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Comparative analysis of cognitive-linguistic evaluation in normal hearing schoolchildren and users of cochlear implants

Análise comparativa da avaliação cognitivo-linguística em escolares ouvintes e usuário de implante coclear

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Keywords

Learning
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ABSTRACT

Purpose: When children becom cochlear implant users, they have already had the opportunity to develop phonological skills; however, it is possible that they miss sound information during speech and, consequently, present difficulties in competences associated with the learning of reading and writing. **Methods:** The study sample consisted of 11 normal hearing children aged 7-10 years and a right-ear cochlear implant user enrolled in the 3rd grade of Elementary School. The Cognitive-Linguistic Assessment protocol was used to evaluate the study participants. Data were transcribed and analyzed using descriptive statistics. **Results:** The following sub-tests presented the highest percentage of children with superior performance: alphabet in sequence (82%), reading of pseudo-words (82%), syllable segmentation (73%), word repetition (82%), copying of shapes (72%), and rapid naming (100%).The cochlear implant user presented superior performance in all the sub-tests except for word repetition, in which average performance was observed. In the rhythm sub-test, none of the normal hearing children presented superior performance, and the cochlear implant user performed poorly. **Discussion:** It was possible to observe that the condition of being a cochlear implant user is not the only determinant for a child's school failure. There are issues that go beyond auditory integrity, because some normal hearing children performed poorly in sub-tests such as repetition of pseudo-words, rhythm, and alliteration. Conclusion: The cochlear implant user presented a cognitive-linguistic profile very similar to those of his hearing peers.

Descritores

Aprendizagem
Cognição
Criança
Implantes Cocleares
Linguagem

RESUMO

Objetivo: Analisar e comparar o desempenho cognitivo-linguístico de uma criança usuária de implante coclear em relação aos seus pares ouvintes em processo de aprendizagem da leitura e da escrita. **Método:** A amostra foi constituída por 11 crianças (na faixa etária de 7 a 10 anos de idade) ouvintes e uma usuária de implante coclear na orelha direita, matriculadas no 3º ano do ensino fundamental. O instrumento de avaliação utilizado foi o Protocolo de Avaliação das Habilidades Cognitivo-linguísticas. Os dados referentes às crianças foram transcritos e analisados utilizando-se a estatística descritiva. **Resultados:** Os subtestes que apresentaram o maior percentual de crianças com desempenho superior foram: alfabeto em sequência (82%); leitura de pseudopalavras (82%); segmentação silábica (73%); repetição de palavras (82%); cópia de formas (72%); nomeação rápida (100%). Desses subtestes, a criança usuária de implante coclear apresentou desempenho superior em todos, exceto o de repetição de palavras, em que obteve desempenho médio. No subteste de ritmo, nenhuma criança obteve desempenho superior e a usuária de implante coclear obteve desempenho inferior. **Conclusão:** A criança usuária de implante coclear apresentou um perfil cognitivo-linguístico bastante semelhante ao dos seus pares ouvintes. Ao que parece, as dificuldades de realização de algumas tarefas cognitivo-linguísticas estão relacionadas a fatores que vão além da integridade auditiva, haja vista que, em alguns subtestes, crianças ouvintes, obtiveram desempenho abaixo do esperado.

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INTRODUCTION

Cochlear Implant (CI) is a surgically installed electronic device that stimulates the remaining nerve fibers of the auditory nerve, allowing the transmission of electrical signals that will be decoded by the cerebral cortex as auditory perception[1]. The CI has provided many children with hearing loss the opportunity to develop phonological skills, but it is possible that these children had lost speech sound information, and consequently face difficulties in reading and writing.

The early years of life are critical for the development because the apex of the maturation process of the central auditory system and neuronal plasticity occur in childhood, making the early detection of hearing loss fundamental to minimize the damages caused by it[2]. Because of this, the main impact of hearing loss on children is the development of hearing and language skills, as well as learning.

