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Original articles

Expressive vocabulary in children with cochlear implants

Vocabulário expressivo em crianças usuárias de implante coclear

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ABSTRACT

Objective: to verify whether children with cochlear implants (CI) acquire vocabulary at the same pace as normally hearing children, and which factors influence their acquisition.

Methods: the vocabulary test of the ABFW was performed on 20 children who had been using the cochlear implant for at least three years. Historical information, such as age at time of implant, hearing age (i.e., at time of implant use), and family participation in the rehabilitation process, was gathered from patients' files. Correlation statistical analysis was then performed.

Results: it was observed that children with CI may acquire vocabulary similar to that of hearing children, depending on many aspects. The age at time of implantation and hearing age did not significantly correlate to the vocabulary results. The factor that demonstrated statistical significance was family participation, which showed a positive correlation: the more the family was involved in the rehabilitation process, the better the children's results on the vocabulary test.

Conclusion: it was, thus, possible to conclude that children with CI develop their vocabulary in a similar manner as hearing children, depending on factors that transcend the child's age at time of implantation and hearing age. Family participation, in the rehabilitation process, was shown to be of critical importance in the child's vocabulary development.

Keywords: Hearing Loss; Cochlear Implants; Vocabulary

RESUMO

Objetivo: verificar a aquisição de vocabulário em crianças surdas, usuárias de implante coclear, bem como os fatores que influenciam esse desenvolvimento.

Métodos: foi aplicada a parte de vocabulário do teste de linguagem infantil ABFW em 20 crianças usuárias de implante coclear por no mínimo três anos. Além disso, foi avaliada a participação familiar no desenvolvimento dessas crianças.

Resultados: foi observado que as crianças implantadas apresentam possibilidade de alcançar o desenvolvimento normal de vocabulário, quando comparadas às crianças ouvintes, a depender de diversos fatores. O fator que apresentou influência estatisticamente significante no vocabulário foi a participação familiar, sendo que quanto maior o envolvimento da família no processo terapêutico, melhores os resultados no teste de vocabulário.

Conclusão: as crianças implantadas podem apresentar desempenho similar às crianças ouvintes no teste de vocabulário, a depender das variáveis que transcendem a idade à implantação ou mesmo o tempo de uso do implante coclear. A estimulação/ participação familiar no desenvolvimento das crianças se mostrou de extrema importância no desenvolvimento da linguagem oral.

Descritores: Perda Auditiva; Implantes Cocleares; Vocabulário

INTRODUCTION

The anatomical and physiological integrity of the auditory system is essential to language and speech acquisition and development. Hearing is the most effective and efficient modality for the acquisition and monitoring of oral language abilities.[1-3]

Oral language involves oral comprehension and expression, practiced and developed through children's significant exposures and experiences in daily life. Children who are exposed to significant oral experiences will be able to access, process, and decode the information. That is to say, they will be able to understand the verbal message being delivered, by understanding that it is possible to build concepts and make associations, to be able to express lately.[4]

Understanding and expression are formed by morphosyntactic, semantic-lexical, pragmatic, and phonological aspects. The semantic-lexical aspect refers to the acquisition of words and their meaning.[5]

The auditory channel is the natural way of learning to speak, and auditory skills are essential for oral language development and for speech production.[6]

Thus, in the case of children with severe to profound bilateral pre-lingual hearing loss, the language acquisition process is compromised, the development of oral language may follow an alternative route, and communicative performance may be lower than expected when compared to hearing children.[3,4]

The Cochlear Implant (CI) is an advanced electronic device capable of replacing the sensory organ of the hearing and represents a very important tool for people with bilateral sensorineural severe and/or profound hearing loss.[7-9] Its main contribution to the acquisition of oral language is the fact that it facilitates access to speech sounds and, thus, the development of auditory abilities.[9,10]

The development of hearing and language skills depends on several factors, including the following: the degree and duration of hearing loss; age at the time of diagnosis and intervention; the child's characteristics; cognitive style, such as the ability to construct language, psychic aspects (memory and attention), and emotional development; family characteristics, meaning the attitude and skills of parents and siblings; adequate environment, meaning the acoustic environment at home and in school; and the quality of rehabilitation and education.[11] The lower the child's age at the time of implantation, associated with a longer use of CI and a better family participation, the better the child's development of oral language will be.

Geers et al. (2009), Geers and Sedey (2011), May-Mederake (2012), and May-Mederake and Shehata-Dieler (2013) have all found that children using cochlear implants demonstrate a similar level of performance to that of their hearing peers.[12-14] Nevertheless, it is necessary to evaluate the factors that influence language development in these children, in order to better understand their intervention needs and the expected development they should seek to achieve.

The purpose of this study is therefore to verify whether or not the acquisition of vocabulary among cochlear implant children is similar to that of their hearing peers, as well as to identify the factors that influence this development.

METHODS

Participants

This project was approved by the Research Ethics Committee of Faculdade de Medicina da Universidade de São Paulo (FMUSP) under process nº 502.921 of January 2014. Participants were enrolled after signing the Informed Consent Form.

Children were selected based on the following conditions: they were aged between 4 and 8 years, had been diagnosed with pre-lingual bilateral profound sensorineural hearing loss, had received the cochlear implant before 4 years of age, and had at least 3 years of effective device use. All subjects were children with hearing parents who were in speech-language rehabilitation with an emphasis on the development of hearing and language skills. Four children were Brazilian Sign Language (LIBRAS) users, as well as oral language users.

