Original Article

Speech Perception in Children Under Noisy Situations

Percepção da Fala em Crianças em Situação de Ruído

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SUMMARY

Introduction: The ability to understand speech is impaired by many factors during evaluations, especially under noise, and it is still more complex for children under these conditions.

Objective: To analyze the speech perception in children with a normal hearing in different noise situations.

Method: Way of study transverse section. The Brazilian Hearing in Noise Test (HINT) was performed in 21 children aged between 7 and 14 with a standard hearing and no cognitive alterations. The sentence lists were randomly used in these situations: silence (S), frontal noise (FN); right-side noise (RN); left-side noise (LN); noise at 180º. (RT) and a comparison between the result of the compound noise (CN) and the diffuse noise in four sound areas at 45º; 135º; 225º e 315º (4 BXS).

Results: The statistical analysis showed a significant difference among the following situations: RN with FN; BN with FN; and it was worse with 4 BXS, where a difference for RN, BN, CN, LN and FN was found. To analyze a correlation with age, it was significant regarding the age, as a result of HINT values only for the frontal noise.

Conclusion: The significant differences in the results of speech perception among the different hearing conditions in the evaluated individuals suggest carefulness when choosing the stimulus in evaluations of speech perception in the noise in hearing-impaired children. Accordingly, researches in this field are necessary to determine the standards and variations related to its application and result interpretation.

Keywords: audiology, noise, speech perception, speech discrimination test.

RESUMO

Introdução: A habilidade em compreender a fala é afetada por muitos fatores durante as avaliações, principalmente no ruído, sendo ainda mais complexa para crianças nessas condições.

Objetivo: Analisar a percepção da fala em crianças com audição normal em diferentes situações de ruído.

Método: Forma de estudo corte transversal. Foi utilizado o Brazilian Hearing in Noise Test (HINT) em 21 crianças de sete a 14 anos com audição dentro dos padrões de normalidade, e sem alterações cognitivas. Foram aplicadas, aleatoriamente, as listas de sentenças nas seguintes situações: silêncio (S); ruído de frente (RF); ruído à direita (RD); ruído à esquerda (RE); ruído a 180º. (RT) e comparado o resultado de ruído composto (RC) com ruído difuso a partir de quatro campos de som em 45º; 135º; 225º e 315º (4CXS).

Resultados: A análise estatística revelou diferença significativa entre as seguintes situações: RD com RF; RT com RF; sendo pior com 4CXS, onde foi encontrada diferença para RD, RT, RC, RE e RF. Para a análise de correlação com a idade, houve significância entre a idade em função dos valores HINT apenas para o ruído à frente.

Conclusão: As diferenças significativas nos resultados de percepção da fala entre as diferentes condições de escuta no ruído na população estudada sugerem cautela na escolha do estímulo em avaliações de percepção da fala no ruído em crianças deficientes auditivas. Assim, pesquisas nessa linha são necessárias para estabelecer os parâmetros e variáveis relacionadas à sua aplicação e a interpretação dos resultados.

Palavras-chave: audiologia, ruído, percepção da fala, testes de discriminação da fala.

Introduction

Understanding speech allows men to communicate with others effectively, which is essential for their social integration. This way, the ability to understand speech must be considered the most important aspect to be measured in human hearing function, since it enables the receptive communication function to be evaluated, by providing data about the individual acts in daily hearing situations by way of easily quantifiable objective information (1).

Several clinical tests were prepared to evaluate the speech perception in small children, due to the need to study the hearing abilities that the child develops when using the individual sound amplification apparatuses (ISAA) or cochlear implant (CI) (2, 3, 4). These procedures also allow the hearing habilitation or rehabilitation program to be evaluated. However, only a few of these tests are available in Portuguese.

Several factors negatively contribute to the ability to understand speech at the time of evaluations, such as the listener's characteristics, including experience in language and hearing, the type and level of material presentation and its response (4, 6). This way, the importance to perform these tests with noise is emphasized, since the results of evaluations in patients with the same abilities of speech perception in silence can appear to be completely different under noise situations (2).

It is known that currently the individuals are exposed to noise in a number of daily activities, and researches show that the same individuals with normal hearing have their speech perception impaired by the environment noises (5, 6). It is common to find complaints about the hearing loss people's difficulty in listening and understanding under noise (7). To evaluate and diagnose how impaired an individual's hearing is, several tests are used in clinical practice; but these tests are not able to detect how the patient's functional ability is with regard to perceiving and understanding speech in noise environments, since they are performed in silence, evaluating children's hearing ability under these conditions is still more complex.