For learning to read and write, the acquisition and development of specific skills are important, such as visual and auditory perception, comprehension, memory and metalinguistic abilities. Upon entering school, the hearing child should have mastery over oral language and present cognitive-linguistic skills appropriate for learning; however, the child still has no idea of what phonological aspects will be required to read and write[3]. Therefore, the child with a CI will certainly have difficulties in identifying, reflecting and manipulating linguistic segments. Changes in cognitive-linguistic performance may influence the perception of speech segments and the recognition of essential elements for the formation and identification of words.

In order to appropriate the reading and writing system to take place, it is necessary for the child to develop cognitive-linguistic components, namely auditory processing, visual processing and logical reasoning. Such abilities include attention, reflection, manipulation, storage of information and skill to think about the constituent aspects of one's own language, a capacity known as phonological awareness[4]. However, the development and improvement of language skills require a good auditory acuity, since hearing is essential for language acquisition.

Besides using the CI to achieve a good performance in the development of the children's hearing abilities, it is essential that the child perform speech-language therapy after surgery, since children should be helped to interpret and give meaning to sounds[5]. The support and involvement of the family and the school are also fundamental for their school and linguistic development[6].

It is important to consider that children with a cochlear implant do not perceive speech sounds in exact the same way as the hearing child, and that the ideal model of the alphabetic system is based on the relationship between the letters and the sounds of speech[7]. For this reason, it is important to verify whether the schoolchild with a cochlear implant presents changes in cognitive-linguistic skills involved in the learning process of reading and writing. It is also important to note that there is little research addressing this theme, making studies to identify such changes relevant.

In view of the above, the objective of this study is to evaluate the cognitive-linguistic performance of a child using a cochlear implant, and compare the results with their hearing peers in the learning process of reading and writing.

METHODS

This study began after approval by the Ethics Committee of the Institution, under Opinion no. 1,571,572, following all requirements of the Resolution no. 466/12. This research was carried out in a private school located in the metropolitan region of Recife with the formal consent of the institution. The sample was established by convenience, consisting of a bilaterally deaf child, user of CI in the right ear, eight years of age, and all hearing children who attended his classroom in the 3rd year of elementary school, totaling 12 children (eight of male gender and four of female gender), with a mean age of 8.6 years. Students with special neurological or psychological educational needs (students' records were used as reference) and children who did not fit the age range recommended for protocol application were excluded.

The individual data of the implanted child were initially collected: diagnosis of hearing loss, etiology of hearing loss, type and degree of hearing loss, age of the first adaptation to hearing aids, age of implantation, age at which the child began speech-language rehabilitation, rehabilitation method, CI brand, and adherence to speech-language therapy – evaluated by frequency (equal to or greater than 75%) and by the Family Permeskill Degree questionnaire (equal to or greater than 30%). These data were obtained as secondary data belonging to the research "Linguistic and Metalinguistic Skills and Learning of Reading and Writing in Children Using Cochlear Implants: A Case Study," conducted at the Human Communication Health Postgraduate Program. Data on hearing performance were also obtained from the GASP (Glendonald Auditory Screening Procedure) and from categorization of language (through the RDLS scale - *Reynel Developmental Language Scales*).

The data collection with hearing children and the CI user regarding cognitive-linguistic skills were performed after parents and/or legal guardians were clarified as to the objectives of the research, at which time they signed an Informed Consent.

Such skills were evaluated through the Cognitive-Linguistic Skills Assessment Protocol[8]. The purpose of this protocol is to evaluate the aspects of cognitive-linguistic processing of children at the literacy stage, helping to identify under-performing children in reading and writing in relation to its class. This protocol contains two versions: collective and individual. The first part of the protocol is the collective version, composed by five sub-tests related to writing, arithmetic, auditory processing and visual processing skills. The second part of the protocol is the individual version. It is applied if the child achieves a performance below its group/class. This version consists of

thirteen sub-tests related to reading skills, phonological awareness, auditory processing, visual processing and processing speed. All children were submitted to both versions of the protocol, regardless of the score obtained in the collective version.