Exclusion criteria involved the presence of multiple handicaps, partial insertion of the electrode array or children who were not participating in rehabilitation programs.

Procedures

The vocabulary test, ABFW Children's Language Test, was used to verify the children's lexical competence, by means of evaluating the expressive vocabulary by appoiting individual colored figures[15]. For each semantic category, the number of figures varies. The results were recorded in the protocol during the test.

The participation of the family in the child's development and stimulation was also evaluated through the Family Involvement Rating scale,[16] translated into Portuguese under the name Escala de Envolvimento

Familiar (in this work, the term Moeller score was used), as one of the potential variables that may influence the lexical competence of deaf children. Each family was rated a score from 1 to 5, according to their participation in the rehabilitation process: the lower the score, the more limited the family participation.[16,17]

Moeller (2000)[16] proposed the following classification, from 1 to 5:

Rating of 1 (Limited Participation)

The family faces significant sources of stress that may take precedence over the child's needs (e.g. domestic abuse, homelessness). The family has limited understanding of deafness and its consequences for the child. Their participation may be sporadic or less than effective. Parent/child communication is limited to very basic needs.

Rating of 2 (Below Average)

The family struggles to accept the child's diagnosis. The family may be inconsistent in their attendance at appointments, in maintaining the hearing aids, and in ensuring they are worn by the child outside of school. They may have some significant sources of stress that interfere with consistent carryover to the home environment. Managing the child presents daily challenges to the family. Communicative interactions with the child are basic. The family lacks fluency in terms of the child's mode of communication.

Rating of 3 (Average Participation)

The family is making efforts to understand and cope with the child's diagnosis. Family members participate in most sessions/meetings. Busy schedules or family stresses may limit opportunities for lessons learnt to be carried over. The family may find managing the child challenging. The family attends Individual Family Service Plan and Individual Education Plan meetings but may rely primarily on professional guidance. The family attempts to advocate but may be misdirected in some of their efforts. Selected family members (e.g. mother) may carry more than their share of responsibility for the child's communicative needs. Family members develop at least basic capacity in child's communication mode. Family members are willing to use language expansion techniques, but need ongoing support and direction.

Rating of 4 (Good Participation)

Family members adjust to the child's deafness better than the average family. Family members regularly attend parent meetings and sessions. Parents take an active role (though perhaps not the lead) in Individual Family Service Plans and Individual Education Plans. Family members serve as good language models for the child and make an effort to carry over techniques at home. Some family members have fairly good abilities in the child's communication mode and/or in techniques for language stimulation. Efforts are made to involve extended family members.

Rating of 5 (Ideal Participation)

The family seems to have made a good adjustment to the child's deafness. The family is able to put the child's disability in perspective within the family. Family members actively engage in sessions, attending sessions and meetings regularly and pursuing information on their own accord. They serve as effective advocates for their child with professionals/school districts, etc. Family members become highly effective conversational partners for the child and serve as strong and constant language models. Family members become fluent/effective users of the child's mode of communication, and are capable of applying language expansion techniques. Extended family members are involved and supportive.

In addition, the Geers (1994)[18] scale was applied, adapted to Portuguese by the Latin American Protocol for Cochlear Implants,[19] with the objective of evaluating and classifying speech perception among children.

The following criteria were used:

- Category 0 – Does not detect speech; This child does not detect speech in normal conversation situations (speech detection threshold> 65 dB).
- Category 1 – Detects the presence of speech signals;
- Category 2 – Perception of speech patterns. Differentiates words by supra-segmental traits (duration, tone, etc.). Ex: dog X airplane, baby X birthday cake;
- Category 3 – Beginning the identification of words. This child differentiates words in a closed set based on phonetic information. This pattern can be demonstrated with words that are identical in duration but contain multiple spectral differences. Ex: tooth brush X hot dog, airplane X lunch box;

- Category 4 – Identification of words through vowel recognition. This child differentiates between words in a closed set that differ primarily in the sound of the vowel. Ex: bird, boat, bike, bat Category 5 - differentiates words by recognizing consonants;
- Category 5 - Differentiates words by recognizing consonants. This child differentiates between words in a closed set that have the same vowel sound, but contain different consonants. Ex: hair, pear, chair, stair;
- Category 6 - Word recognition in an open set. This child is able to hear words out of context and extract enough phonemic information, and recognize the word exclusively by hearing.

The application of the ABFW vocabulary test and the scales were performed by speech therapists in the cochlear implant team at the institution where the study was carried out, which had direct contact with children and families.

The results were statistically analyzed using the Pearson correlation test adopting a significance level of $p < 0.05$.

RESULTS

Twenty children (Table 1) participated in the study, whose mean age at the time of test application was 6 years old, while their hearing age ranged from 3 to 5 years, and their age at the time of implantation ranged from 1 to 4 years.

