SSW test in school children aged between 7 and 10 from two dissimilar socioeconomic cultural backgrounds

Teste SSW em escolares de 7 a 10 anos de dois distintos níveis socioeconômico-culturais

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Resumo

Introdução: A audição envolve muito mais do que apenas a sensibilidade periférica. Para a interpretação dos sons é necessária a participação de uma série de habilidades auditivas. Sabe-se do importante papel de um ambiente estimulador para o desenvolvimento destas habilidades.
Objetivo: estudar as habilidades auditivas avaliadas pelo Teste Dicótico de Dissílabos Alternados - SSW - em escolares de 7 a 10 anos, de diferentes níveis socioeconômico-culturais.
Método: Estudo prospectivo, clínico e observacional. Participaram 51 crianças divididos em dois grupos de acordo com o nível socioeconômico-cultural. Assim, o Grupo 1 - G1 - (classe média-alta) ficou constituído por 23 crianças e o Grupo 2 - G2 - (classe média-baixa) por 28. Realizou-se a aplicação do teste SSW, sendo analisados os aspectos quantitativos: condições direita competitiva (DC) e esquerda competitiva (EC) e o total de acertos do teste, e os aspectos qualitativos: efeito de ordem (EO), efeito auditivo (EA), inversões e padrão Tipo A.
Resultados: Aspectos quantitativos: houve diferença estatisticamente significante entre os grupos estudados para o total de acertos do teste, mas para as condições DC e EC, não. Aspectos qualitativos: verificada diferença estatisticamente significante apenas para o EO. Embora a análise estatística não tenha verificado diferença significante para todas as variáveis estudadas, foi possível observar que em todas elas, o G1 apresentou resultados superiores.
Conclusão: as habilidades auditivas avaliadas pelo teste SSW, em escolares de 7 a 10 anos, apresentaram escores superiores nas crianças de nível socioeconômico-cultural médio-alto em relação às de nível médio-baixo.
Palavras-chave: audição, fatores socioeconômicos, criança.

Summary

Introduction: Hearing comprises a lot more than just a peripheral sensitivity. To interpret such sounds, the participation of wide-ranging hearing abilities is necessary. It is known that a motivating environment plays a key role to develop these abilities.
Objective: study the hearing abilities evaluated by the Staggered Spondaic Word test - SSW - in school children aged between 7 and 10 from dissimilar socioeconomic and cultural backgrounds.
Method: A prospective, clinical and watching study. 51 children participated in this study and were divided into two groups in accordance with their socioeconomic and cultural backgrounds. Accordingly, Group 1 – G1 - (medium-high class) was comprised of 23 children and Group 2 – G2 – (medium-low class) had 28 children. SSW test was performed by analyzing both quantitative features: competitive right (CR) and competitive left (CL) conditions and the total of right answers in the test, and qualitative features: order effect (OE), hearing effect (HE), inversions and A-type standard.
Results: Quantitative features: a statistically significant difference was found between the studied groups regarding the total of right answers in the test, but not in relation to CR and CL. Qualitative features: a statistically significant difference was noticed for the OE only. Although the statistical analysis has not found a significant difference for all the studied variants, it was possible to observe that G1 had higher results for all of them.
Conclusion: the hearing abilities evaluated by the SSW test in school children aged between 7 and 10 showed higher scores in children with a medium-high socioeconomic and cultural backgrounds in comparison with those of medium-low socioeconomic and cultural backgrounds.
Keywords: hearing, socioeconomic factors, child.

INTRODUCTION

When the sound is picked up by the external ear, it is detected by the inner ear and then it passes through numerous cognitive and physiological processes so that the decoding and understanding thereof can occur (1).

This system is challenged by the accurate coding task of the input sound. Auditory information rises from the cochlea, along parallel paths, making a synapses on multiple structures on its route towards the cortex (2). These structures, together with the auditory cortex, are responsible for the physiological mechanisms of hearing. Each of these mechanisms is associated with certain skills, which will be more specific as it becomes increasingly necessary to detail the type of sound stimulus (3). So, the auditory processing refers to the effectiveness and efficiency which the central nervous system uses the auditory information with (4).

