SPEECH RECOGNITION IN STUDENTS FROM SEVEN TO TEN YEARS OLD FROM TWO DIFFERENT SOCIOECONOMIC-CULTURAL LEVELS

Reconhecimento de fala em escolares de 7 a 10 anos de dois distintos níveis socioeconômico-culturais

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ABSTRACT

Purpose: to research and compare the speech recognition of 7 to 10 years-old normal-hearing scholars from different socioeconomic-cultural levels, through a test that uses sentences as stimulus (silence and competitive noise). **Method:** 51 children, from seven to ten years and 11 months, divided into two groups according to the socioeconomic-cultural level participated of the study. Thus, the Group 1 (G1) – middle high level – was comprised of 23 children and the Group 2 (G2) – middle lower level – of 28 children. Realized procedures: anamnesis; meatoscopy; to obtain hearing thresholds, measures of acoustic impedance and Recognition Sentence in the Silence Thresholds (RSST) and in the Noise (RSNT), expressed by the signal/noise ratio (S/N). These Recognition Sentence Thresholds were obtained using the Portuguese Sentence Lists test (PSL). The data were statistically analyzed. **Results:** there was no statistically significant difference between right and left ears for the analyzed variables in both groups. The average for the RSST for the G1 was 9.3 dB HL and for the G2, 10.7 dB HL. The S/N average in the G1 was -5.9 dB HL and in the G2, -1.7 dB HL. Statistical analysis showed significant difference between groups only for the S/N. **Conclusions:** when the auditory processing is more required, the middle lower level children demonstrated reduced performance, comparing to the upper middle level children.

KEYWORDS: Hearing; Speech Perception; Socioeconomic Factors; Child

INTRODUCTION

Listening is an ability that depends on the innate biological competence and mainly from the individual environment experience. To give meaning to acoustic sounds is necessary to associate information and experiences previously acquired[1].

Children that develop themselves in a lower socioeconomically pattern may present not well improved listening competences[2]. The sooner children get involved in social relations, more benefits they will obtain in a short or long term, considering experiences acquired and learning that results from such interactions[3].

That happens because in a not favored cultural and socioeconomically environment, the poor conditions to which several families are exposed contribute to not constructive and stimulating contexts to the childish development, besides the precarious health assistance and the lack of social and educational resources or disinterest to find it [4].

Furthermore, a lot of children with normal peripheral audition may present difficulties on their hearing perception skills, mainly in which concerns

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to their speech comprehension ability. The complex sentences comprehension depends on the perceptual processes and the attention that the individual will acquire throughout life and its origin depends of the changes presented on their development [5].

The speech recognition must be considered as the most important aspect to be measured on human hearing functions, because it allows an evaluation of the receptive communicative function. Due the challenge that this task represents, its evaluation provides relevant information about the individual ability concerning hearing skills in noisy environments [6].

Tests in which sentences are used as stimulus, mainly with competitive noise application, consist in an essential tool to the hearing abilities evaluation that represents daily hearing experiences [6].

Considering all the information mentioned above, the aim of this study is to research and compare the speech recognition of normal-hearing students from different socioeconomic-cultural levels, through a test that uses sentences as stimulus, presented in silence and with competitive noise context.

METHOD

This research presents a quantitative aspect, transversal, prospective and contemporary.

51 children from seven to ten years and 11 months old, from private and public schools and/or philanthropist institutions, which assist children in need, from the city of Santa Maria, Rio Grande do Sul, were evaluated. The schools permission was demanded by an Institutional Authorization Term.

The individuals, as well as their parents or people in charge of them, were informed about the aims, procedures, risks and benefits of this study and the Free and Clarified Permission Term was signed by the children's parents or people in charge.

In order to participate of the study, children had to have tonal hearing thresholds to air conducted until 25 dB in the frequencies of 500 to 4000 Hz on both ears[7]; Speech Recognition Threshold (SRT) Agree to ± 6 dB with the average hearing thresholds at 500, 1000 and 2000 Hz[8]; Tympanogram Type A and present acoustic reflexes. Moreover, the absence of neurological, cognitive, psychological and hyperactivity problems known and articulatory or phonological changes that might interfere in the hearing stimulus repetition. The articulatory or phonological changes absence was analyzed by observational evaluation during the child spontaneous speech before the beginning of the evaluations.

Firstly, the children's parents or people who are responsible for them answered to an anamnesis, applied by the researcher, which provided some information about audiological complaints verified in the moment of the evaluation, students level, extra-curricular activities and living habits. Then, there was a visual inspection of the external ear channel and the auditory thresholds were obtained, the SRT and acoustic ersatz measures.