Table 1. Demographic distribution of the studied group, ordered according to hearing age at the date of vocabulary assessment

ID	Age at surgery (years)	Chronological age in ABFW (years)	Hearing age in ABFW (years)	Average thresholds 500-4000Hz (dB)	GEERS category (speech perception)	Family (Moeller, 2000)
SBM	3	6	3	30	7	3
ABCG	4	6	3	30	6	4
BAS	4	7	3	40	6	5
EVN	4	7	3	25	3	3
MSB	1	4	3	30	6	4
KML	3	6	3	40	7	4
ACCF	1	5	3	30	6	4
WLS	2	6	4	30	7	3
VMM	2	6	4	30	5	3
ARP	3	7	4	25	4	2
HRJ	3	6	4	25	6	5
LFS	0,91	5	4	35	5	4
TPS	4	8	4	25	6	5
SOS	3	7	4	25	3	3
RVC	1	5	4	20	5	4
LHGP	3	8	5	45	4	4
JVSR	3	7	5	35	3	3
GA	1	6	5	20	7	4
RLM	1	6	5	20	7	5
MMAG	2	7	5	35	7	5
Average	2,4455	6,25	3,9	29,75	5,5	3,85
Min	0,91	4	3	20	3	2
Max	4	8	5	45	7	5

Subtitle: (Hearing age = chronological age – age at surgery).

Table 2 shows the demographic data of the studied group, based on the hearing age of each child. Using the following data, it is possible to observe that all children fell within the average auditory thresholds, at frequencies of 500 to 2000 Hz with access to speech sounds. It is also clear that there was no considerable variation in the category of auditory perception.[18]

Table 2. Average demographic data grouped by hearing age (i.E. Years of implant use)

Hearing age (years)	N	Average age at surgery (months)	Chronological age (years) Average (Min-Max)	Thresholds (dBNA) Average	Auditory Perception (Geers, 1994) Average (Min-Max)	Moeller (min-max)
3-3a11m	7	40,2	6 (4-7)	30,4	5,7 (3-7)	4 (3-5)
4-4a11m	8	30,6	6,5 (5-8)	28,1	5 (3-7)	4 (2-5)
5-5a11m	5	34	7 (6-8)	35	6 (3-7)	5 (3-5)

When children were grouped by their hearing age (Figure 1), it was possible to observe that there was no statistically significant relation (p = 0.7481) between the increase in the duration of CI use and the increase in vocabulary. Children with three years of age presented better performance than children with 4 years of use. The figures below show this distribution.

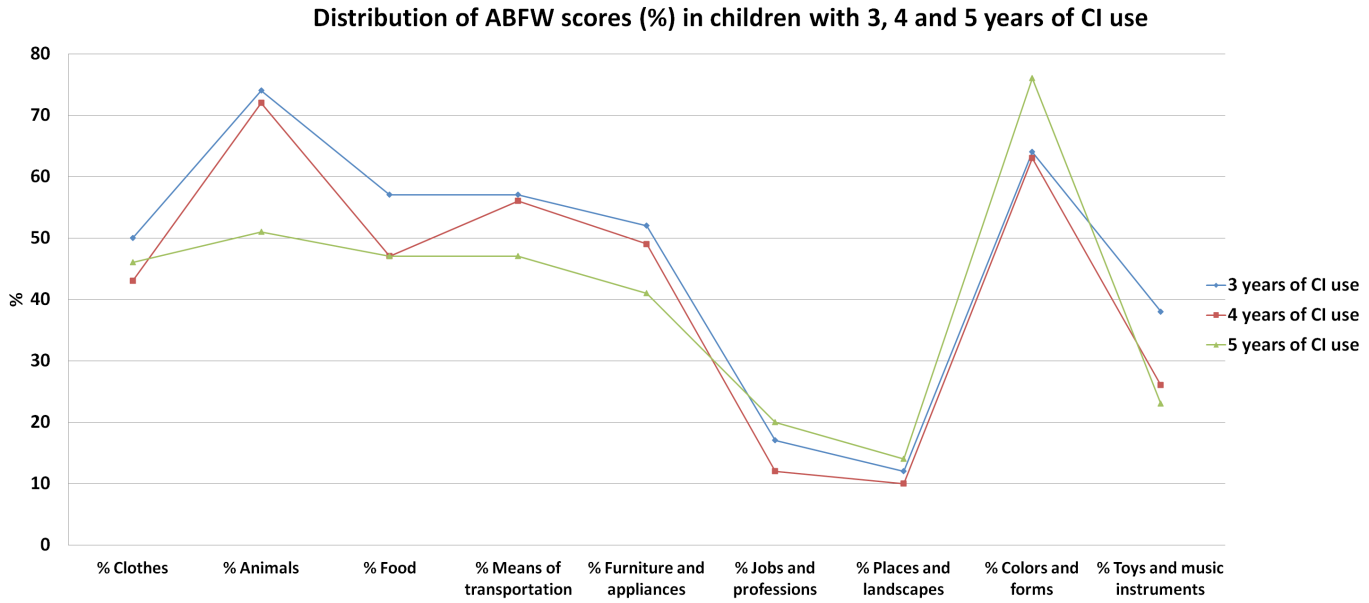

Figure 1. Mean score of ABFW scores according to semantic field among children using CI grouped by hearing age