Therefore, hearing is a part of a specialized system of communication, involving much more than just peripheral sensitivity. This intricate sense involves the participation of complex neuronal chains and higher mental functions to interpret verbal and non-verbal sounds (5).

Thus, understanding the skills, abilities or capacities to deal with sound is possible by observing the reactive behaviors of children and adults in the tasks to detect, discriminate, recognize and understand the sound stimulus (3, 6).

Special Tests were developed to evaluate the specific auditory skills, whether associated or not with the alterations in communication, with the purpose of identifying an auditory processing disorder (7). One of the specific tests using the dichotic hearing task is the Dichotic Test of Alternating Disyllable, as adapted by Borges for the Brazilian Portuguese (1986) (8), namely the SSW (Staggered Spondaic Word Test).

The SSW is an important tool to evaluate the process of dichotic listening. Thus, knowing how this procedure can help understand the perceptual learning of speech becomes important in speech therapy (7), since there may be a co-occurrence of auditory processing disorders and disorders in speech, learning, and difficulties in reading and writing (9, 10).

The importance of an stimulator environment for the correct development of the auditory system and its skills is known. One factor that strongly influences the experiences and the resulting cognitive stimulation of an individual from childhood to adulthood, is the socioeconomic status (11). The inappropriate stimulation, generated by both socioeconomic influences and family's educational level, can contribute to delays in the child's overall development, refraining motor skills, language and cognition from being acquired (12).

Therefore, the objective was to study the auditory skills evaluated by the Staggered Spondaic Word Test - SSW - among schoolchildren aged between 7 and 10 years, from different socioeconomic and cultural levels.

METHOD

The research is a part of the "Survey and Database on Hearing Health" project in the Projects registered under No. 019731, approved by the Ethical Committee in Research with a certificate No. 0138.0.243.000-06 on 05/12 / 2006. It was performed at the Audiology Ambulatory of the Federal University of Santa Maria (UFSM)'s Phonoaudiological Department Service (SAF), between November 2009 and October 2010, and it is characterized as quantitative, cross-sectional, prospective and contemporary.

51 children aged between 7 years and 10 years and 11 months, coming from private schools and public schools and/or philanthropic organizations serving needy children in the city of Santa Maria/RS Were evaluated. The authorization of the schools was requested by way of the Term of Institutional Authorization.

Individuals and their parents and/or guardians were informed about the objectives, procedures, risks and benefits. Only children who consented to participate in the research and who had the Term of Free and Clarified Agreement signed by parents and/or guardians were evaluated.

The following aspects were used as selection criteria: air pure-tone audiometry thresholds up to 25 dB at frequencies of 500 to 4000 Hz in both ears (13); Speech Recognition Threshold (SRT) 6 dB above or below average of the pure-tone thresholds of 500, 1000 and 2000 Hz (14); Tympanometrry type A (15) and acoustic reflexes (16); in addition to the absence of known neurological, cognitive, psychological and hyperactivity disorders as well as articulatory and/or phonological changes that could interfere with the repetition of the speech stimuli. The absence of articulation and/or phonological changes was analyzed by an observational assessment during when the child spontaneously spoke before the commencement of the tests.

Firstly, children's parents and/or guardians answered an anamnesis applied by the researcher, who provided information about hearing disorders found at the time of

audiological evaluation, education, extracurricular activities and lifestyle habits. After the anamnesis, the children passed by the visual inspection of the external acoustic meatus and the tests of hearing thresholds, SRT and acoustic immitance audiometry (AIA).

Evaluations occurred in an acoustically treated booth, using a Fonix - *Hearing Evaluator - FA - 12, type I two-channel digital audiometer, and TDH-39P Telephonics earphones*. To obtain AIA, the middle ear Interacoustic Analyzer AZ7 used, the Telephonics TDH-39 p headset, Cochin MX-41, and a probe of 220 Hz to 70 dB NPS.

Parents and/or guardians of children also filled out a socioeconomic questionnaire composed of two general questions, the first of which referring to items found at home and the second referring to the level of education of the family's chief. This questionnaire is a part of the Economic Classification Criteria of Brazil by the Brazilian Association of Research Companies - ABEP (2008) (17), and it estimates the purchasing power of families.