The evaluations were performed in a sound-treated cabin, using a digital two-channel audiometer, *Fonix* brand – *Hearing Evaluator* – model FA – 12, type I and earphones type TDH-39P, *Telephonics* brand. To obtain the acoustic immittance measures, it was resorted a *Telephonics* middle ear analyzer, model TDH-39P and coxim MX-41 and a probe of 220 Hz to 70 dB SPL.

The 51 children were divided into two groups according to the socioeconomic-cultural level, based in the Criterion of Economic Classification of Brazil made by the Brazilian Association of Research Companies (in Portuguese, Associação Brasileira de Empresas de Pesquisa – ABEP (2008))[9], which estimates the level and capacity of the families to purchase material goods. These criteria proceeds with a questionnaire application composed by two general questions: the first one refers to items disposed in the house of a specific family and the second one to the educational degree of the responsible for the family's economy.

For the analysis of the questionnaire, it was used a scoring system for the items in each issue, described by ABEP. Then, an addition calculus was made to demonstrate the socioeconomic status of each child. The ratings of the questionnaire are: class A1, A2, B1, B2, C1, C2, D and E.

The classification suggested by ABEP does not use any kind of nomenclature for each class. In order to assist in textual clarity and to denominate groups 1 and 2, the terms *socioeconomic medium-high level* and *socioeconomic low-medium level* were used, respectively.

The extra-curricular activities performed by children were also considered, besides the leisure activities of the family, as well as running courses in foreign language, music (playing a musical instrument) and access to computer and / or Internet.

After that, it was performed a research of Recognition Sentences in the Silence Thresholds (RSST) and in the Noise (RSNT). These Recognition Sentences Thresholds were obtained using the Portuguese Sentences Lists test – PSL[10]. The sentences were presented using a *Compact Disc (CD) Player Digital* Toshiba – 4149, linked to an audiometer already described.

Portuguese Sentence Lists Test - PSL

The test was developed by Costa (1998) and it is recorded on CD. The test consists on eight

lists of sentences and a speech spectrum noise, recorded in separate channels, allowing the presentation of sentences in noise, with different levels of presentation.

Before starting the test with each subject, the output of each channel of the CD was calibrated using the VU meter of the audiometer. The 1 kHz tone in this CD on the same channel in which the sentences were recorded, as well as masking noise present in the other channel, was placed at zero.

The lists of sentences and the competing noise were presented monaurally and ipsilaterally through earphones, allowing the evaluation of the ears separately. Different lists of sentences were used, one for each test condition in order to eliminate the possibility of better performance due to the memorization of sentences. The use of different lists was not considered a variable, because the lists applied were equivalent [11].

The sentences were applied in the following order:

- Silence Measures Obtainment:
  - Training: Presentation of the sentences from 1 to 5 of the list 1A in the right ear (RE) and from 6 to10 in the left ear (LE).
  - Research of RSST: presentation of the lists 1B and 2B in the RE and LE, respectively.

- Noise Measures Obtainment:
  - Training: Presentation of the sentences from 11 to 15 of the list 1A in the RE and from 16 to 20 in the LE.
  - Research of RSNT: presentation of the lists 3B and 4B in the RE and in the LE, respectively.

The initial intensity of transmission of the first sentence of each list - the necessary intensity for each subject's success in the first sentence of each list of the test - was based on the results described above when training, and on the research with competitive noise, it was fixed at a constant intensity of 65 dB HL.

The strategy used to research the RSST and RSNT was sequential or adaptive, or ascending-descending[12]. This one allows measuring the required intensity for the individual to identify, correctly, about 50% of the speech stimulus presented in a certain ratio S / R.

Considering this strategy, when the child correctly recognizes speech stimulus presented, the intensity was decreased, otherwise increased. A response was considered correct only when the child repeated, without any error or omission, the whole sentence presented.

Ranges from 4 dB until the first change in considering the type of response were suggested and then, intervals of stimulus presentation of 2 dB between each other until the end of the list. However, due to the technical possibilities of the equipment available to perform this study, it has been used presentation intervals of 5 dB and 2.5 dB, respectively.

It is noted that after recording the CD, it was found by spectrographic analysis computed as requested by the author of the material to a technician, a difference of 7 dB between the recording volume of the two signals (speech and noise) in which it was found out that the sentences were recorded at an average intensity of 7 dB below the noise intensity. For this reason, in the evaluations using earphones, it must be subtracted from 7 dB of the average values observed and presented on the dial of the equipment; procedure adopted in this research as well as in all research with earphones, since confirmed this observation[13].