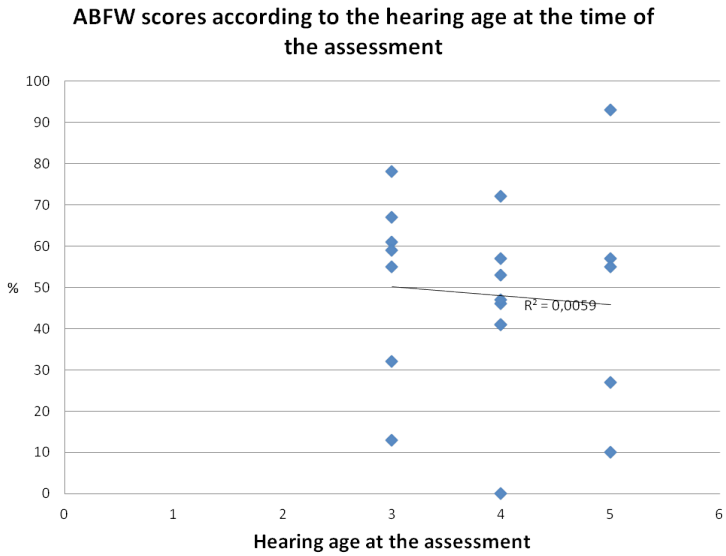

Figure 2. Distribution of total ABFW scores of children using CI grouped by hearing age

Figure 3 shows the distribution of the scores obtained in the ABFW, when the children were grouped by chronological age. Those older than 6 years of age presented the lowest scores. Chronological age did not have a statistically significant influence on the children's vocabulary (P = 0.07). There was a tendency towards significance, but with an inversely proportional relation; that is to say, test performance worsens with increasing chronological age.

Children's age at the time of surgery did not present any statistically significance, but showed a tendency to significance (p = 0.07), meaning that the higher the child's chronological age at the time of surgery, the lower the performance in the vocabulary test was.

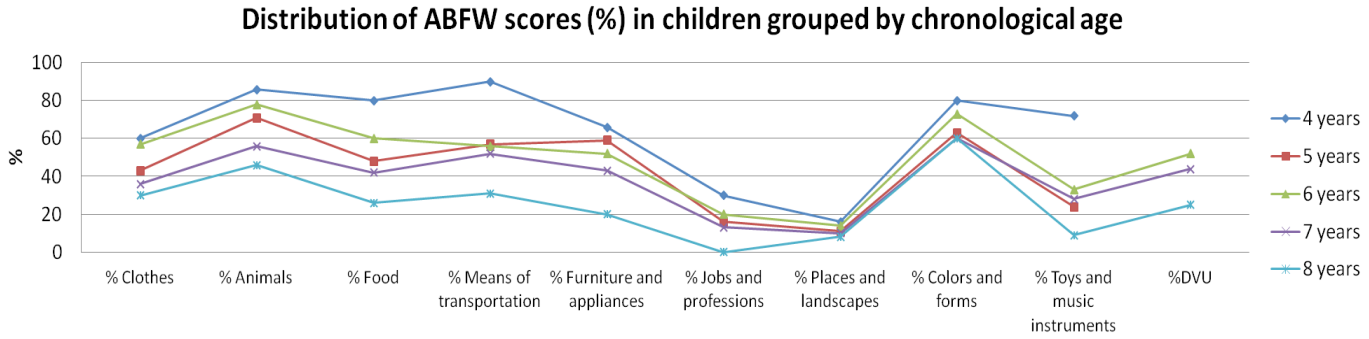

Figure 3. Average ABFW scores in each semantic category for children with CI grouped by chronological age

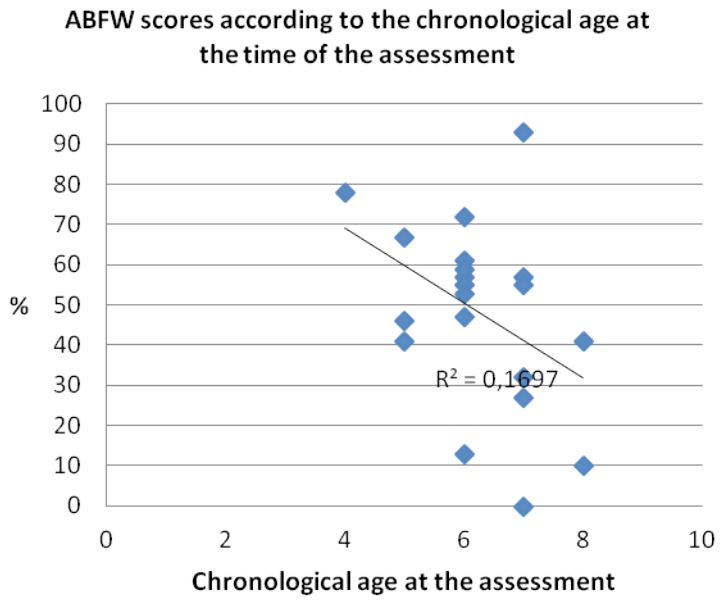

Figure 4. Graph distribution of the total ABFW score of children grouped by chronological age.

