Original Article

Artigo Original

Determinants of communication skills development in children with hearing impairment

Fatores determinantes no desenvolvimento de habilidades comunicativas em crianças com deficiência auditiva

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Keywords

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Hearing aids
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ABSTRACT

Purpose: To establish relationships between age at onset of individual hearing aid use, functional hearing, communication skills, family involvement and family expectations regarding language development of children diagnosed with hearing loss during the first three years of life. **Methods:** Thirty-five babies diagnosed with moderate to severe hearing loss who were receiving treatment at the Children's Hearing Center/Derdic (CeAC) were evaluated during a period of 24 months. Assessments were carried out every six months and included: VRA - Visual reinforcement audiometry (with and without amplification); IT-MAIS; MUSS; and satisfaction of family regarding child development. **Results:** Cluster analysis was performed among the subjects. Consistent use of hearing aids was the only variable that exhibited a strong relationship with hearing and language skills. Children whose parents were not satisfied exhibited severe hearing loss and limited auditory capacity even with the use of hearing aid, and, consequently, poor auditory skills and speech production. **Conclusion:** Datalogging monitoring can guide the knowledge of speech-language pathologists and audiologists and it can also be used on strategic planning. Family involvement, quality of parental participation in the intervention program as well as expectations about the future are also important aspects to consider as these can aid therapists and researchers on the assessment of deaf babies intervention effectiveness.

Descritores

Perda auditiva
Auxiliares de audição
Desenvolvimento da linguagem
Questionários
Reabilitação de deficientes auditivos

RESUMO

Objetivo: Estabelecer relações entre a idade de início de utilização de aparelhos de amplificação sonora individual (AASI); audição funcional, habilidades comunicativas, envolvimento familiar e as expectativas da família em relação ao desenvolvimento de linguagem em criança com deficiência auditiva diagnosticadas nos três primeiros anos de vida. **Métodos:** Foram avaliados 35 bebês com diagnóstico de deficiência auditiva de grau moderado a profundo, ao longo de 24 meses, em acompanhamento no Centro Audição na Criança/Derdic (CeAC). Foram realizadas avaliações semestrais incluindo: VRA – Audiometria de reforço visual (com e sem amplificação); IT-MAIS; MUSS; e satisfação da família com o desenvolvimento das crianças. **Resultados:** foi realizada análise de agrupamentos entre os sujeitos. O uso consistente do AASI foi a única variável com forte relação com habilidades auditivas e de linguagem entre os grupos. Em comum, os sujeitos com os pais não satisfeitos possuem filhos que apresentam deficiência auditiva de grau profundo e capacidade auditiva limitada mesmo com o uso do AASI, consequentemente também as habilidades auditivas e produção de fala em padrões rebaixados. **Conclusão:** O acompanhamento dos recursos de *datalogging* pode nortear o conhecimento do fonoaudiólogo servindo de estratégia. O envolvimento familiar, a qualidade da participação dos pais no programa de intervenção assim como as expectativas em relação ao futuro são aspectos importantes a serem considerados nesses achados que podem contribuir para terapeutas e pesquisadores na avaliação da efetividade de propostas de intervenção para bebês com deficiência auditiva.

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INTRODUCTION

Information and knowledge can be considered highly relevant factors in today's culture s. In this sense, listening, speaking, reading, writing and using electronic technologies should be available to hearing impaired children with the maximum use of their capabilities as they will be adults in 2030, 2040 and 2050, and the speech-language pathologist is part of the multidisciplinary team that contributes to the preparation of these children[1]. Early stimulation of the auditory pathways – and consequent stimulation of auditory brain areas – has an important influence on the organization of these pathways[2,3].

Hearing loss can be compared to an invisible filter that eliminates, distorts and undermines the sounds that arrive to the subject and, therefore, the use of electronic devices has a key role in the development of oral language, reading and academic skills. There is a great need to assess functional hearing as it establishes important distinction between communicative assessment of a child with normal hearing and a child with hearing loss. It is known that hearing corresponds to the most effective and efficient method for the acquisition and monitoring of oral language skills[4,5].

In this sense, auditory and language skills evaluation initiatives – from the perspective of service quality within the hearing health – have important implications for the design of intervention programs[6].

There are different factors that influence the prognosis of spoken language development in children with hearing disabilities, one of which is the appropriate use of sound amplification. Families need guidance on the use of sound amplification and on the scope of the child prognosis as soon as possible given the critical period of brain development and neuroplasticity[7].

