FACTORS AFFECTING THE PERFORMANCE OF USERS OF COCHLEAR IMPLANT IN SPEECH PERCEPTION TESTING

Fatores que interferem no desempenho de usuários de implante coclear em testes de percepção de fala

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ABSTRACT

Purpose: to analyze the relation between speech perception tests in cochlear implant users. **Methods:** questionnaires and speech perception tests were applied in 25 individuals from both genders with sensorioneural hearing loss and users of unilateral cochlear implant. **Results:** 48% of the participants had a good performance (50%) on speech perception tests. The participants who had the best results are not the ones with higher auditory age. 12 participants had a score higher than 50% and 10 (83%) of those, did the cochlear implant surgery before 5 years old. The use of hearing aid contralateral to the cochlear implant had a significant influence on the participants performances on tests. The participants who started using hearing aids earlier did not have the best results on the tests. **Conclusion:** the early activation of the cochlear implant is an important variable on the tests performance. The use of hearing aid contralateral to the cochlear implant had a significant influence on the speech recognition tests.

KEYWORDS: Hearing; Hearing Loss; Cochlear Implantation; Speech Perception

■ INTRODUCTION

Hearing is the means through which an individual can exchange information. It allows the acquisition and development of speech and language, and, consequently, favors school learning. Hearing is composed of a peripheral and a central part, and the integrity of these systems is necessary, as learning is connected to these factors[1].

In the act of hearing and deciphering what is being said, the relation between the integrity of the peripheral auditory system and the central auditory system may be observed. Therefore, in order to have effectiveness in communication, the auditory processing skills are extremely important [2].

Cochlear implants are high-technology biomedical electronic devices, developed to perform the function of the cochlear hair cells, which are damaged or absent. They provide individuals with severe and profound hearing loss the direct electrical stimulation of the remaining nerve fibers, allowing the transmission of the electric signal to the auditory nerve, in order to be decoded by the *cerebral cortex.* The cochlear implant provides the sensation of hearing with the necessary quality for the perception of the speech sounds [3].

The impact of hearing impairment on language cannot be considered only from the sensory deprivation perspective. The language difficulties in deaf children, in many cases, exceed the physiological conditions of their auditory system, although it is undeniable that these difficulties have their origins exactly in the partial and distorted acquisition of acoustic signals. Speech production and perception are complex processes, which involve different skills. However, the audibility conditions of the speech sounds, imposed by the limits of the dynamic auditory field determine, largely, the perceptual possibilities[4].

There is considerable variability in the auditory performance of Cochlear Implant (CI) users. This variability is attributed to the characteristics of the

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peripheral and central auditory systems, resulting from the impact of sensorineural hearing loss on the afferent neural structures [5].

Sensorineural hearing loss distorts sound perception, resulting in a reduction in sensitivity, abnormal growth of the intensity sensation, frequency selectivity reduction, and temporal resolution reduction. With the impairment in the ability to resolve frequencies, there is difficulty in speech perception, especially in the presence of competing noise. The temporal envelope of speech, which codifies information, is distorted in an altered auditory system, resulting in distortion in speech perception[6].

According to Geers(1994), in the assessment of the speech perception skills, phonemes, syllables, words, or sentences may be used. In these tests, the stimuli which define the phonetic contrast should be widely used, as they are easily perceived by the child, regardless of their phonological awareness. However, speech perception tests for children should, frequently, use familiar words (significant stimulus), and the phoneme perception information must be deduced from the child's answer [7].

Many factors contribute for a delay on the child's oral language development, such as reduced production and perception of language and hearing skills, causing a loss in auditory feedback as well as alterations or delays in short-term auditive memory development. These processes are necessary for auditive discrimination 8.

Thus, this research is situated in a framework with many variables in the results of speech perception tests and therapeutic prognosis. Its objective is to analyze the factors that interfere on cochlear implant user performance in speech perception tests.

■ METHODS

This is a cross-sectional study of a series of cases. The casuistic was constituted of 25 individuals, from both genders, with severe to profound sensorineural hearing loss, manifested in the prelingual period, users of unilateral cochlear implant, with chronological age of 5 years or higher, and auditory age of brain development starting at 3 months.