The sentences presentation levels were recorded for subsequent calculation of the average score from the values where there was a change in the type of response. After obtaining the average value, it was subtracted from the 7 dB above, resulting in the RSST and RSNT.

Finally, it was calculated the ratio signal/noise (S / R) by subtracting the value of RSST in the level of noise intensity (65 dB NA).

The variables considered in the study were the RSST and RSNT (expressed as the ratio S / R).

It was performed at the Audiology Clinic of the Speech and Hearing Service from Universidade Federal de Santa Maria (in the period between November 2009 and October 2010, considering the project "Pesquisa e Base de Dados em Saúde Auditiva", registered at Projects Cabinet under number 019731 and approved by Research Ethics Committee with certificate number 0138.0.243.246-06, on May, 12th, 2006.

Data Analysis

Firstly, the Wilcoxon not parametric test was applied in order to compare the results obtained between the right and the left ear of the tested individuals on each group.

Then, there it was made a descriptive analysis of the values which used the arithmetic average, a standard deviation and minimum and maximum points coming from the evaluation of RSST and S/R.

For comparison between the RSST and S/R ratios means of the subjects of the two groups, it was used the nonparametric Mann-Whitney U, considering two independent groups.

It was considered the significant statistic level of $p \leq 0,05$ (5%).

Statistically significant results were marked with an asterisk (*) in the following tables.

RESULTS

There were no children in this study rated on class A1, neither on class E. All the children from private schools were classified as class A2, B1 and B2, and were gathered on Group 1 (G1). The public school and philanthropical institution's children were rated as class C1, C2 and D, and were grouped on Group 2 (G2).

After data results of the anamnesis had been exposed, it was noted that children rated in G1 showed a large number and variety of extracurricular activities and entertainment, held foreign language courses and / or music and had computer access and / or Internet . The children classified in G2 showed activities that were summed up to the tours and activities offered by the school itself, with no foreign language classes, and just one student that have played a musical instrument; those who had computer access and / or the Internet did so at relatives' houses.

Considering all the analysis that has been made, it seems important to include the term *cultural* when rating the groups. It can be observed that different activities performed by children may interfere with their development, so the more diversified activities and the access to different technologies those children has been exposed to, enables a positive progress of such individuals.

Thus, the groups were rated and constituted by this way:

- G1 – socioeconomic medium-high level: 23 children.
- G2 – socioeconomic low-medium level: 28 children.

Statistically, no significant difference was found between the results of right and left ears of children of different ages in both groups for both measures obtained in silence and in noise. Therefore, the results of the both ears were grouped and analyzed together. Thus, we analyzed 46 ears of G1 and 56 of G2.

In Table 1 are shown the mean, standard deviation, maximum and minimum values of RSST and S/R ratio in groups 1 and 2.

In Table 2 are shown the data obtained by comparative analysis of RSST and S/R ratio founded for each group (Mann-Whitney U test).

Table 1 – Mean, standard deviation (SD), maximum and minimum values of RSST and S/R ratio in groups 1 and 2, in decibel (dB NA)

	Variáveis	n	Média	Mínimo	Máximo	DP
G1	LRSS	46	9,3	3,35	18,50	3,60
	S/R	46	-5,9	-2,00	-9,50	2,22
G2	LRSS	56	10,7	4,80	21,30	4,25
	S/R	56	-1,7	+5,20	-5,80	2,50

Legend: RSST – Recognition Sentence in the Silence Thresholds; S/R – signal to noise ratio; SD – standard deviation

Table 2 – Results of Mann-Whitney U test for RSST and S/N ratio of both groupsU de Mann-Whitney test

	n	Média LRSS	Valor de p
G1	46	9,3	0,152017
G2	56	10,7	
	n	**Média Relação S/R**	**Valor de p**
G1	46	-5,9	0,000000*
G2	56	-1,7	

* Statistically significant difference ($p \leq 0,05$)
Legend: RSST – Recognition Sentence in the Silence Thresholds; S/R – signal to noise ratio

DISCUSSION

The aim of this study was to research and compare the speech recognition of students between 7 to 10 years old from different socioeconomic-cultural levels, through a test that uses sentences as stimulus.

In order to elucidate the explanation of the results, as well as reading and understanding of them, the discussion is divided into two parts, related to (1) recognition sentences in the silence thresholds (RSST) and (2) recognition sentences in the noise thresholds (RSNT).