The identification of babies with hearing loss still at the maternity hospital brought demands of knowledge production regarding the role of hearing during the first months of life and adaptation and use of amplification devices[8]. The selection of the device, its adjustments or settings, discomfort, validity and reliability of behavioral assessments and use of results of evoked brainstem response (ABR) at specific frequencies are some of the issues that have been discussed[9].

The adequacy of amplification at this stage is an ongoing process that unfolds from not only the auditory responses, but mainly from the analysis and interpretation of the hearing and language interface. Rituals of attributing meaning and qualification of behaviors involving the ear canal are determinants of device settings and of deployment of Speech-Language Therapy techniques. These issues are discussed in a case study of a baby with hearing loss diagnosed in his first days of life[10].

A multicenter, multifactorial study performed in the United States points to the importance of family investment for the successful development of oral language and speech-language therapy process and also to age of onset of hearing aid use and degree of hearing loss as important prognostic predictors of oral language development[11].

Fundamentals of speech and hearing therapy for the hearing impaired aiming oral language communication comprise an interdisciplinary approach related to language, hearing, psychological and social development. This approach should be discussed from the use of electronic devices that are based on knowledge of other sciences and involves theories of speech perception and production, neuronal plasticity, physical acoustics and acoustic-phonetic articulation among others[12].

The question of the relation between hearing and language has been discussed for decades. In the proposed speech and language therapy for the hearing impaired, the role of hearing on language acquisition establishes and determines the clinical method and the therapeutic techniques. In the task that aims at the acquisition of spoken language, the discussion of this relationship is one of the main clinical supports for the hearing impaired and involves a rearrangement of interactional situations in order to favor the auditory canal providing access to speech sounds. The relationship between speech perception and production and auditory response over time in the first three years of life has important implications for the design of therapeutic programs for the hearing impaired[13]. However, the role of family intervention in early life implies the involvement of a multidisciplinary team and consideration of aspects that are directly related to quality of service.

In programs of hearing loss diagnosis, the professional support provided to the child and also directly to parents and/or guardians has a direct impact on the effectiveness of hearing loss detection and early intervention. These actions provide the mitigation of the effects of hearing loss in children[14].

Multiple variables determine the oral language development of deaf children, and front to the great investment in the implementation of newborn hearing screening programs (NHS) and audiological diagnosis in the first year of life – which have generated increasing demand for intervention – it becomes necessary measuring results and prognosis of the therapeutic process in the network of hearing health in the medium and long-term.

In the Hearing Health network, particularly in the care of low-income population, other factors interact with those traditionally addressed in the literature. These factors influence the continuation or discontinuation of therapy. The facilitation of the adherence to treatment is not easy; it is a challenge that demands continuous attention. In some situations, families of patients adhere to the health service in charge of the condition, but not to the treatment itself – i.e. the families attend appointments and schedule follow-up audiological returns, however, the child does not use the amplification devices in an appropriate and recommended manner.

From this perspective, the purpose of this study was to assess the auditory and linguistic skills in children with hearing loss diagnosed before 36 months of age, and to establish relationships between the degree and age of onset of hearing loss, consistency of use of hearing aids and satisfaction of parents regarding the development of the child.

METHODS

This study was conducted at the Children's Hearing Center (CeAC) of the Division of Education and Rehabilitation of Communication Disorders (*Divisão de Educação e Reabilitação*

dos Distúrbios da Comunicação) at the Pontifícia Universidade Católica de São Paulo (DERDIC/PUC-SP), Graduate Program in Speech-Language Pathology and Audiology/Childhood Hearing Research, and School of Speech-Language Pathology and Audiology. This consists in a high complexity service, accredited by the National Health System, which provides care for children with suspected hearing impairment or hearing impaired children who are under three years of age. The service offers: audiological diagnosis, selection and appointment of hearing aids, speech and language therapy, monitoring and family guidance and also functions as clinic and laboratory of the CNPq Research Group - Hearing in Children.

The current research followed the precepts of code for ethics with human research and was approved by the ethics committee of PUC-SP under Research Protocol number 033/2010.

The study included 35 children with bilateral moderate to profound sensorineural hearing loss, with no neurological cognitive or motor impairment who had undergone selection and fitting of hearing aids and attended for follow-up visit during the data collection period. Data were obtained through records regarding the date of the last follow-up session. Selection criteria included: bilateral tympanometry curves type A on the date of hearing assessments and parents and/or guardians with normal hearing.