The sample makes effective CI use, and some also wear a contralateral personal amplification device (PAD).The participants of the research use oral language as the main form of communication. The subjects were invited through a Free Informed Consent (Appendix A).The selected participants were patients that went to the Language and Hearing Clinic – CLIAL (Clinica de Audição e Linguagem), located on 713/913 south – Building Porto Alegre,

and to the LudovicoPavoni Language and Hearing Educational Center – CEAL-LP (Centro Educacional da Audição e Linguagem – LudovicoPavoni), both located in the city of Brasília-DF, Brazil.

All the subjects, or their guardians, went through an initial interview, in which data regarding the hearing impairment and the cochlear implant (CI) were collected.

The speech perception assessment protocols were selected according to the hearing and linguistic skills of each participant. The tests were presented openly, without the support of lip reading or gestures.
– For the participants aged five (5) to seven (7) years, the list of words was used as the procedure for assessing speech sounds perception in hearing impaired children [9]. The participant was requested to repeat the presented stimulus in the way he/she understood it.
– For the participants who were over seven (7) years old, the CPA (Audiological Research Center) sentence perception test [10] was used, in which the results are expressed in percentages. The participants were asked to repeat the stimulus presented, in the way they understood it.

The research followed the steps described below:
1. Filling out the Consent form
2. Previous questionnaire, with objective questions
3. Speech perception assessment:
   – For children aged between 5 and 7 years: list of words [9].
   – For children over 7 years of age: open format list of sentences [10].

The present research was submitted to the Research and Ethics Committee of the Catholic University of Brasília (Universidade Católica de Brasília), under the protocol Res. CNS 196/96, and after approval, the data collection was performed in the months of August and September,2010.

The statistical analysis of the data was done through the SPSS Statistics package version 15.0. The Phi and Cramer's V correlations were used for nominal variables, and Pearson's R for interval variables. The ANOVA test was used to compare the performance between groups.

■ RESULTS

In table 1, the data collected from the participants through the questionnaire and from the applied speech perception tests are organized. The parents or the participants themselves answered the questionnaires.

The sample was constituted of 25 participants, 16 (64%) females and 9 (36%) males, unilateral cochlear implant users that present oral language as the primary form of communication. The chronological age of the participants varied from 5 to 32 years, and the mean age is 10 years and 6 months. The answers obtained with the questionnaires are described below:

Data on hearing:

The etiologies found for the hearing loss are presented in Figure 1. PAD use began from 5 months to 2 years and 8 months of age after the diagnosis of hearing loss. When asked about the use of the PAD contralaterally to the CI, it was verified that 52% of the participants used this device.

Data on cochlear implant:

In the sample of 25 participants, 19 (76%) received cochlear implant before they were 5 years old; 1 (4%) received it when he/she had between 5 – 10 years of age; and 5 (20%) received the CI after 10 years of age, as presented in Figure 2.

All the participants (100%) answered they use cochlear implant every day of the week, for more than 8 hours a day.

In order to assess speech perception, the tests applied were: List of words[9] – for the participants aged between 5 and 7 years – and list of sentences in an open format [10] – for the participants who are over 7 years old.

Table 1 – Sample distribution according to gender, age, hearing age, age at CI activation, etiology, PAD use, percentage of precise answers in the speech perception test