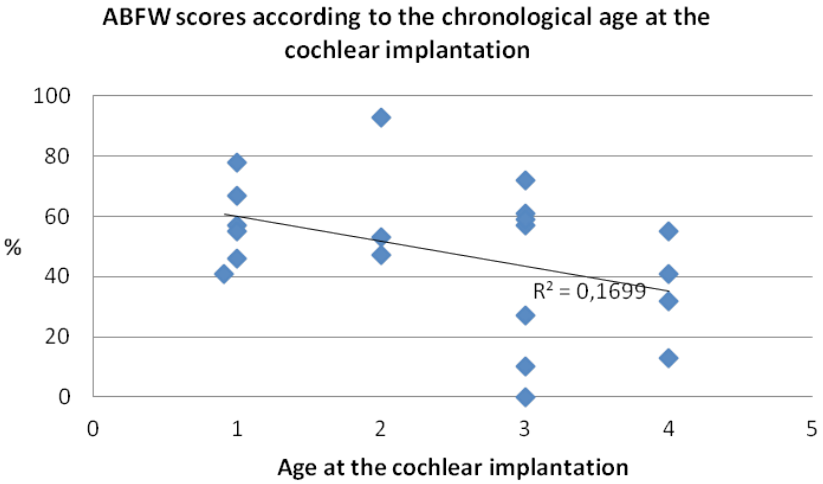

Figure 5. Distribution of the total ABFW score in children grouped by chronological age at the time of surgery

Figure 6 shows that, when compared to hearing children of the same hearing age, children having spent 3 years of cochlear implant use performed at or above the expected age, while children at 4 and 5 years of age exhibited lower than expected performance.

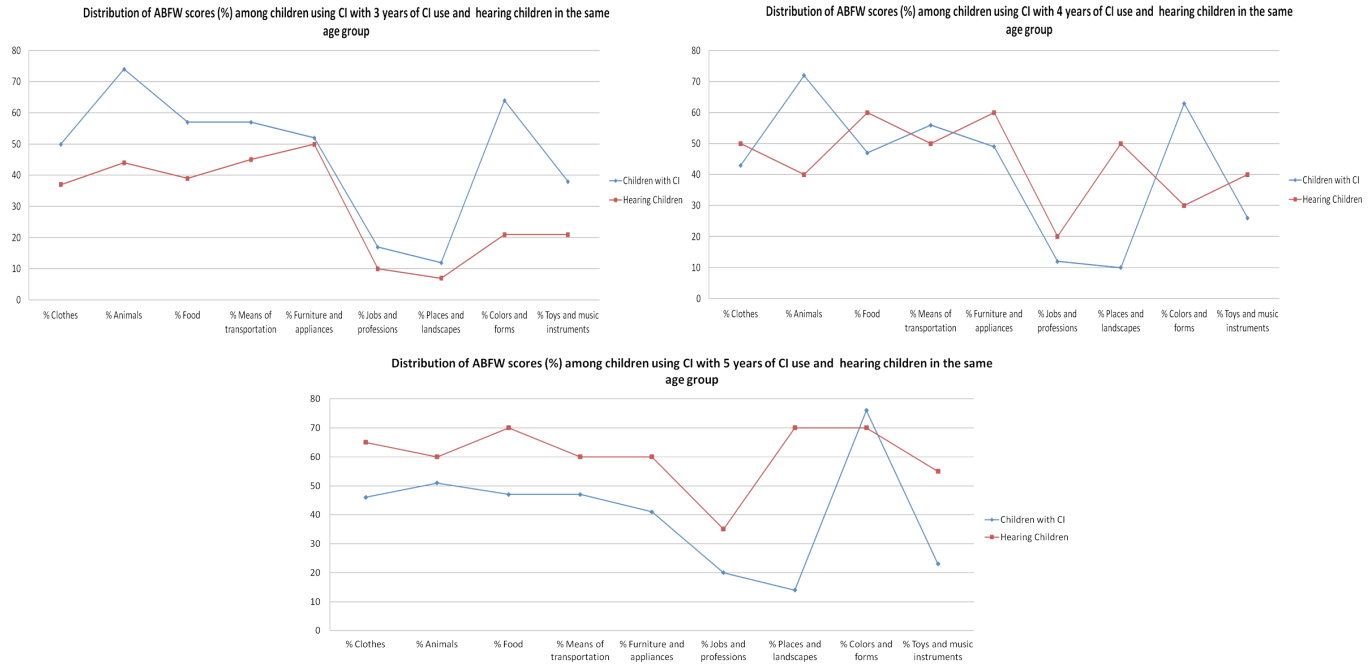

Figure 6. Mean score of the ABFW score according to semantic field among children using CI grouped by hearing age and compared according to age group in hearing children (Andrade et al., 2004)[15]

When the vocabulary of the children with CI was compared to that of hearing children of the same chronological age, only children at 4 years of age had reached the expected scores.

Dividing children according to their family involvement category,[16] it was possible to observe a statistically significant difference (P = 0.0003): the higher the family category, that is to say, the better the family's intervention and support of the families, the better the children vocabulary becomes in most semantic fields. Figures 7 and 8 show the comparison between the family categories in the ABFW score by semantic field and the distribution of the total test score in children with CI grouped by the Moeller score category respectively.