The descriptive statistics of the sample group regarding age, chronological age (months), age at diagnosis (months), hearing age - time of hearing aid use (months), age at onset of hearing aids use (months), and average audiometric thresholds at 500 Hz, 1, 2 and 4 kHz in the better ear are shown in Table 1. Regarding gender, the sample was comprised by 66% of girls.

Systematic speech and language therapy and preferred mode of communication at the time of the evaluations were also considered. However, given the variability regarding therapy and choice of sign language, these variables were not included in the quantitative analysis. All children were receiving oral therapy and had been adapted to hearing aids soon after diagnosis.

The following instrument was used to perform the evaluation of auditory abilities: IT-MAIS (Infant-Toddler Meaningful Auditory Integration scale)[15] adapted to Brazilian Portuguese(16). For assessment of language skills, the MUSS (Meaningful Use of Speech Scales) was applied. This instrument is based on the original MUSS[17] and it was adapted and validated to Brazilian Portuguese[18].

As an indicator of consistency in the use of hearing aids, the record of datalogging (technology available on hearing aids that records usage during the interval between sessions) was used. In case the device had no datalogging, data regarding the condition of hearing aids and molds was obtained in the interview. Structured interview involving satisfaction and expectations regarding treatment and language development of the child was used for the satisfaction analysis[19].

Aiming to form homogeneous groups of individuals regarding IT-MAIS and MUSS simultaneously, cluster analysis was performed given the relationship between the two instruments[20]. The clustering method applied was the average of the distances; the Euclidean distance was considered.

The averages of the variables: age at diagnosis, mean threshold, age at onset of hearing aids use, hearing age, chronological age and average daily use of hearing aids were compared with the application of analysis of variance (ANOVA)[21]. When necessary, Tukey's method was applied to locate differences between means. The likelihood ratio test was applied to compare satisfaction regarding hearing and language[22]. Differences were considered when p was smaller than 0.05.

RESULTS

The results were organized in order to allow the analysis of how the studied variables explained the results obtained in tests that evaluated hearing and language skills, namely IT-MAIS and MUSS. The results obtained in interviews regarding family satisfaction with hearing and language development were analyzed according to groups.

The dendrogram obtained from the cluster analysis considering the variables IT-MAIS and MUSS suggested the composition of four groups (Figure 1). The numbers shown on the horizontal axis of the graph identify the individuals in each group. The numbering follows the order in which individuals are listed on the data sheet.

Descriptive statistics for IT-MAIS and MUSS were calculated with the aim of characterizing the groups (Table 2). It is noted that group one consists of children with higher percentages in both tests, whereas group four consists of individuals with lower percentages. Groups two and three correspond to average scores on the IT-MAIS and slightly lower scores on the MUSS and not as high on the IT-MAIS and average MUSS scores, respectively. Grouping allowed the identification of variables that are determinant in auditory and language skills.

The results of this analysis suggest that children in group one stand out from the others regarding the results of the tests because they showed the highest mean values. The relative

Table 1. Characteristics of the subjects in relation to age at onset of hearing aids use, hearing age, chronological age, and average hearing thresholds at 0.5, 1, 2 and 4 kHz in the better ear (n=35)

Variables	Mean	SD	Minimum	Median	Maximum
Age at onset of hearing aid use (months)	20.2	11.5	3.4	22.0	42.7
Hearing age (months)	27.9	18.3	0.9	25.0	63.9
Chronological age at assessment (months)	48.3	21.0	8.2	48.2	86.2
Average hearing threshold in the better ear	78.1	20.1	39.1	82.5	120