Recognition Sentences in the Silence Thresholds – RSST

The average values for the RSST were 9.3 dB NA in G1 and 10.7 dB NA in G2 (Table 1). The analysis found no statistically significant difference for this measure when compared to the both groups (Table 2). That is, when evaluated in the silence, the children of socioeconomic medium-high level and socioeconomic low-medium level has demonstrated similar performance.

Studies using the PSL found values of 6.81 dB NA for RE and 8.14 dB NA for LE in normal-hearing children, aged between 9 to 12 years old with no history of *otitis media*[14]; and 5.95 dB NA and 6.79 dB NA for RE and LE, respectively, in normal-hearing children, ages 9 and 11 years with no history of school failure[15]. A study in children with and without musical practice and from different socio-cultural levels, aged between 7 and 13 years old, found values of 6.60 dB NA to the children of upper--middle class with musical experience; 7.75 dB NA for children of upper-middle class with no musical experience and 10.43 dB NA for children from lower social class[16].

As a consequence, the results show that the average values of RSST gathered here for both groups are close to those found in the literature.

Several studies with normal hearing[15, 17] has demonstrated excellent results when subjects are evaluated in silence, though when evaluated in noise, the performance drops significantly. According to these authors, it happens because when the evaluation is performed in silent places, few listening skills channels are required for the auditory information processing occurrence.

To obtain a good speech recognition in silence is necessary that the individual present previous knowledge of the language (familiarity with the words) and hearing threshold within normal limits, considering that these variables are closely related[18].

Besides those mentioned, some studies have shown that the average tone thresholds of 0.5, 1 and 2 kHz can be used as a benchmark for the analysis and interpretation of the results obtained on the RSST research[19].

Therefore, as the normal hearing was one of the criteria for inclusion in this study and all children were literate, it was expected that the subjects evaluated in both groups had good performance in silence, which was confirmed by analyzing the results of this variable.

Recognition Sentences in the Noise Thresholds – RSNT

When the measurements were obtained in the presence of competitive noise, the values were found for the ratio S/R of -5.9 dB HL in G1 and G2 -1.7 dB HL (Table 1).

There is a study that evaluated normal-hearing children, aged 9-12 years, with and without history of *otitis media*. Values of -5.55 dB HL for RE and -5.61 dB HL for LE in the group without *otitis* and -4.61 dB HL for RE and -4.35 dB HL for the LE group with *otitis media* were found[14]. A second study evaluated normal-hearing children from 9 to 11 years with and without any kind of education failure. The values obtained were -6.02 dB HL and -5.83 dB HL to the right and left ears, respectively, for the group without complaint, and -2.81 dB HL for the RE and -3.34 dB HL for LE in the group with the complaint[15].

For students with and without musical practice and from different socio-cultural levels, aged between 7-13 years, the researchers found values of -3.94 dB HL for children with musical experience from upper-middle class; -4.61 dB HL for children with no musical experience from upper-middle class and -1.54 dB HL for children from lower class[16].

In addition, it was found other studies about children concerning speech recognition, but with data expressed in different forms of measurements[5, 6, 20]. Those studies also verified differences between control and study groups, with better performances in the control groups, demonstrating perceptual and cognitive factors that directly interfere with this task.

Thus, the values found here to the ratio S/R in G1 are similar to those in control groups of the researches mentioned above. For its part, when compared with study groups, we could verify that the values for G2 are below those found by these researches, only agreeing with the results of one of them for children from lower class[16]. It demonstrates that children of socioeconomic-cultural low-medium level had lower performance comparing with children with *otitis media* history and learning difficulties, but similar to the children from lower class found by Gambini (2004).

When the performance of children from G1 and G2 for this variable was compared, the analysis found

a statistically significant difference between both groups (Table 2). In other words, when measured in noise, the groups behaved differently; the children of low-medium socioeconomic-cultural level (G2) had significantly lower performance comparing to children of medium-high socioeconomic level (G1).

It proves that children of G2 required a ratio S/N more favorable to recognize around 50% of the speech stimuli presented in noise. It is noticeble that the largest negative value of ratio S/R means a worst situation and better subject's performance.

Children of low-medium socioeconomic-cultural level required a ratio S/N of 4.2 dB HL average more favorable to perform the same task as the children of medium-high socioeconomic-cultural level.

To measure the importance of this difference in speech recognition in noise, according to literature[21, 22], the variation of 1 dB in ratio S/R in normal--hearing subjects represents significant changes in speech recognition.