	Gender	Age	Hearing age	Age at activation	Etiology	Wears PAD?	Age when began PAD use	Test results
1	Female	25y 3m	2y 3m	23y	Congenital	no		74%
2	Female	20y 7m	8y 2m	12y 5m	Measles	no		18%
3	Female	5y	2y 5m	2y 7m	Idiopathic	yes	1y 10m	45%
4	Female	33y 5m	1y 8m	31y 9m	Hereditary	yes	1y	0%
5	Female	26y 6m	2m	26y 4m	Meningitis	no		0%
6	Male	23y 3m	11y 4m	11y 10m	Meningitis	no		22%
7	Female	7y 3m	2y 11m	4y 4m	Syndromic	yes	7m	15%
8	Male	5y	3y 3m	1y 8m	Syndromic	no		50%
9	Female	5y 5m	2y 4m	3y 1m	Idiopathic	yes	2y 6m	60%
10	Female	5y 4m	3y 6m	2y 10m	Idiopathic	yes	2y 2m	40%
11	Female	6y 4m	3y 11m	2y 5m	Meningitis	yes	1y 10m	30%
12	Male	7y	2y 8m	4y 3m	Idiopathic	no		65%
13	Female	6y 4m	1y 6m	4y 10m	Idiopathic	yes	2y 2m	35%
14	Female	7y	4y 3m	2y 9m	Idiopathic	yes	2y 1m	40%
15	Male	6y	2y 7m	4y 5m	Idiopathic	yes	2y	15%
16	Female	6y 6m	2y 8m	3y 8m	Idiopathic	no		85%
17	Female	6y 9m	4y 6m	2y	Hereditary	yes	5m	55%
18	Male	14y 7m	7y 3m	6y 4m	Meningitis	no		90%
19	Male	6y 9m	2y 4m	4y 6m	Idiopathic	yes	1y 7m	0%
20	Male	11y 1m	7y 7m	3y 5m	Idiopathic	no		42%
21	Female	5y 9m	4y 2m	1y 8m	Hereditary	yes	11m	85%
22.	Male	5y 9m	2y 5m	3y 5m	Idiopathic	no		90%
23	Female	11y 6m	8y 5m	3y 1m	Genetic	no		88%
24	Female	6y	2y 9m	3y 3m	Idiopathic	yes	2y 8m	70%
25	Male	10y 6m	5y 9m	4y 9m	Idiopathic	no		74%

In the analysis of the speech perception tests (Figure 3), the results were related to some variables, and it is possible to observe that, considering a sample of 25 participants, 12 (48%) reached a good performance in the speech perception test results, presenting at least 50% of precise answers. Moreover, it was verified that from this sample, 13 participants (52%) presented less than 50% of precise answers. During the application and analysis of the tests, only the words emitted completely precisely were considered correct.

Regarding the relation between the hearing age and the speech perception test results, it was possible to observe that the participants who obtained better results are not necessarily those who have higher hearing age. In the statistical analysis, relevant correlation between these variables (p=0.30) was not identified.

When comparing the age at which the participants were cochlear implanted (age upon activation) and the results of the speech perception tests, it was found that out of the 12 participants who achieved performance above 50%, only 2 (16.6%) were implanted after 5 years of age, that is, 10 participants (83.3%) were implanted earlier (before 5 years of age). In the statistical analysis, however, significant correlation between the variables was not identified.
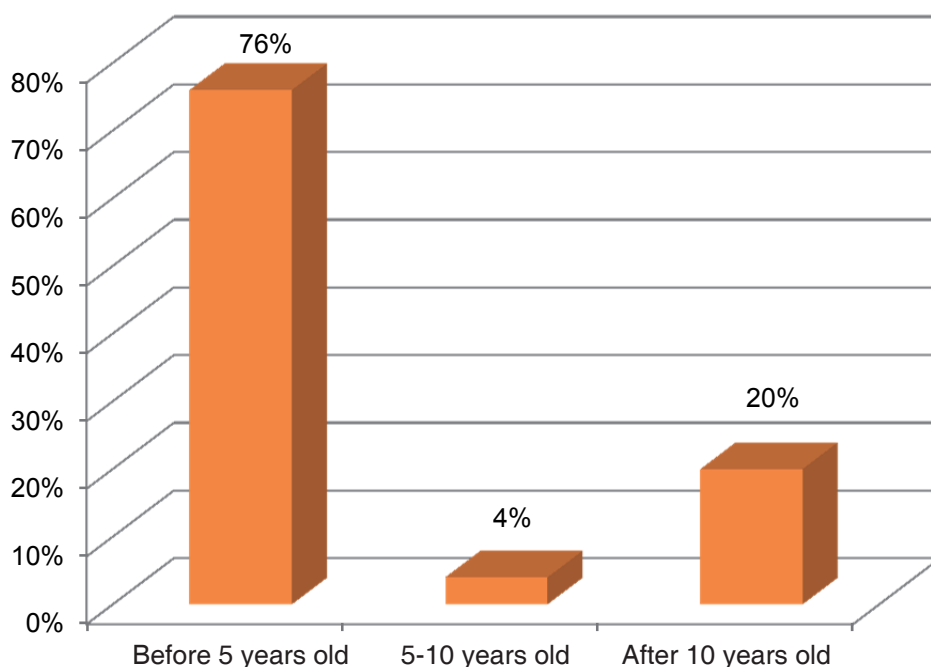