The application of the individual version of the protocol was carried out in a proper place, so that the results can be obtained in a more directed way without interruptions of third parties, only with the participation of the researcher and the student. The collective version of the protocol was applied in a classroom with the presence of all students participating in the research.

The score of each version of the protocol was recorded in the answer sheet, so that the researcher could observe the performance of the child and even compare the performances obtained among students. The collective version answer sheet was filled by the child himself and the individual version answer sheet was filled by the researcher.

After obtaining the answers, a descriptive analysis was made aiming to observe the cognitive-linguistic abilities of the child with a CI and its hearing peers who attended its school series, establishing comparisons between them. The results of the children's evaluations were analyzed based on the classification parameters established by the protocol itself, according to school year.

The analysis of the results was performed according to the performance by sub-tests in three categories: Superior Performance (SP), Medium Performance (MP) and Low Performance (LP), considering the number of hits per sub-test within each test.

An analysis was also conducted considering the number of hits (points) obtained by each child in all skills and sub-tests. From this, the mean scores of hearing children were obtained in order to compare it with the outcome of the child with CI. Descriptive analysis was also performed on the children's cognitive-linguistic abilities seeking to relate them to the following characteristics: age of diagnosis of hearing loss, chronological age, current hearing age, etiology of loss, age of implantation and adherence to speech-language therapy.

RESULTS

Characterization of the child using a cochlear implant

The child with CI is male, eight years old, only child, and resides with his parents. The parents deny history of hearing loss in the family and absence of other factors, and the hearing loss was considered idiopathic. He was diagnosed with deep bilateral sensorineural hearing loss at the age of nine months, after which he was referred to a hearing care reference center in the metropolitan area of Recife for implantation, receiving individual sound amplification devices at 15 months (one year and three months) and performing surgery to insert the CI in the right ear at 20 months (one year and eight months). He has currently six years of auditory experience with CI. The implant used is made by the Cochlear manufacturer, and the speech processor is Nucleus 5. All electrodes were introduced and activated.

Immediately after implantation, the child started Speech Therapy with Aurioral approach once a week at the same center where the implantation was performed. In addition, he attends the third year of elementary school in a full-time private school, with no history of year repetition.

The child was able to recognize 100% of words in a closed set and 100% of sentences in an open set. In terms of language, the child is in the category 5[9], being able to construct sentences with more than five words, conjugate verbs and use plurals.

Results of cognitive-linguistic skills

Collective version

The first skill evaluated was writing, taking into account the writing of the alphabet in sequence, in addition to the dictation of words and pseudo-words. In the writing of the alphabet in sequence, 9 (82%) hearing children obtained a SP (with 100% accuracy) and 2 (18%) presented a MP (50-90% of correct answers). In the writing of words, 2 (18%) had a SP (25-30 words), 7 (64%) had a MP (15-24 words) and 2 (18%) had a LP (0-14 words). Among those who presented a LP, all were able to write at least 10 words correctly. In relation to the pseudo-words writing, 6 (55%) children had a SP (8-10 pseudo-words), 4 (36%) had a MP (5-7 pseudo-words) and 1 (9%) had a LP (0-4 pseudo-words).

In both alphabet writing and word writing, the CI user child performed similarly to the majority of the class, fitting into SP and MP, respectively. However, in pseudo-word writing, he obtained a MP, being able to write 5 words correctly, while 55% of the class reached a SP.

In relation to auditory processing skill (AP) (digit memory sub-test), 6 (55%) children had a SP (2-6 digit sequence reproduction), 2 (18%) had a MP and 3 (27%) presented a LP (reproduction of sequences, only 2). The CI user obtained a MP in this skill, reproducing sequences of 2-4 digits.

With regard to visual processing skill (VP) (form copying sub-test), all children were able to reproduce at least 3 shapes (maximum of 4 shapes). Among the results, 8 (73%) children had a SP (reproduction of 4 shapes) and 3 (27%) had a MP (reproduction of 2-3 shapes). The CI user obtained a SP on this sub-test, as the majority of the class.