Based on these considerations, this study has the objective to analyze the speech perception in children with a normal hearing in different hearing situations under noise.

Method

The work was developed after it was approved by the Research Ethics Committee (Process no. 136/2007). The parents, after clarification was made about the research's objectives and procedures, signed a term of agreement, certifying their permission for their child to participate in this work and for the obtained data to be published. The participants had their anonymity and their right to waive their agreement at any time guaranteed. The study involved a non-invasive procedure, and it was regarded as having a minimum risk to the participants' health.

21 children and teenagers aged between 7 and 14 with a standard hearing and no cognitive alterations participated in this study. For casuistics purposes, random contact was made with the employees and professionals at the Phonoaudiology Clinics of the Dentistry School of Bauru (FOB-USP), with a view to inviting their children in the age group of 7-14 years to take part in this study. As inclusion criteria, the children could have no school and/or behavioral complaints, no attention history or difficulty, understanding problems, as well as no hearing complaints and/or alterations.

To annul any presence of audiologic alteration and middle ear alterations in the evaluated situation, a visual inspection of the external auditory canal and auditory screening were previously performed by the otorhinolaryngologist doctor.

The following equipment was used to develop the study: HINTPro 7.2 Audiometric System (Bio-logic Systems Corp) (8); 5 open-field boxes; CD-recording computer; printer; room with an acoustic treatment.

To evaluate speech perception, the procedure taken was the application of the Hearing in Noise Test (HINT), Brazilian version (9), in an open field. HINT is a customizable test, in which the individual is requested to recognize and repeat simple sentences in silence and in noise (7). It is comprised of 12 sentence lists with 20 sentences each, in a total of 240 available sentences. The presentation intensity varies until the Sentence Recognition Threshold (SRT/HINT) is reached, what is obtained when 50% of the sentences are correctly repeated under the following situations:

a) 20 sentences derived from a frontally positioned box (0o.) in silence (S);
b) 20 sentences derived from a frontally positioned box (0o.) with a noise at a fixed intensity of 65 dBNA and frontally presented: 0o.(RF);
c) 20 sentences derived from a frontally positioned box (0o.) with a noise at a fixed intensity of 65 dBNA and presented to the right: 90o.(RN);
d) 20 sentences derived from a frontally positioned box (0o.) with a noise to the left; 90o.(LN);

e) Compound Noise (CN): Calculated by HINTPro software by way of an estimated average of the four previous conditions: CN = (2*FN+RN+ LN)/4.
f) 20 sentences derived from a frontally positioned box (0°.) presented in four open-field boxes at 45°, 135°, 225° and 315° (4 boxes). The noise is fixed at 65 dBNA on dial.
g) 20 sentences derived from a frontally positioned box (0°.) with a noise at a fixed intensity of 65 dBNA and presented behind: 180 (BN).

It is important to emphasize that the application sequence of speech stimuli and the lists used in the different situations randomly occurred, in order to annul variations regarding participants' tiredness, attention and learning phenomenon.

Based on the calculations of the sample size, for an estimated standard deviation of 1.7 and by adopting α = 0.05 and a test power of 80%, the size sample (n) 21 is enough to prove a 1.7 difference among the evaluated conditions.

Statistical analysis

To compare the 7 conditions, Variation Analysis was used as a criterion for repeated measurements and Tukey Test was used for multiple comparisons.

To verify the correlation between age and HINT values, Pearson's Correlation Coefficient was used.

In all the statistical procedures, a significance level of 5% ($p<0,05$) was adopted.

Results

The results of the Hearing in Noise Test (HINT) results, Brazilian version, in 21 children aged between 7-14 (average = 10.4 years old, pd = 2.4 years) with a standard hearing and no cognitive alterations, are individually presented at Table 1.

The statistical analysis showed a significant difference ($p<0,05$) among the following situations: The worst situation was with 4 boxes with a difference for all other conditions, and FN was worse than RN and BN. Among the other conditions, there was no statistically significant difference.

The analysis of correlation between age and HINT values showed a statistical significance only when noise was frontal (FN) ($r = -0,62$; $p= 0,003$).

Table 1. Distribution of SRT/HINT values to the open-field sample.