Figure 1 – Age at which participants were cochlear implanted

In the sample of 25 participants, 13 (52%) use a PAD in the contralateral ear and they obtained better performance in the speech perception tests. The statistical analysis revealed that the use of a PAD in the contralateral ear significantly influenced (p=0.05) the indexes of word or sentence recognition. The ANOVA test to compare the performance between these two groups identified a strong trend towards the group of PAD users, but the result was not statistically significant (p=0.08).

Out of the 13 (52%) subjects who wear PADs, 8 (32%) began use at latest 2 years of age, but these participants who started PAD use earlier were not necessarily those who presented better results in the speech perception tests. The statistical analysis did not identify correlation between the data.

■ **DISCUSSION**

In this study, the factors which may affect the performance of users of cochlear implant in speech perception testing were analyzed. The period of sensory deprivation, the age at the activation of the electrodes, the period of activation of the cochlear implant (hearing age), the use of the PAD in the contralateral ear, and the etiology of the participants were considered.

It was observed that the main etiology of the hearing impairment of most participants was idiopathic / unknown. A study which analyzed 200 charts from patients users of cochlear implant verified that 40% of all cases presented unknown cause of deafness[11]. Another retrospective study of the audiological and etiological profile analyzed 162 cases of hearing impairment and observed that 32% of the cases presented unknown etiology [12].
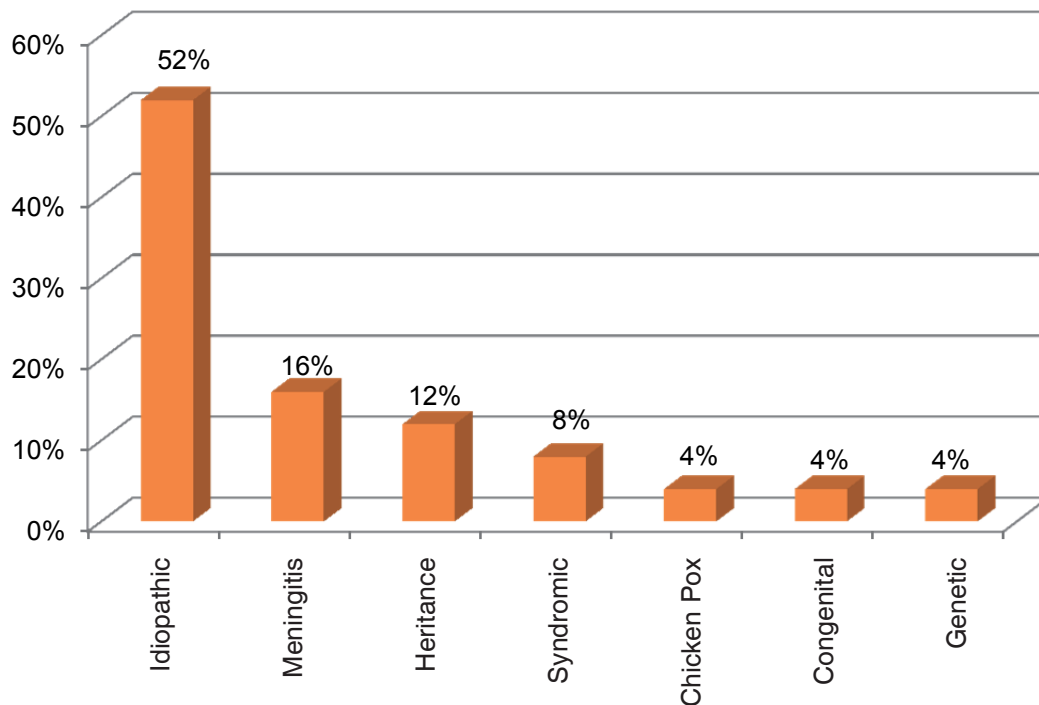

Figure 2 – Etiologic profile of the subjects participating in the study

The relationship between the hearing age and the speech perception test results demonstrated that the participants who obtained better results are not necessarily those who have worn a cochlear implant longer, differently from the literature researched. Other studies observed significant influence of duration of CI use in the assessment of cochlear implanted adults in the CPA sentence recognition indexes, as the longer the duration of use, the higher the sentences recognition indexes[13].