To analyze the questionnaire, the scoring system was used for the items in each issue, as described by ABEP. In the end, a calculation was made and each child's socioeconomic status was obtained. The classifications of the questionnaire are: class A1, A2, B1, B2, C1, C2, D and E.

No children in this study was classified as class A1 or class E. All children from private schools were classified in classes A2, B1 or B2 were grouped together, therefore, in Group 1 (G1). Children of public schools and philanthropic institutions were classified in classes C1, C2 or D, and then grouped into Group 2 (G2).

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

In addition to the socio-economic issue, the after-school activities undertaken by the children, the family's leisure activities, as well as courses of foreign languages, music (playing some musical instrument) and access to computer and/or Internet were also taken into account.

After obtaining the anamnesis data, it was realized that the children classified under G1 showed a big quantity and diversity of after-school and leisure activities, attended foreign language and/or music courses and had access to the computer and/or the internet. The children classified in G2 showed activities that were as simple as tours and activities offered by the school itself, they attended no foreign language course, only one played a musical instrument and those who had access to computers and/or the Internet did so at relatives' houses.

In light of these observations, it was considered important to include the term *cultural* in the denomination of groups. It is believed that the different activities performed by children may interfere with their development, and the most diversified activities and access to different technologies can positively contribute to the individuals' development.

Thus, the groups were named as such and established:

- G1 - *medium-high socioeconomic* and cultural: 23 children.
- G2 - *medium-low socioeconomic* and cultural: 28 children.

Subsequently, the Staggered Spondaic Word Test – SSW was applied.

Staggered Spondaic Word Test - SSW

The test created by Katz in 1962 (18) and adapted to Portuguese by Borges in 1986 (8) was applied as proposed by Pereira and Schochat (1997) (19). It consists in the presentation of four sequences with 40 words each, presented to the patient 50 dB above the three-tone average of the frequencies of 500, 1000 and 2000 Hz. These words are disyllabic paroxytones extracted from Brazilian Portuguese.

The SSW test is a procedure developed as a way of evaluating the central integrity. It was presented with a Toshiba Digital-4149 Compact Disc Player coupled with the audiometer described above.

It uses dichotic stimuli and the presentation of the sequences is as follows: the first word is presented to the right ear without a contrasting message (right ear not contrasting - RNC), two words are presented in both ears simultaneously (right ear contrasting - RC and left ear contrasting - LC) and the last word is presented without a contrasting message on the left ear (left ear is not competitive - LNC).

Before the start of the test, the child is guided about the task to be performed. The child's task was to recognize and repeat aloud the four-word sequences that were presented.

The responses of the 160 words were analyzed individually, and they were considered right or wrong.

Errors were regarded as: omission, replacement or distortion of the word to be repeated. Inverting the word order in each sequence was also considered, but not as an error.

SSW test results allow a quantitative analysis of the hearing condition and a qualitative analysis of the types of errors. By a quantitative analysis to evaluate the hearing abilities of back-figure for verbal sounds and by qualitative analysis, the ability of temporal ordering of sounds is evaluated, among others (7).

For this study, the RC, LDC and total of right answers of the test were analyzed in relation to the quantitative aspects and the order effect (OE), the auditory effect (AE), inversions and Type A, in relation to the qualitative aspects.

For qualitative aspects, a classification of the type of errors was made when they occurred outside the range of the expected limit (20). So when AE is high-low and/or low-high OE, it is classified as a *phonemic decoding*; when low-high AE and/or high-low OE occurs, it is classified *as gradual loss of memory*; and when the number of inversions is higher than expected, it is classified *as organization*; and when the Type A is present, it is *considered integration*.

To classify normal and abnormal performance in the SSW test, the reference values were considered by age group (21).

Data analysis

The descriptive analysis of the values was made, for which the calculation of the arithmetic average, the standard deviation and the maximum and minimum points of the variants in question was used.

To compare quantitative variants between the two groups studied, the Non-Parametric Mann-Whitney U test was used for tackling two independent groups. As for the analysis of qualitative variants, the independence Chi-Square test was applied.

The level of statistical significance was regarded as $p < 0.05$ (5%).

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

Results

In Table 1, the results of the averages, minimum and maximum values, standard deviations (SD) and the statistical analysis in relation to the conditions of contrasting right (CR), contrasting left (CL) and the total of right answers in comparison of the groups 1 (G1) and 2 (G2) are shown.