All children, including the CI user, presented a LP in the sub-test of mathematical calculation, obtaining a maximum of 9 hits (maximum of 20).

According to the parameters established by the protocol, the children who presented a LP were classified as "under attention" due to the below-expected performance for their school series.

Figure 1 shows the classification of the performances obtained by hearing children and users of CI in the sub-tests of the collective version.

Individual version

Regarding the reading of words, 5 (45%) children had a SP, and 6 (55%) had a MP. In the reading of pseudo-words, 9 (82%) children had a SP, and 2 (18%) had a MP. The CI user presented MP and SP in the reading sub-tests of words and pseudo-words, respectively.

In the sub-tests related to the skill of Phonological Awareness (PA), the following results were found: in the alliteration subtest, 5 children (45%) had a SP, 5 (45%) had a MP, and 1 (10%) had a LP. Regarding rhyme, 2 (18%) children had a SP, and 9 (82%) had a MP. Regarding syllabic segmentation, 8 (73%) children had a SP, while 3 (27%) had a MP. The child with CI had the following results in all three sub-tests: in the alliteration he obtained a MP; in the subtest of rhyme, he presented a MP; and in the syllabic segment, he obtained a SP. That is, in the three sub-tests, the child with CI presented a similar performance to the majority of the class.

In the subtest word repetition, 9 (82%) children had a SP, and 2 (18%) had a MP. In the repetition of pseudo-words, 2 (18%) had a SP, 7 (64%) had a MP, and 2 (18%) had a LP. The CI user had a MP in both sub-tests. In the subtest of rhythm, 8 (73%) children had a MP, and 3 (27%) had a LP. The cochlear implant user had difficulty in this subtest, and obtained a LP.

With regard to word and digit fast naming sub-tests, all children (100%) obtained a SP, since, according to the parameters established by the protocol, 60 seconds would be the maximum time for the best performance in each of the sub-tests. Concerning the sub-test of sounds discrimination, 6 (55%) children had a SP, and the other 5 (45%) children had a MP. The child with CI obtained a SP in the word and digit fast naming sub-tests and a MP in the sounds discrimination sub-tests.

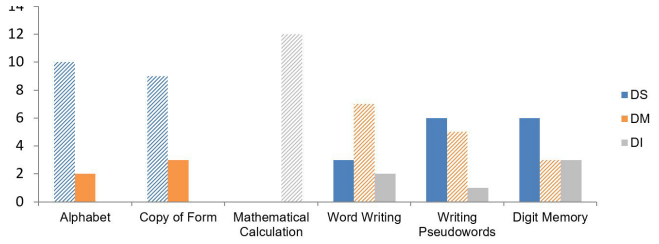
The last sub-test was the repetition of numbers in reverse order. The results obtained were 8 (73%) children with a SP, 2 (18%) children with a MP and 1 (9%) children with a LP. The cochlear implant user obtained a MP in this sub-test.

Figures 2 and 3 show the classification of the performances obtained by hearing children and the CI user in the sub-tests of the individual version.

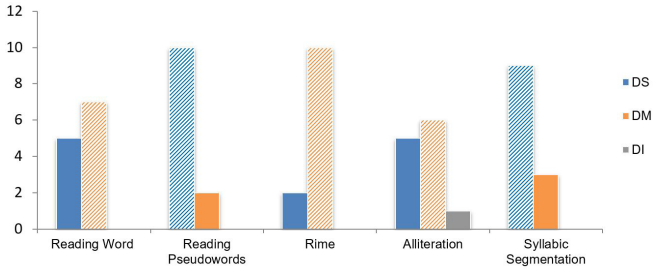
Collective and individual version

Figure 4 shows the average accuracy of each cognitive-linguistic skill, both in the collective and individual versions, considering the various sub-tests.