Situation	Average	PD	Minimum	Maximum
S	11,9a	4,4	6,0	22,1
RN	-6,5b	1,7	-8,9	-2,5
BN	-6,2b	2,3	-12,6	-2,0
CN	-5,9bc	1,2	-7,6	-2,6
LN	-5,8bc	1,8	-9,6	-1,7
FN	-4,6c	1,5	-8,0	-2,6
4 BXS	1,4c	1,5	-1,9	-4,0

Legend: S = Silence; RN = Right-side Noise; LN = Left-side Noise, CN = Compound Noise; FN = Frontal Noise; BN = Back Noise; 4 bxs = 4 boxes. Situations with the same superscript letter does not show a statistically significant difference between each other ($p>0,05$).

Discussion

According to Table 1, the average values of the Sentence Recognition Threshold (SRT/HINT) under noise varied between -6.5 and 1.4 n the different hearing situations, and in different researchers with adults and the elderly with a standard hearing, values ranging between -8,0 and -3,5 (10); -12,2 and 4,6 (11); -8,14 (12) were found. The literature indicates that speech recognition in normally hearing children is mostly affected by adverse conditions such as under noise and/or in reverberant environment in comparison with adults and this worse performance in children to perceive speech under noise is expected until the age of ten or twelve (13-21). The studies did not use a diffuse noise, such as the four open-field boxes used in this work.

There was a significant difference between the compound noise and the diffuse noise at four sound fields at 45°; 135°; 225° and 315°, with better answers for the compound noise (Table 1) and the significant difference between RN and FN; BN with FN; and it was worse with 4 BOXES, where it was found a difference for RN, BN, CN, LN and FN, corroborating with studies that demonstrate that when the speech intelligibility is evaluated under noise in separate room conditions binaurally (speech and noise located in differently angulated sources), the intelligibility threshold can vary at a maximum of 10 dB in standard hearing individuals. The worst threshold occurs when the speech and noise are in the same position, justifying the worse results found for FN (Table 1) and the only correlation with age as a result of HINT values was observed only for this situation, in which speech and noise were at 0°. The best responses that were expected are under separate noise and speech conditions at 90°, with speech at 0° in front of the evaluated individual and the noise at 90° to the

individual's right or left, what was also found in this work (Table 1) (10 – 14).

Regarding the audiometric profile, there was no significant difference between RN and LN (Table 1). In a Brazilian study of populational base to characterize children's hearing, it could be observed that in children above the 4 years of age, thresholds showed a small variation between their own frequencies and evaluated ears and the three-tone average of the RE was 13.95 dB and LE was 14.79, and it was as regulated by the World Health Organization for children's reference (22).

GUBT was developed in 14 different languages, where, in all the languages, there is a creation of sentence lists balanced regarding phonetics and difficulty, an estimation of the performance-intensity function, development of rules and reliability. Taking into consideration that, currently most of the available tests to evaluate speech perception in hearing loss individuals were standardized in a language other than Brazilian Portuguese, HINT development in Brazilian Portuguese is an evolution in the evaluation of speech perception, providing parameters of both clinical and research analysis (9).

Although the Brazilian version HINT does not have an available test version for children, like in other languages (*Hearing in Noise Test for Children* /HINT-C) (23, 24), many studies use HINT with this population (6, 25-27), since the speech material developed for the test attempts to methodologically control the variations that can influence the speech intelligibility for children and adults (11).

It is important to emphasize that the ligature using HINT and its analyzed results is restricted, as indicated by HINTPro user manual, and several studies use a higher and higher number of acoustic boxes and describe the results in percentage in procedures related to fixed S/R (28) and others record the sentences or use them vocally. This way, some researches with HINT give children a smaller number of sentences per list, just like HINT-C does, i.e.,. ten sentences per list instead of twenty.

Because of the variations found in open-field speech tests (speech size, acoustic conditions, existence or absence of a reflecting surface, reverberation level, calibration, the number of people inside the test environment, among others) (11, 12), and the small sample studied in the present work, just like in other researches, suggest that each audiologist determines his/her own parameters, taking into consideration the situation in which the patients' evolution will be performed (12) and, considering that the speech recognition ratio in silence does not reflect the speech recognition rate in a competitive environment (29), for, although the speech perception tests began in the late 1960's with authors (30) defending that these measurements should be a part of the audiological routine, at present, almost 40 years later, it is clear that less than half of the professionals use any kind of noise evaluation at the routine of ISAA indication/adaptation (31).

Conclusion

The significant differences in the results of speech perception among the different hearing conditions in the evaluated individuals suggest carefulness when choosing the stimulus in evaluations of speech perception in the noise in hearing-impaired children. Accordingly, researches in this field are necessary to determine the standards and variations related to its application and result interpretation.

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