed in an atmosphere of monolingual communication and education, using exclusively oral language [6–10,18,19].

However, there is a second line of research that compares subjects who have used exclusively oral language with others who have combined oral and sign language [3,11].

The studies conducted as part of the first line of research, referring to the exclusive use of oral language, indicate that 6 months after the CI is implanted, the subjects have improved in aspects such as recognition of vowels and the execution of monosyllables, always in multiple choice tests [18] and continued improving these aspects by up to 62% after 2 years of monitoring [10]. In a study to monitor the progress of a 20-month-old baby girl 1 year after the implant [8], the child's comprehensive vocabulary had reached 240 words and expressive vocabulary 90 words. Similarly, a study

performed over 6 years showed a stable increase in the percentage of words produced without phonetic error, as well as an increase in the length of vocal emissions [7].

Furthermore, as indicated previously, there are various studies that compare bilingual communicative models with audiolingual methods in communication and education subsequent to CI implantation. For example, Geers et al. [12] analysed a sample of 27 subjects during the 3 years after the procedure was performed, who were educated using two languages, oral and sign. Furthermore, on a sample of 181 children, who had used the CI for a period of between 4 and 7 years, Geers et al. [2] observed that their communication skills using both total communication and oral language are predictors of good results in the acquisition of spoken language following CI implantation.

Tobey et al. [20] analysed a sample of 131 children with CI 4 years after the device was activated, observing that those who had been immersed in oral language achieved better speech intelligibility results than those who had communicated through speech and sign language.

A study carried out on children who received the CI before the age of 5 and who, subsequent to the procedure, were educated in both languages, concluded that the children whose oral language development had improved thanks to the CI then used oral language to communicate, but in the cases in which oral development had not been as good, the children tended to opt for sign language, which correlated negatively with speech intelligibility and the use of syntax [12]. In relation to this result, Connor et al. [11] concluded that subjects who choose oral communication, on average, display greater accuracy in the production of consonants. However, when the device is implanted before the age of 5, those who use both sign and oral language achieve better results in aspects such as comprehensive and expressive vocabulary.

Spencer and Bass-Ringdahl [21] offer a novel perspective following the longitudinal study carried out with 19 children with CI over the course of 2–7 years of monitoring, concluding that oral language is the most suitable to ensure the device yields good results, but sign language should not be ruled out, since it can be used as a 'backup copy' when oral communication is not possible, either because the device is faulty or because of an incident that leaves the child without the option of using the CI, difficulties that are far from infrequent in the everyday life of a deaf child.

Finally, Stacey et al. [22] performed a study on the basis of 2858 family surveys and 2241 surveys completed by teachers, comparing children with

and without CI, concluding that paediatric implantation is associated with the best results when – controlling all external variables – oral communication is used and as long as the child has received the device before the age of 5.

Ultimately, although there is a considerable amount of literature, the results are not yet conclusive and at times contradictory, which could be fundamentally due to the diversity of methods used. Hence, further research is required into this phenomenon, in order to gain a more in-depth understanding of various aspects of language development and respond to the question of whether it is better to use just oral language or whether bilingualism is preferable. Therefore, the aim of this study is to compare two groups of deaf children that are equally matched except that one uses oral and the other uses oral + sign language, in order to discover the differences between these groups in certain specific aspects of language development.

2. Material and methods

2.1. Participants

18 profoundly prelingually deaf children aged between 4 years old and 3 months old, and 8 years old (average = 6.25 years old; median age = 6.3 years old) took part in this study. They had all received unilateral CI between the ages of 15 months years old and 5 years old (average = 3.2 years old).