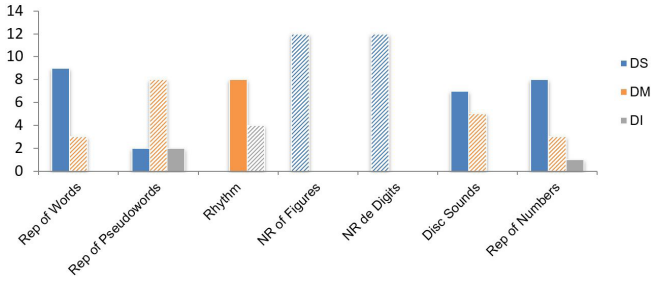
In relation to reading (reading of words and pseudo-words) and writing (writing of the alphabet, writing of word dictation and pseudo-words), the average number of hits of hearing children on reading was 65.55 and in writing 53.72. The CI user obtained a quantitative of correct answers similar to their hearing peers, with 65 hits in reading and 54 correct answers



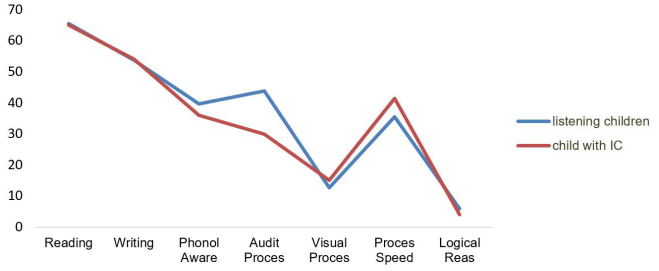
Caption: Striped bars are indicative that the child with CI is in the group. DS: Superior Performance; DM: Medium Performance; DI: Lower Performance
Figure 1. Performance of the cognitive abilities of hearing children and cochlear implant users in the collective version (n = 12)



Caption: Striped bars are indicative that the child with CI is in the group. DS: Superior Performance; DM: Medium Performance; DI: Lower Performance
Figure 2. Performance of hearing children and CI users in subtests of the individual version (n = 12)



Caption: Striped bars indicate that the child with HF is in that group. DS: Superior Performance, DM: Medium Performance, DI: Lower Performance. Rep of words: Repeat words; Rep of pseudowords: Repeat of pseudowords; Rep of numbers: Repeat numbers; NR: Rapid Automatized Naming; Disc Sounds: Discrimination of sounds
Figure 3. Performance of hearing children and CI users in subtests of the individual version (n = 12)



Caption: Phonol Aware: Phonological Awareness; Audit Proces: Auditory Processing; Visual Proces: Visual Processing; Logical Reas: Logical Reasoning
Figure 4. Distribution of mean scores of cognitive abilities of hearing children and users of CI (n = 12)

Table 1. Average scores of hearing children and number of correct answers for the child using a cochlear implant by subtest

Subtest	Hearing children (n=11)	Cochlear implant users (n=1)	Maximum score
Alphabet	25.36	26	26
Copy of form	3.73	4.00	4
Mathematical Calculation	6.00	4.00	20
Word Writing Under Dictation	21.00	23.00	30
Writing Pseudowords under Dictation	7.36	5.00	10
Digity Memory	7.45	5.00	10
Reading Words	56.64	57.00	70
Word Reading Time	85.09	80.00	-
Reading Pseudowords	8.91	8.00	10
Alliteration	7.45	7.00	10
Rime	14.64	11.00	20
Word Repetition	5.27	3.00	8
Pseudowords Repetition	3.09	4.00	7
Rhythm	4.27	3.00	12
Syllabic Segmentation	17.64	18.00	20
Rapid Automatized Naming of Picture	38.00	46.00	40″
Rapid Automatized Naming of digits	33.00	37.00	60″
Visual Memory with 2 Figures	1.82	2.00	-2
Visual Memory with 3 Figures	1.55	2.00	-2
Visual Memory with 4 Figures	1.36	.00	-2
Visual Memory with 5 Figures	.45	.00	-1
Discrimination of Sounds	17.73	11.00	20
Repeat numbers	6.00	4.00	10

in writing. The maximum score in the reading skill is 80 hits, and in writing 66 hits. Regarding reading time, there was also a small difference between the hearing children and the CI user. The average time of reading of the hearing children was 85.09 seconds, and the time of the child using the CI was 80 seconds.