Note: SD = standard deviation

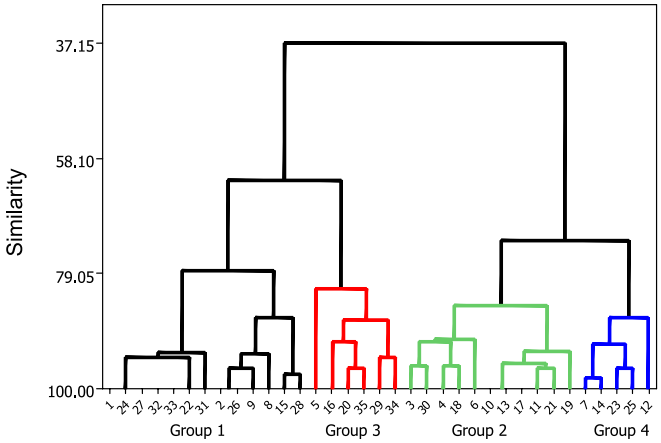
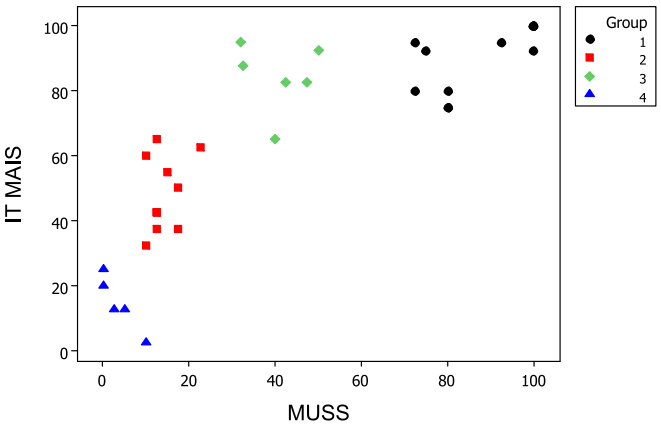


Figure 1. Dendrogram obtained based on the variables IT-MAIS and MUSS

Table 2. Descriptive statistics for IT-MAIS and MUSS according to group

	Group	n	Mean	SD	Minimum	Median	Maximum
IT-MAIS	1	13	91.2	10.0	75	95.0	100
	2	11	48.0	11.2	32.5	42.5	65
	3	6	84.2	10.7	65	85.0	95
	4	5	14.5	8.6	2.5	12.5	25
	Total	35	65.4	29.9	2.5	75.0	100
MUSS	1	13	88.7	12.0	72.5	92.5	100
	2	11	14.1	3.8	10	12.5	22.5
	3	6	40.8	7.5	32	41.3	50
	4	5	3.5	4.2	0	2.5	10
	Total	35	44.8	36.9	0	32.5	100

Note: SD = standard deviation



Note: ⊕ = mean

Figure 2. Scatter plot of IT-MAIS and MUSS scores

performance of the four groups can be observed in the scatter plot (Figure 2).

The variables involved in the analysis were: Mean thresholds in the better ear (degree of hearing loss), age at onset of use of hearing aids (it was opted not to consider age at diagnosis separately since the range for selection and fitting of hearing aids never exceeded two months after the diagnosis), hearing age (time in months of amplification use), average daily use of hearing aids, chronological age at assessment and parental satisfaction regarding listening and language skills.

Average thresholds in the better ear – Degree of loss according to group

The average degree of hearing loss was not the same in all four groups (p=0.027) (Figure 3). In further analysis, means were compared in pairs using the Tukey method in order to locate the differences. It was found that the average in group one was smaller than in group two (p=0.028), and that there were no differences between the means in groups one and three (p=0.773), one and four (p=0.143), two and three (p=0.472) and two and four (p=0.999).

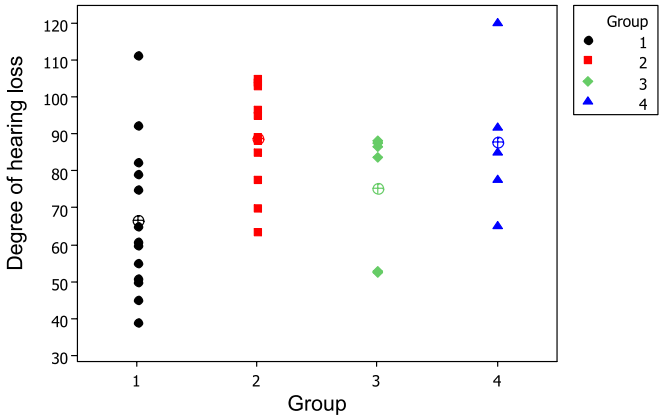


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Figure 3. Graph of individual and mean values for degree of loss according to group