They were divided into two groups, depending on whether they had been educated in a bilingual (Spoken + Sign Language—G1) or monolingual (Spoken Language—G2) environment, both before and after they had had the IC put in. The groups shared several common characteristics and their equivalence was confirmed statistically: gender ($\chi^2 = 0.23$; $g.l. = 1$; $p > 0.05$), age ($F_{1,17} = 3.6$; $p > 0.05$), age at which they received the implant ($F_{1,17} = 2.27$; $p > 0.05$), age of diagnosis (average = 10 months) ($F_{1,17} = 0.03$; $p > 0.05$) and the length of time using the implant (average = 3.1 years) ($F_{1,17} = 4.2$; $p > 0.05$).

2.2. Instruments

The participants were evaluated using four tests: Induced Phonological Register [23], the Peabody Picture Vocabulary Test (PPVT) [24], the Illinois Test of Psycho-linguistic Abilities (ITPA) [25] and the Inventory for Client and Agency Planning (ICAP), an adaptive behaviour inventory for people with disabilities [26].

All the instruments were validated and measured on the Spanish population.

2.3. Design

A simple group quasi-experimental design was used with a control group.

The independent variable was the mode of communication used by the children: spoken language or spoken + sign language.

The dependent variables were the results obtained in the aforementioned tests.

2.4. Procedure

The evaluations were performed by the lead author of this paper (who has extensive experience in this area) individually after spending a period of adaptation with each child. The evaluator provided oral stimuli as and when required. The assessment tests were filmed and viewed by two professional psychologists. Inter-observer reliability was calculated to be 100% (agreements/agreements + disagreements).

2.5. Statistical analysis

The data were tabulated using SPSS software (SPSS for Windows). ANOVA analysis was used to compare the two groups (G1–G2).

3. Results

The children's speech development, measured using the Peabody test [24], revealed an average delay of 5.7 months in relation to their chronological age in the bilingual group (G1) and 1.5 months in the spoken language group (G2), but there were no statistically significant differences ($F_{1.17} = 0.7$; $p > 0.05$). Fig. 1 shows that the bilingual group

Table 1

TEST	gl	F
Visual reception (ITPA)	1/16	0.182
Verbal expression (ITPA)	1/16	8.368 ^a
Manual expression (ITPA)	1/16	31.7 ^a
Induced phonological registration	1/16	12.68 ^a
Auditory reception (ITPA)	1/16	7.93 ^a
Auditory association (ITPA)	1/16	19.15 ^a
Grammatical closure (ITPA)	1/16	9.2 ^a
Peabody picture vocabulary test	1/16	1.6
Visual association (ITPA)	1/16	1.6
Visual closure (ITPA)	1/16	0.678
Visual sequential memory (ITPA)	1/16	0.00017
Auditory sequential memory (ITPA)	1/16	3.48 ^a
Social dexterities ans of communication (ICAP)	1/16	1.8

^aSignificative differences with alpha = 0.05.

(G1) achieved better results than the spoken language group (G2) in two of the ITPA [25] sub-tests, *manual expression* and *verbal expression*. The sub-test *manual expression* measures the capacity to express meanings using hand gestures and *verbal expression* measures verbal fluency, evaluated on the basis of the number of concepts expressed verbally.

The Analysis of Variance performed indicated that these differences were statistically significant. The results are shown in Table 1.

The group of children who communicated using exclusively spoken language, on the other hand, performed better in aspects such as speech intelligibility and the ITPA sub-tests *Auditory Reception*, *Auditory Association* and *Grammatical Closure*, revealing a potentially better performance in aspects related to auditory discrimination.