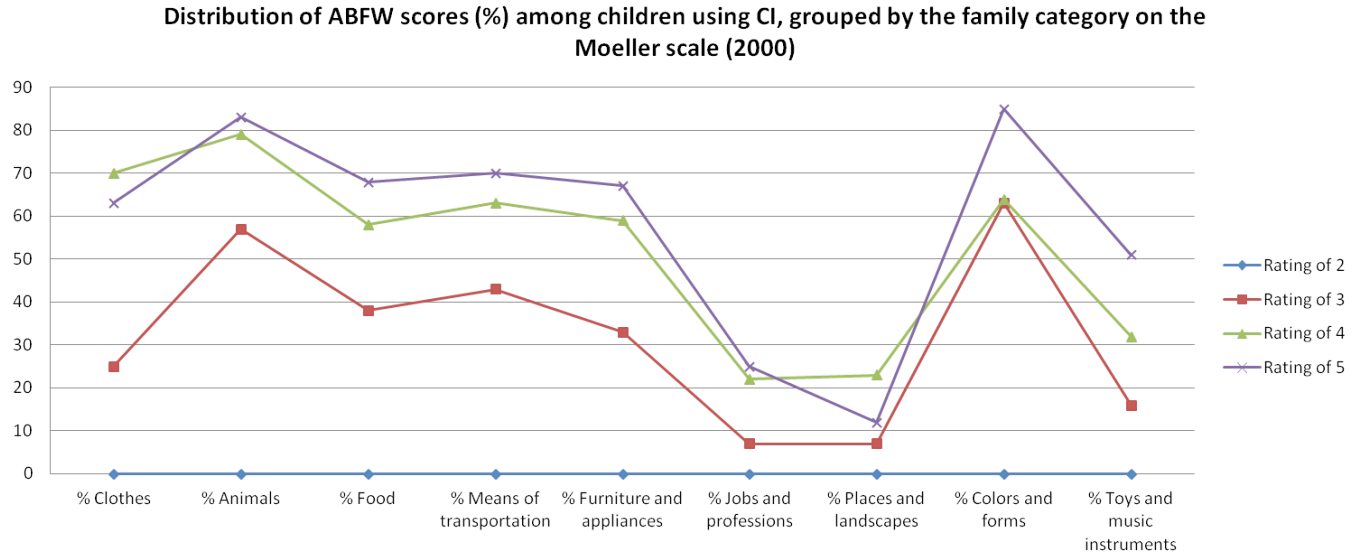

Figure 7. Mean score of the ABFW score according to semantic field among children using CI grouped by the family category on the Moeller scale (2000)[16]

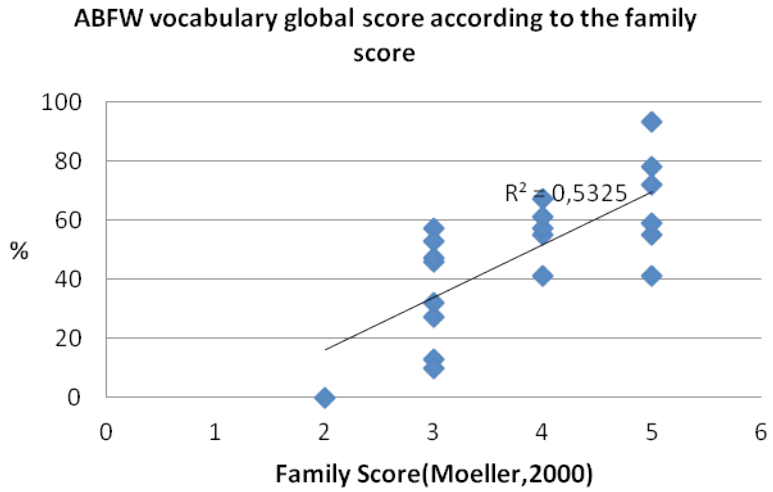

Figure 8. Distribution of the total ABFW score in children grouped by Moeller's score at the time of the assessment

DISCUSSION

In the present study, vocabulary performance was evaluated in children using CI, as well as the influence of factors such as hearing age (time of cochlear implant use), age at the time of implantation, and family participation in the oral language stimulation of their child.

Our results showed that the time of implant use—the hearing age—was not related to the increase of the vocabulary performance, since children with 3 years of device use presented better results than the children with four years of CI use (Figures 1 and 2). This result differs from the initial hypothesis, based on the literature, which theorized that the longer the use of the implant, the greater the acquired vocabulary.[20,21] This result shows that the duration a child has used a CI is not a sufficient factor in the development of vocabulary, leading us to investigate what other factors may be influential.

In children implanted at 12 months of age, Fagan (2015)[22] showed that expressive vocabulary performance was 6 months behind age-level expectations when compared with hearing children of the same chronological age. However, this number was higher than age-level expectations when compared to hearing children of the same the hearing age.

When children were grouped by chronological age, there was no correlation between chronological age and vocabulary performance. Conversely, older children had the lowest scores, while the 4-year-old child had the best performance (Figures 3 and 4). It is noteworthy that the study was not longitudinal; that is to say, children were not evaluated over time. The variability of the studied group may have influenced this result, since only one child with a chronological age of 4 was evaluated, and this child was implanted as a 1 year old and experienced a good level of family participation (score 4).

This result does not mean that, with increasing chronological age, children using CI lag behind in vocabulary; indeed, other factors influencing its development must be taken into account. In addition, children aged 4 to 6 years old were implanted earlier than older children, which could justify this result.

Although the present study did not find a correlation between the age of the child at the time of the surgery and their performance in the vocabulary test, since the children implanted at 4 years of age obtained better results than those implanted at 3 (Figures 5); indeed, several studies indicate that the earlier the implantation, the better the oral language skills.[23-26] The sample size may not have been sufficient to show differences in the results of children implanted at younger ages.

In addition, children implanted at 4 years of age had a higher average Moeller family involvement than those implanted at 3 years, that is, they had a better family participation in the rehabilitation process. Miguel and Novaes (2013)[27], also noted that better family involvement influences the consistency of device use, which is directly reflected in the acquisition of vocabulary. Yanbay et al. (2014)[28] studied 37 children, analyzing the Moeller's scale of family involvement and vocabulary, and found that more than half of the children achieved vocabulary levels comparable to their peers, while 16/37 showed lower values demonstrating

that, despite diagnosis and intervention at appropriate age, a number of children had poor development.