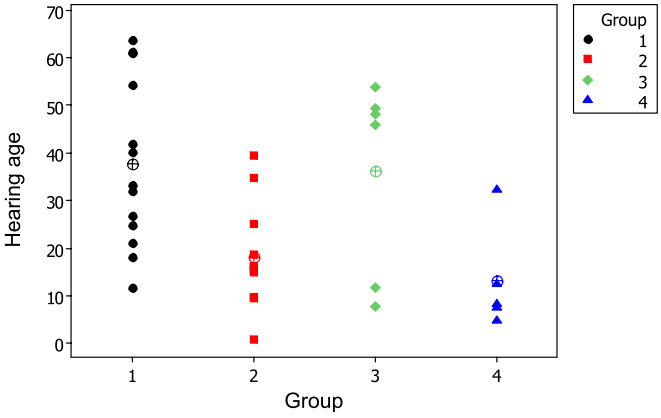
Age of onset of hearing aids use, hearing age and chronological age

There was no difference between the mean age of onset of hearing aids use among the four groups (p=0.300) probably due to large variability in each group (Table 3). However, the mean hearing age in the four groups are not equal (p=0.005) despite the variability of groups (Figure 4). The average in group one was higher than in group two (p=0.023) and higher than in group four (p=0.026). There were no differences between the means in groups one and three (p=0.997), two and three (p=0.130), two and four (p=0.931) and three and four (p=0.092).

Table 3. Descriptive statistics for age of onset hearing aid use according to group

Group	n	Mean	SD	Minimum	Median	Maximum
1	13	18.0	12.5	4.2	11.6	42.7
2	11	23.8	11.4	3.4	26.8	36.2
3	6	23.8	10.0	8.1	26.1	36.3
4	5	13.7	9.3	3.4	16.7	22.1
Total	35	20.2	11.5	3.4	22.0	42.7

Note: SD = standard deviation



Note: ⊕ = mean

Figure 4. Graph of individual and mean values for hearing age according to group

The mean chronological age of the four groups were not all equal (p=0.014). The average in group one was higher than in group four (p=0.033). There were also no significant differences between the means in groups one and two (p=0.287), one and three (p=0.953), two and three (p=0.220), two and four (p=0.476). The average in group three was higher than in group four (p=0.029).

Average daily use of hearing aids

There was no difference among the four groups regarding the means of average daily use of hearing aids (p=0.082). However, the p value is less than 0.10 and a larger sample size might lead to the rejection of the hypothesis of equality due to the heterogeneity characteristic of the studied population. The systematic use of hearing aids was the only variable with a strong relationship with auditory and language skills. Degree of hearing loss and age of onset of hearing aid use did not explain the development of children in the study. The individual and mean values for average daily use of hearing aids according to group are shown in Figure 5.

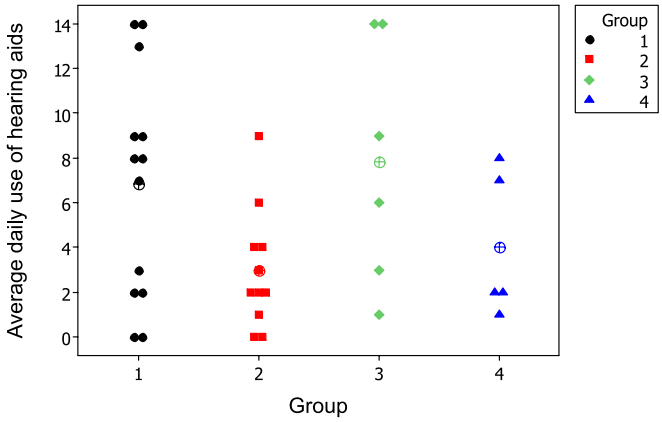
Family satisfaction regarding the development of auditory and language skills

There were no differences between the percentage distributions of satisfaction with hearing in groups one and three (p=0.566) and two and four (p=0.889) (Table 4). The distribution in groups one and three was different than that in groups two and four. It can be said that the percentage of satisfaction in groups one and three was higher than in the groups two and four.

The percentage of satisfaction with language observed in group four is smaller than in the other groups (Table 5). However, there was no evidence to reject the hypothesis of equal percentages of satisfaction in all four groups (p=0.136).

DISCUSSION

This study contributes to the establishment of processes and procedures that are more effective in the Hearing Health Network, allowing its improvement. Considering the heterogeneity among children with hearing loss, a multiplicity of factors and their interactions contribute to the selection of different intervention options. This selection can be made in partnership with parents throughout the early stages of the therapeutic process. Among the variables studied, degree of hearing loss and hearing age were the ones that showed significant differences among the groups despite their heterogeneity. Regarding the degree of hearing loss, the trend observed in this study with regard to the decrease of test scores suggests a tendency of individuals with severe hearing loss of presenting listening skills and oral language development below the expected.