Fig. 2 shows the tests which did not reveal any statistically significant differences between the two groups, such as the Peabody test for receptive vocabulary, the ICAP social and communicative skills, and the ITPA sub-tests referred to as *Visual*

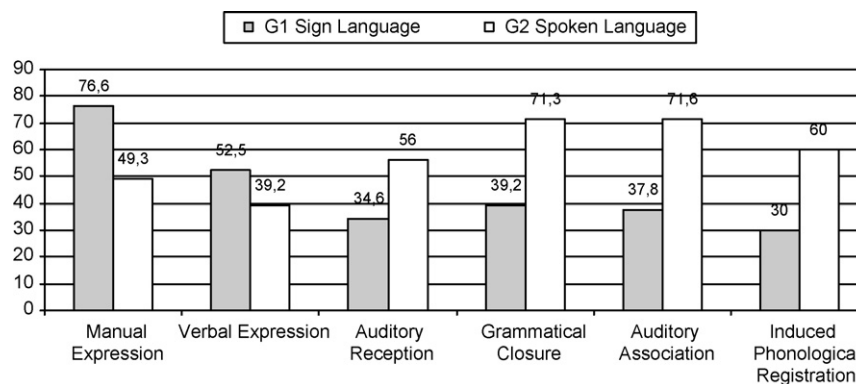


Fig. 1 Comparisons between G1 and G2 with significant differences in ANOVA.

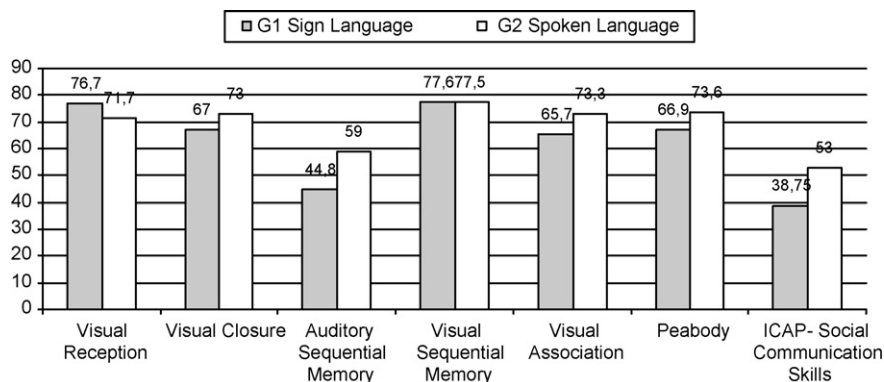


Fig. 2 Comparisons between G1 and G2 without significant differences in ANOVA.

Closure, Auditory Sequential Memory, Visual Sequential Memory and Visual Association.

4. Discussion

The results of this study reveal that children who have used spoken and sign language from an early age achieve better results in aspects such as expression using hand gestures, comprehension of visual symbols and verbal fluency, an extremely important linguistic skill.

However, the children who communicated exclusively in spoken language outperformed the other group in terms of pronunciation, oral comprehension and the use of grammatical rules.

The fact that the children in the spoken language group were better able to use grammar and displayed better pronunciation is to be expected, since they are immersed in an exclusively oral environment. Similarly, it is not surprising that the bilingual children were able to express meaning using gestures. However, the unexpected and therefore somewhat paradoxical finding is this latter group displayed superior skills in terms of verbal fluency, since they were able to evoke a greater number of words using a picture as a stimulus, which might suggest a generalisation of verbal skills from sign language, learned earlier on, to spoken language.

CI clearly allow deaf children to hear and therefore promote the development of speech with only a minimal delay in relation to their age. However, it is very important to continue studying children with CI at the point when they should have achieved more advanced language levels, which require metalinguistic skills such as understanding metaphors. Furthermore, as indicated by Spencer et al. [21], sign language can be an important tool that facilitates communication when technical problems prevent the proper use of the CI, an occurrence that is still far too frequent.

Seeing as bilingual children with CI seem to perform better in linguistic skills such as the evocation of words, it might be interesting to conduct further research into this issue, using larger samples, regarding the development of speech following CI and to analyse how their speech continues to develop, whether it affects the acquisition of written language and language of concepts, as well as the structuring of thought.

However, the study does not allow us to answer the question whether the differences may or may not be caused by cochlear implant, since there was no baseline data showing that the groups were the same or different before the implant. This limitation can be solved through a developmental study or at least having taking data previously to the implant.

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