The average score of the hearing children in the PA sub-tests was 39.73 hits, while the CI user had 36 hits (maximum score of 50 hits). In relation to auditory processing sub-tests (discrimination of sounds, rhythm, repetition of words, repetition of pseudo-words, and repetition of numbers in reverse order), the hearing children obtained an average of 36.36 hits and the child with CI obtained 25 hits (maximum score of 67 hits).

As for the visual processing sub-test (visual memory with figures), the mean number of hearing children was 9 hits, while the CI user had 11 hits (maximum score 36 hits).

In the processing speed skill (fast naming of figures and digits), for the purpose of punctuation, the arithmetic average of the times of realization of the two sub-tests was performed. The CI user child achieved an average of 41.5 seconds, while the average time of his hearing peers was 35.5 seconds.

In logical reasoning (mathematical calculation), the average of hearing children was 6 hits, and the result of the child with CI was 4 hits (maximum score of 20 hits), revealing an extreme difficulty by all children.

In order to allow for a more detailed comparative analysis between the CI user child and his hearing peers, the mean number of correct hits per sub-test (both the collective and the individual version) by the hearing children and the number of hits of the child with CI is described below (Table 1).

It is possible to observe that the child with CI had very similar results to hearing children in most of the sub-tests. However, it was not possible to perform an inferential statistical analysis because there was only one child with CI. On the other hand, there were lower values more accentuated in some sub-tests of auditory processing, for example, memory of digits in random order, rhythm, discrimination of sounds and repetition of numbers in reverse order, besides the sub-test of rhyme, which make up the skill of phonological awareness.

DISCUSSION

In terms of cognitive-linguistic abilities, as described above, the child with CI presented performances within the expected range of abilities, according to the protocol, except for the sub-tests of rhythm and mathematical calculation, in which he obtained a low performance.

On the other hand, although he has been classified with a medium performance in the sub-tests of memory of digits in random order, discrimination of sounds, repetition of numbers in reverse order and rhyme, the number of hits he obtained was lower than the average of hits of his hearing peers. This analysis by quantitative of correct hits, and not by performance, as the protocol proposes, seems to bring additional information to the development of cognitive-linguistic skills, allowing to

propose more targeted interventions. Figure 4 shows the greatest difficulty in auditory processing skills, which is expected for hearing impaired children, even if a user of CI, especially when the implant is unilateral.

Concerning the discrimination of sounds, for example, difficulties were observed on the part of the child with CI, especially among phonemes acoustically very close to one another and that, because they had the same points of articulation, led the child to confuse them. Although these difficulties were observed, he obtained a MP in this sub-test, as mentioned. The other children, however, obtained a medium to superior performance.

It is also worth noting that the sub-test of rhythm was the only one in auditory processing in which the CI user had a below-average performance. For the hearing impaired, the auditory perception of rhythm (musical sounds) is vague, and depends on a good auditory residue and training opportunities. This perception is amplified through the interaction between multiple perceptual systems[10].

With regard to the results obtained by hearing children in writing of word dictation and pseudo-words, there was no great difference in quantitative hits between both sub-tests, in which the CI user had a MP in both of them, but with a greater number of correct answers in writing words. This data may be related to the fact that, in order to auditively recognize a pseudo-word, the child needs, among other abilities, the recognition of each sound segment. In this regard, studies[1] have pointed out that although the CI provides many hearing impaired children with the opportunity to develop phonological skills, it is possible that they may lose speech information and, consequently, face difficulties in skills related to speech reading and writing skills. It is important to emphasize that CI users, in situations where they do not perceive all the segments of a word, resort to the auditory closure strategy in which they infer the word by accessing their lexicon. Since pseudo-words are created, they cannot resort to this strategy.