Thus, for example, is used a study found a variation of 13.2%[21] in speech recognition for each variation of 1 dB in S / N ratio, we could predict that the children of G2 present speech recognition in noise about 50% worse compared to the children of G1.

These results agree with other studies[15, 17] and corroborate the importance of tests in noise, since individuals with the same abilities of speech recognition in silence may have results considerably different in noisy environments. According to these authors, when the evaluation occurs in the noise, instead of silence, several audio channels are required to achieve the same level of speech recognition, indicating that more detailed sensory information are necessary in difficult listening conditions.

This task requires a complex set of cognitive and perceptual skills, including auditory working memory, detection and processing of spectral and temporal aspects[23, 24], and auditory skills of figure--ground[25], auditory closure and selective attention[26].

The speech comprehension in noisy environments is a challenge for any listener. This difficulty is related, in part, to the negative effects of noise on neural synchrony, resulting in a degraded representation of speech in cortical and subcortical levels[20].

For this reason, the mechanisms involved in these skills must be intact. It is known that the lack of stimulation during the development of the auditory system can hamper the proper formation of engrams for the speech recognition sounds[24, 27]. The environments and childhood experiences in different socioeconomic classes are, at least, partly responsible for the different neurocognitive outcomes in these children[28].

D'Angiulli *et al.* (2008)[29, demonstrated, through] neuroimaging techniques, that it was how is expressed the selective attention ability in children of different socioeconomic levels. The subjects had to attend to two target sounds and ignore the other two that were irrelevant ones. They concluded that, although children studied carried out the proposed task similarly, children of low socioeconomic class used additional resources to meet also the irrelevant information.

Stevens, Lauinger & Neville (2009)[2 demonstrated that] children aged 3 to 8 years old, from low-medium socioeconomic level have a limited effect of selective attention on neural processing. The differences were specifically related to a reduced ability to filter out irrelevant information. These data provide direct evidence for differences in the stages of processing within the neural systems mediating selective attention in children of different social classes.

Therefore, it appears that a higher stimulation during the child's development is extremely important for the necessary connections that have to be established on the auditory development.

Whereas most of the low-medium socioeconomic level children have lack of stimulation, the performance of several skills involved in speech recognition, compared to competitive noise, is at disadvantage, which reflects in a worst performance on this task, as observed in this study.

Thus, we can infer that the children of G2, when in learning situations in noisy environments, which are very common, especially in classrooms where the noise level is higher [30], may consequently have more difficulty on required tasks and this may interfere on their learning process.

CONCLUSIONS

Considering the results obtained it is verified that there is no difference in the sentence recognition in silence between children of different socioeconomic and cultural levels, nevertheless whenever they were evaluated with competitive noise the lower socioeconomic and cultural level children presented a significantly worse performance.

RESUMO

Objetivo: pesquisar e comparar o reconhecimento de fala em escolares de 7 a 10 anos de diferentes níveis socioeconômico-culturais, por meio de teste que utiliza sentenças como estímulo apresentadas no silêncio e com ruído competitivo. **Método:** 51 crianças, de 7 anos a 10 anos e 11 meses, foram avaliadas e divididas em dois grupos de acordo com o nível socioeconômico-cultural. Assim, o Grupo 1 (G1) – nível médio-alto – ficou constituído por 23 crianças e o Grupo 2 (nível médio-baixo) por 28. Procedimentos realizados: anamnese, meatoscopia, obtenção dos limiares auditivos, das medidas de imitância acústica e dos Limiares de Reconhecimento de Sentenças no Silêncio (LRSS) e no Ruído (LRSR), expresso na relação sinal-ruído (S/R). Para a obtenção dos LRSS e LRSR foi utilizado o teste Listas de Sentenças em Português - LSP (Costa, 1998). Os dados foram analisados estatisticamente. **Resultados:** não houve diferença estatisticamente significante entre as orelhas direita e esquerda para as variáveis analisadas em ambos os grupos, dessa forma os resultados foram agrupados e analisados conjuntamente. A média obtida para os LRSS no G1 foi de 9,3 dB NA e no G2 de 10,7 dB NA. A média da relação S/R no G1 foi de -5,9 dB NA e no G2 de -1,7 dB NA. A análise estatística verificou diferença significante entre os grupos apenas para a relação S/R. **Conclusões:** quando a tarefa exigiu maiores demandas do processamento auditivo (ruído competitivo), as crianças com nível médio-baixo demonstraram desempenho reduzido, em comparação com crianças de nível médio-alto.

DESCRITORES: Audição; Percepção da Fala; Fatores Socioeconômicos; Criança

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