Some authors investigated the performance of 20 users of a cochlear implant and a personal amplification device (PAD) in the contralateral ear in speech perception and sound localization tests. The abilities to comprehend words in silence and in noise were tested using only the personal amplification device and only the cochlear implant, and with combined use of both, and sound localization was tested using only the cochlear implant and the PAD combined. The results demonstrated the benefit of the combined use of a cochlear implant and a PAD for speech perception in the presence of competing noise and at sound localization [14]. Another work evidenced compatible results with regard to contralateral PAD and CI, as both in silence as in noise there were higher scores in the tests with monosyllables and sentences with the use of CI and PAD[15]. The findings of the studies mentioned previously agree with those of this study [14, 15].

Some studies refer that in a long period of auditive deprivation can negatively influence the speech perception tests and that the period of auditive deprivation is directly proportional to the lowest performance in speech recognition[5, 16,17]. The clinical analysis in this study evidenced that the early activation of CIs, that is, a smaller period of auditive deprivation is an important variable in the test performance.
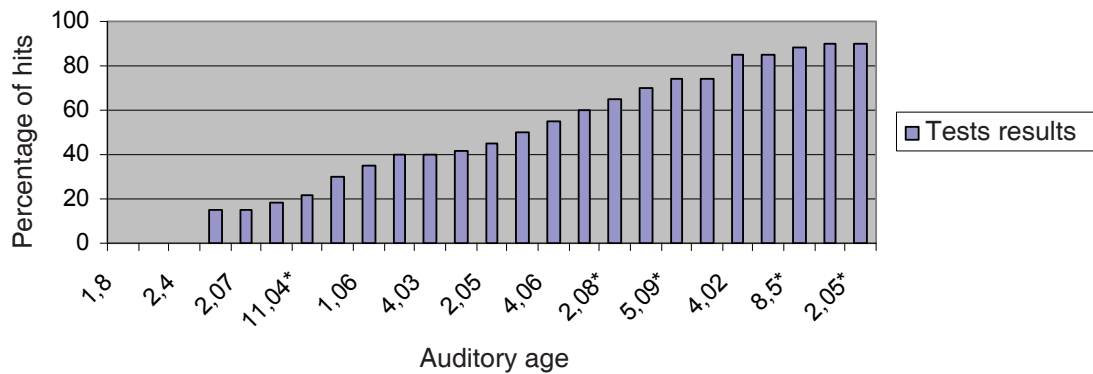
Figure 3 – Performance according to participant's hearing age

CONCLUSION

From the results obtained in this study, it was possible to conclude that the factors that interfere on the performance of cochlear implant users in speech perception tests are the early CI activation and the use of a PAD in the contralateral ear.

RESUMO

Objetivo: analisar os fatores que interferem no desempenho de usuários de implante coclear em testes de percepção de fala. **Métodos:** foram aplicados questionários e testes de percepção de fala em 25 indivíduos, de ambos os sexos, portadores de perda auditiva neurossensorial e usuários de IC unilateral. **Resultados:** – 48% dos participantes atingiram bom desempenho nos resultados dos testes de percepção de fala, apresentando porcentagens maiores ou iguais a 50 % de acertos. – Os participantes que obtiveram melhores resultados não são necessariamente os que possuem maior idade auditiva. – Dos 12 participantes que atingiram desempenho acima de 50%, 10 (83,3%) foram implantados mais precocemente (até 5 anos). – O uso do AASI na orelha contralateral influenciou significativamente nos índices de reconhecimento das palavras ou sentenças. – Os participantes que iniciaram o uso de AASI mais cedo não foram necessariamente os que apresentaram melhores resultados nos testes. **Conclusão:** a ativação mais precoce dos IC mostrou-se uma variável importante no desempenho dos testes. – O uso do AASI na orelha contralateral influenciou significativamente nos índices de reconhecimento das palavras ou sentenças.

DESCRITORES: Audição; Perda Auditiva; Implante Coclear; Percepção da Fala

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