When children using CI were compared to hearing children of the same hearing age,[15] it was possible to observe the fact that children aged 3 and 5 presented a performance within the expected age range, while the performance among those aged 4 years was lower than expected (Figure 6). These results show that the vocabulary scores of the implanted children varies, but that they can reach the expected results for both their hearing age and chronological age. This result is in line with the literature, which has also found varied results. Some studies showed that children using CI may present oral language closer to that expected for hearing children.[12-14,20,29,30]. On the other hand, other studies have found that the oral language of the implanted children is below that which would be expected for their age.[29,31-33] Boons et al.(2013)[34] studied 70 children implanted before 5 years of age, and matched them with 70 hearing children by gender and chronological age, found that approximately 50% of children with CI reach age-appropriate levels of language.

The variability of the presented results may be related to the following factors not evaluated in this study: characteristics and the timing of speech therapy; auditory thresholds with hearing aids before implantation; interruption in the use of the CI device due to maintenance problems, among others.

The relation between the participation / stimulation of the family and the increase of the vocabulary was observed: the higher the family's participation in the child's development, the higher the child's score in the vocabulary test (Figures 7 and 8). This result is in line with several studies that have evaluated and emphasized the importance of family participation in the development of children with cochlear implants.[16,27,35-37] According to Yanbay et al. (2014) [28], family involvement explained the 33.3% of the variance in vocabulary test results.

The four children using Brazilian Sign Language (LIBRAS) included in the study, although included in an oral rehabilitation process with an emphasis on the stimulation of hearing and language skills, did not present satisfactory development and therefore needed sign language support. Analyzing the Moeller score of each of these children in isolation, it was possible to perceive that all children presented scores between 2 and 3.

Several factors that influence the development of the vocabulary in children using CI were evaluated. The fact that no statistical correlation was found between the time of CI use, children's age at the time of surgery, and their chronological age, does not mean that the development of vocabulary is not influenced by these factors. Nevertheless, family participation showed statistical significance and may justify these results.

The present study is hindered by certain limitations, such as sample size and the variability between the groups, which may have influenced the findings. Further studies are needed in which the standardized sample by age at the time of implantation and the length of use (hearing age) so that this bias does not question the influence of family participation on the development of vocabulary, evidenced in the present study.

CONCLUSION

It is therefore possible to conclude that children with CI are able to perform at a similar level to that of hearing children in vocabulary tests, depending on certain variables that transcend their age at the time of implantation or even at the time of the CI insertion. The family's support of and participation in the development of children is extremely important in the development of oral language. Although the use of cochlear implants and age at the time of implantation are also important for vocabulary development, these factors alone are not enough to influence children's performance without the adequate family participation in the therapeutic process.

REFERENCES

1. Boothroyd A. Auditory perception of speech contrasts by subjects with sensorioneural hearing loss. J Speech Hear Res. 1984;27(1):134-44.
2. Ying E. Speech/language/auditory management of infants and children with hearing loss. In: Madell J, Flexer C. Pediatric Audiology: diagnosis, technology and management. New York: Thieme; 2008. p.240-49.
3. Novaes BCAC, Mendes BCA. Terapia fonoaudiológica da criança surda. In: Fernades FDM, Mendes BCA, Navas ALPGP. (Orgs). Tratado de Fonoaudiologia. 2a.ed. São Paulo: Roca; 2009.p. 202-9.
4. Reynell JK, Gruber CP. Reynell developmental language scales. Los Angeles: Western Psychological Services; 1990.