Note: ⊕ = mean

Figure 5. Graph of individual and mean values for average daily use of hearing aids according to group

Table 4. Distributions of frequencies and percentages of satisfaction with hearing skills according to group

Group	Satisfaction with hearing skills		Total n (%)
	Yes n (%)	No n (%)	
1	12 (92.3)	1 (7.7)	13 (100.0)
2	4 (36.4)	7 (63.6)	11 (100.0)
3	5 (83.3)	1 (16.7)	6 (100.0)
4	2 (40.0)	3 (60.0)	5 (100.0)
Total	23 (65.7)	12 (34.3)	35 (100.0)

Table 5. Distributions of frequencies and percentages of satisfaction with language according to group

Group	Satisfaction with language skills		Total n (%)
	Yes n (%)	No n (%)	
1	12 (92.3)	1 (7.7)	13 (100.0)
2	8 (72.7)	3 (27.3)	11 (100.0)
3	5 (83.3)	1 (16.7)	6 (100.0)
4	2 (40.0)	3 (60.0)	5 (100.0)
Total	27 (77.1)	8 (22.9)	35 (100.0)

Only group one differed from group two regarding the average auditory thresholds.

Regarding hearing age, group one - the one with better listening and language skills – exhibited differences when compared to groups two and four[23,24]. Consistent use of hearing aids also proved to be a determining factor in the auditory and language skills as the difference between groups one, two, three and four was $p<0.10$ which seems to demonstrate that, in a larger population, this would possibly be a determining factor in prognosis of child development.

According to some studies[25-27] there are different factors that influence the prognosis of oral language development of children with hearing impairment[28], one of which is the appropriate use of sound amplification. Therefore, families need guidance as soon as possible on the use of hearing aids and on the possibilities of development of the child given the critical period for the development of brain neuroplasticity.

Monitoring the datalogging resource ensures the use of amplification by the child – i.e., consistency of the use of hearing aid - and can guide the knowledge of the Speech-Language Pathologist and Audiologist about the understanding of the family and their compliance with treatment. It also aids possible necessary orientations as both parents and children require help given the variety of factors that influence the continuity or discontinuity in the use of hearing aids[28].

Although there was a trend for parents being most satisfied in groups of children who had better auditory and language abilities, the differences were not significant. This fact indicates that the low expectations regarding the development of children make parents not question their progress.

Given the low expectations of most low-income families in the development of their children[29], it becomes essential to establish periodic assessments and support and awareness groups regarding the possibilities of the child. Family involvement, quality of parent participation in the intervention program as well as expectations for the future are also important aspects to be considered. These findings may contribute to therapists and researchers in assessing the effectiveness of proposed intervention for hearing impaired infants using instruments and protocols of longitudinal follow-up in an oral speech and language therapy approach[14,23,28].

Studies[11,30] indicate the importance of family participation for the successful development of oral language and therapy work. Age of onset of hearing aid use and degree of hearing loss are also important prognostic and predictive parameters of oral language development.

In the current study, the majority of respondents considered the use of hearing aids a major factor related to satisfaction with the development of hearing and language. This was also observed in a different study[19]. It was also found that the lower the hearing ages, the more satisfied parents were with both the development of auditory and language skills of children with hearing loss, probably reflecting initial progress as soon as the hearing aid was fitted. Satisfaction with auditory development was higher in groups one and three compared to groups two and four - groups with children with poorer degree of hearing loss. The satisfaction with the development of language does not follow the same trend. In groups one, two and three parents were mostly satisfied, regardless of the results of the language scale. Family satisfaction with the development of the child was not related to the results on the scales of auditory and language skills.

CONCLUSION

Although the four groups were in similar age ranges, differences in hearing aid use, degree of hearing loss and chronological age and consistency in the use of hearing aids influenced the results. The satisfaction of parents with child development needs to be further studied regarding its relationship with the variables traditionally related to the performance of the child as family attitudes are decisive for the outcome and adherence to the intervention process. It is suggested that further studies are carried out with more homogeneous groups and with instruments with higher sensitivity for evaluating differences in auditory abilities. In the current study, the instrument used might have been a factor that made groups one and three quite heterogeneous, making the analysis more difficult.

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