In relation to the processing speed skill, in which both the hearing children and the CI user presented a SP, as already described, the digits were named faster when compared to the figures by hearing students. This finding can be explained by the fact that the naming of figures always requires access to meaning for the subsequent production of the name. Also in the same study, it was evidenced that the time of fast naming also depends on the socioeconomic-cultural level of the individual. It is related to educational practices used by teachers of different schools, to the family support given by the parents with better sociocultural conditions, and to the social environment.

With regard to the reading time of the participants, the CI user obtained a reading time similar to his class, a result already expected due to the good performance in the tests of processing speed. The brain has specific areas for several functions, and the occipital-temporal region is the area where the visual recognition of words is processed, and where the automatic and fast reading is performed. When the activation of these areas becomes more automatic, more efficient the reading process will be. Effective readers use this fast, automatic route to read the words[11].

Regarding the skill of PA, most children demonstrated a good skill to reflect on the sound structure of speech as well as to manipulate its structural components. It was also identified that only one child had a LP in the alliteration sub-test. An important data to be highlighted is the fact that the PA of the CI user child was also used in speech therapy, as part of the therapeutic goals of the Aurioral approach. It is likely that rehabilitation contributed to the development of this skill, since it was essential to have a good auditory acuity so that the nuances of the sounds that make up the words could be perceived.

The evolution of these abilities is usually gradual, starting with the discrimination of expressions, words or syllables within broader units of speech, advancing towards the discrimination of rhymes, alliterations and syllables, and only then does one become aware of phonemes as independent units in speech. This evolution is closely related to the level of cognitive requirement in each task[12].

With regard to the visual processing skill, in general, a great difficulty of children in the execution of the sub-test of visual memory with shapes was observed. Besides the difficulty of memorizing the images, the children also showed difficulty in the perception of the positioning of figures. The researcher observed anxiety of part of children in trying to memorize all the stimuli, which could have impaired the final performance.

Considering the skill of logical reasoning (mathematical calculus), not only the child with CI, but also all hearing children obtained an inferior performance, being unable to perform most of the mathematical calculations involving addition, subtraction, multiplication and division operations. All these mathematical knowledge should be consolidated, or in the process of consolidation, considering the school series in which the participants of this study were at the time of data collection (second semester of the third year). It is possible to infer that several questions may be related to the high failure rate in these sub-tests, for example: limitations of teaching strategies, difficulties in long-term memory, immature understanding of the principles of counting, and difficulties in the visual-spatial representation of information.

Therefore, it is emphasized that the condition of the user of CI is not the only determinant for the school failure of the child. There are issues that go beyond auditory integrity, since in sub-tests, such as repetition of pseudo-words, rhythm and alliteration, some hearing children have obtained a LP.

The National Pact for Literacy at the Right Age (PNAIC) is conducted by the Federal, Federal District, State and Municipal governments. In order to achieve its objectives, the Pact's actions comprise an integrated set of curricular and pedagogical programs, materials and references, made available by the Ministry of Education, which contribute to literacy. The main focus is the continuing education of literacy teachers[12].

According to the PNAIC, being literate means much more than mastering only the rudiments of reading and writing,

even being able to read and write all words. The literate person is able to read and write in different social situations in such a way that it allows the person to insert himself and to participate actively in a literate world, facing challenges and social demands. For that to happen, the domain of knowledge related to language is not enough: a broad field of disciplines is necessary, such as mathematics, in which numbers and the decimal numbering system are fundamental, but not the only aspects that must be addressed at school.

Mathematical Literacy is understood as an instrument for reading the world, a perspective that goes beyond simply decoding numbers and solving the four basic operations. In other words, various concepts and mathematical skills are needed so that the child can be considered literate.

The data of this research provoke reflections on the way by which schools have developed their pedagogical plans and how educators have been trained, qualified and instrumented, so that their pedagogical practices effectively favor children's literacy, not only in written language, but also in mathematics.