5. Rodríguez VMA, Santana AMM. Dificultades de lenguaje en ambiente educativos – del retraso al transtorno específico de lenguaje. Barcelona: Masson; 1999.
6. Bevilaqua MC, Formigonni GMP. O desenvolvimento das habilidades auditivas. In: Bevilaqua MC, Moret ALM. Deficiência auditiva: conversando com familiares e profissionais de saúde. São José dos Campos: Pulso; 2005. p. 179-201.
7. Mesquita ST, Canôas JW, Costa QO. A. Implante coclear: quem são seus usuários. J Bras Fonoaudiol. 2002:3(13):207-73.
8. Bento RF, Brito Neto R, Castilho AM, Goffi-Gomez MV, Giorgi SB, Guedes MC. Resultados auditivos com o implante coclear multicanal em pacientes submetidos a cirurgia no Hospital das Clínicas da Faculdade de Medicina da Universidade de São Paulo. Rev Bras ORL. 2004; 70(5): 632-7.
9. Bevilacqua MC, Costa AO, Martinho- de Carvalho AC, Moret ALM. Implante Coclear. In: Fernandes FDM, Mendes BCA, Navas ALGP, editores. Tratado de Fonoaudiologia. 2ª edição (Roca). São Paulo: Roca; 2009. p.220-31.
10. Dowell RC, Cowan RSC. Evalutation of benefit: infants and children. In: Clark GM, Cowan RSC, Dowell RC. Cochlear implantation for infants and children. San Diego: Singular Publishing Group; 1997. p.205-21.
11. Bevilaqua MC, Formigonni GMP. O desenvolvimento das habilidades auditivas. In: Bevilaqua MC, Moret ALM. Deficiência auditiva: conversando com familiares e profissionais de saúde. São José dos Campos: Pulso; 2005. p. 179-201.
12. Geers AE, Moog JS, Biedenstein J, Brenner C. Spoken language escores of children using cochlear implants compared to hearing age-mates at school. J Deaf Stud Deaf Educ. 2009:14(3):371-85.
13. May-Mederake B. Early intervention and assessment of speech and language development in young children with cochlear implants. Int J Pediatr Otorhinolaryngol. 2012;76(7):939-46.
14. May-Mederake B, Shehata-Dieler W. A case study assessing the auditory and speech development of four children implanted with cochlear implants by the chronological age of 12 months. Case Rep Otolaryngol. 2013:359218. doi:10.1155/2013/359218.
15. Andrade CRF, Befi-Lopes DM, Fernandes FDM, Wertzner HF. ABFW: Teste de linguagem infantil nas áreas de fonologia, vocabulário, fluência e pragmática. 2ª ed. Barueri: Pró-Fono; 2004.
16. Moeller MP. Early intervention and language development in children who are deaf and hard of hearing. Pediatrics. 2000;106(43):1-9.
17. Figueiredo CC, Gil D. Avaliação do grau de envolvimento familiar nos atendimentos de crianças com deficiência auditiva. Audiol Commun Res. 2013;18(4):303-307.
18. Geers AE. Techniques for assessing auditory speech perception and lipreading enhancement in young deaf children. The Volta Review, 1994;96(5):85-96.
19. Protocolo Latino Americano para Implantes Cocleares. Elaborado pelo Grupo de Pesquisas Latino-americano. Cochlear Américas, 2003.
20. Schramm B, Bohnert A, Keilmann A. Auditory, speech and language development in young children with cochlear implants compared with children with normal hearing. Int J Pediatr Otorhinolaryngol. 2010;74(7):812-19.
21. Yoshinaga-Itano C, Baca RL, Sedey AL. Describing the trajectory of language development in the presence of severe to profound hearing loss: a closer look at children with cochlear implants versus hearing aids. Otol Neurotol. 2010;31(8):268-74.
22. Fagan MK. Cochlear implantation at 12 months: Limitations and benefits for vocabulary production. Cochlear Implants Int. 2015;16(1):24-31.
23. Geers AE, Nicholas JG, Moog JS. Estimating the influence of cochlear implantation on language development in children. Audiol Med. 2007:5(4):262-73.
24. Geers AE, Nicholas JG. Expected test escores for preschoolers with a cochlear implant who use spoken language. Am J Speech Lang Pathol. 2008;17(2):121-38.
25. Houston DM, Miyamoto RT. Effects of early auditory experience on word learning and speech perception in deaf children with cochlear implants: Implications for sensitive periods of language development. Otol Neurotol. 2011;31(8):1248-53.
26. Geers AE, Nicholas JG. Enduring advantages of early cochlear implantation for spoken language development. J Speech Lang Hear Res. 2013;56(2):643-55.
27. Miguel JHS, Novaes BCAC. Reabilitação auditiva na criança: adesão ao tratamento e ao uso do

aparelho de amplificação sonora individual. ACR. 2013;18(3):171-8

28. Yanbay E, Hickson L, Scarinci N, Constantinescu G, Dettman SJ. Language outcomes for children with cochlear implants enrolled in different communication programs. Cochlear Implants Int. 2014;15(3):121-35.
29. Costa MCM, Chiari BM. Verificação do desempenho de crianças deficientes auditivas oralizadas em teste de vocabulário. Pró-Fono R Atual Cient. 2006;18(2):189-96.
30. Geers AE, Sedey AL. Language and verbal reasoning skills in adolescents with 10 or more years of cochlear implant experience. Ear Hear. 2011;32(1 Suppl):39S-48S.
31. Young GA, Killen DH. Receptive and expressive language skills of children with five years of experience using a cochlear implant. Ann Otol Rhinol Laryngol. 2002:111(9):802-10.
32. Stuchi RF, Nascimento LT, Bevilacqua MC, Brito Neto RV. Linguagem oral de crianças com cinco anos de uso do implante coclear. Pró-Fono R Atual Cient. 2007;19(2):167-76.
33. Percy-Smith L, Bush G, Sandahl M, Nissen L, Josvassen JL, Lange T, Rusch E, Caye´-Thomasen P. Language understanding and vocabulary of early cochlear implanted children. Int J Pediatr Otorhinolaryngol 2013;77(2):184-8.
34. Boons T, De Raeve L, Langereis M, Peeraer L, Wouters J, van Wieringen A. Expressive vocabulary, morphology, syntax and narrative skills in profoundly deaf children after early cochlear implantation. Res Dev Disabil. 2013;34(6):2008-22.
35. Li Y, Bain L, Steinberg AG. Parental decisionmaking in considering cochlear implant technology for a deaf child. Int. J. Pediatr. Otorhinolaryngol. 2004:68(8):1027-38.
36. Quittner AL, Leibach P, Marciel MS. The impact of cochlear implants on young deaf children. Arch. Otolaryngol. Head Neck Surg. 2004;130(5):547-54.
37. Moret ALM, Bevilacqua MC, Costa OA. Implante coclear: audição e linguagem em crianças deficientes auditivas pré-linguais. Pró-Fono R Atual Cient. 2007;19(3):295-304.