Research involving the cognitive-linguistic skills of children with CI should be performed so that a feedback can be obtained on both the effectiveness of speech-language rehabilitation and the difficulties and potentials found in these children at school age. It is important to carry out other studies with more children with CI and comparing them, since in this study, only one child with CI was evaluated, which means a limitation of this study. In contrast, the evaluation of a single child was relevant to evidence that the child with CI has a cognitive-linguistic profile very similar to their hearing peers.

CONCLUSION

Through the evaluation carried out in this study, we concluded that hearing children obtained a medium to superior performance in most of the cognitive-linguistic abilities and the CI user child presented a performance similar to his hearing peers.

In addition, the effectiveness of the CI and speech-language stimulation provided the child with a good performance in cognitive-linguistic abilities, although some difficulties related mainly to the auditory processing skill were identified.

Therefore, it is important that auditory abilities be worked out in a systematic way to favor the development of the school learning process.

REFERENCES

1. von Muenster K, Baker E. Oral communicating children using a cochlear implant: good reading outcomes are linked to better language and phonological processing abilities. Int J Pediatr Otorhinolaryngol 2014;78(3):433-44. http://dx.doi.org/10.1016/j.ijporl.2013.12.009. PMid:24434131.
2. Pinheiro ABSM, Yamada MO, Bevilacqua MC, Crenitte PAP. Avaliação das habilidades escolares de crianças com implante coclear. Rev CEFAC. 2012;14(5):826-35. http://dx.doi.org/10.1590/S1516-18462012005000059.
3. Silva C, Capellini S. Correlação entre habilidades Cognitivo-linguísticas em escolares com dificuldades de aprendizagem. Ver. Psicol. 2012;29(89):183-96.
4. Hogan TP, Bowles RP, Catts HW, Storkel HL. The influence os neighborhood density and work frequency on phoneme awareness in 2nd and 4th grades. J Commun Disord. 2011;44(1):49-58. http://dx.doi.org/10.1016/j.jcomdis.2010.07.002. PMid:20691979.
5. Barbosa FV, Lichtig I. Protocolo do perfil das habilidades de comunicação de crianças surdas. Rev. Est. Ling. 2014;22(1):95-118.
6. Furlaneto M, Buffa MJMB, Costa AS. Percepção e participação da família no contexto escolar de crianças com implante coclear. Serviço Social & Realidade (Franca). [Internet]. 2010 [citado em 2017 Fev 20];19(2). Disponível em: https://ojs.franca.unesp.br
7. Cruz CR, Finger I. Aquisição fonológica do português brasileiro por crianças ouvintes bilíngues bimodais e surdas usuárias de implante coclear. Let Hoje. 2013;48(3):389-98. PMid:25506105.
8. Capellini AS, Silva C. Protocolo de avaliação de habilidades cognitivo-linguísticas: livro do profissional e do professor. 1. ed. Marília: Fundepe; 2012. 116 p.
9. Bevilacqua MC, Delgado EM, Moret ALM. Elaboração de um procedimento de avaliação de percepção de fala em crianças deficientes auditivas profundas a partir de cinco anos de idade. In: Marchesan IQ, Zorzi JL, Gomes ICD, editor. Tópicos em fonoaudiologia. São Paulo: Lovise; 1996. p. 411-33.
10. Santana AP, Guarinello AC, Bergamo AO. A clínica fonoaudiológica e a aquisição do português como segunda língua para surdos. Rev. Distúrb Comun. 2013;25(3):440-51.
11. Bernarnido JA, Freitas FR, Souza DG, Maranhes EA, Bandini HHM. Aquisição de leitura e escrita como resultado do ensino de habilidades de consciência fonológica. Rev Bras Educ Espec. 2014;12(3): 423-50.
12. Brasil. Ministério da Educação. Secretaria de Educação Básica. Diretoria de Apoio à Gestão Educacional. Pacto Nacional Pela Alfabetização na Idade Certa. Brasília: MEC; 2015

Authors contributions

CISM researcher responsible for data collection and study development; BAMQ researcher responsible for analysis and interpretation of statistical data; AGCR researcher responsible for the development of the study; AAAC Supervisor, responsible for the development of research, analysis and interpretation of data.