In Table 2, it is possible to observe the distribution of the number of children who have not shown any changes in the quantitative variant, as well as those that did not fulfill the expected CR and CL conditions in both groups.

In Table 3, the results for the qualitative variant are shown, which was performed in accordance with the trends of responses - OE, AE, inversions and Type A - based on the number of children with typical results and changes in each group.

In Table 4, the classification of the type of error is shown according to the occurrence of OE, AE, inversions and type A.

Discussion

This research, according to the objectives described above, studied the auditory skills evaluated by the SSW test in schoolchildren of different socioeconomic and cultural levels.

For the first analysis, relating to the quantitative aspects, there was a statistical study in order to check differences between the two groups studied (G1 and G2) in the conditions of contrasting right (CR) and contrasting left (CL) and the total of right answers (Table 1). The analysis showed a statistically significant difference for the

Table 1. Distribution of the number of individuals, averages, maximum and minimum values, and standard deviations of the CR, CL conditions and the total of right answers for both groups expressed in percentage (%).

	Contrasting Right		Contrasting Left		Total of right answers	
	G1	G2	G1	G2	G1	G2
N	23	28	23	28	23	28
Average	74.7	66.7	73.4	64.7	82.2	76.6
Minimum	40.0	32.5	47.5	32.5	52.5	53.8
Maximum	97.5	90.0	97.5	92.5	97.5	90.6
SD	15.0	16.6	14.3	18.6	11.2	10.0
P	0.1055	0.1015	0.0497*			

Mann-Whitney's U test

* Statistically significant difference ($p < 0.05$)

Legend: CR - contrasting right; CL - contrasting left; SD - standard deviation, P - p value.

Table 2. Distribution of the number of children with and without a change in the SSW test in relation to the quantitative variant of the groups G1 and G2.

	Without change		Changed CR		Changed CL		Changed CR and CL	
	N	%	N	%	N	%	N	%
G1N=23	5	21.7	4	17.4	1	4.4	13	56.5
G2N=28	2	7.2	2	7.2	1	3.6	23	82.0

Legend: CR - contrasting right; CL - contrasting left.

Table 3. Exposure of the qualitative variants of the SSW test in relation to the number of children with typical results and changes in the groups G1 e G2.

	G1 (n=23)	G2 (n=28)	p
OE			0.0161*
Typical	16	10	
Changed	7	18	
AE			0.8432
Typical	17	20	
Changed	6	8	
Inversions			0.5104
Typical	16	17	
Changed	7	11	
Type A			0.1096
Typical	20	19	
Changed	3	9	

Chi-Square Test

* Statistically significant difference ($p < 0.05$)

Legend: OE: Order effect; AE: Auditory Effect.

Table 4. Classification of the type of error observed in the qualitative analysis for groups G1 and G2.

Qualitative Analysis	Classification	G1 (N=23)	G2 (N=28)
	Typical	39.1%	10.7%
High-low AE and/or Low-high OE	Decoding	21.7%	35.8%
Low-high AE and/or High-low OE	Gradual Loss of Memory	34.8%	57.2%
Inversions	Organization	30.5%	39.3%
Type A	Integration	13.0%	32.2%

Legend: AE - auditory effect; OE - order effect.

total of right answers of the test but not for conditions of CR and CL.

Although there has been a statistically significant difference between groups in CR and CL, it was found that the average results, as well as the maximum and minimum values of the children of a medium-high socioeconomic and cultural level were above those of medium-low level.

It is possible that the occurrence of a statistically significant difference in the total of right answers was due to the participation of non-contrasting conditions in its analysis, which usually have higher scores compared to competitive conditions (22). This shows that the total score of the test, the children of the G1 showed superior results compared to G2.

It was also verified, according to Table 1, that the average results are below the normal range expected for the G1 and G2 and the G1 is beyond the results found for control groups in some studies (23, 24, 25) and G2 results are close to those found for children with learning disorders (25).

As the data shown in Table 2, it can be observed that in both groups, fewer children had unchanged results in the CR and CE. The vast majority had changes in both conditions. Among those who had a change in only one condition, the CR prevailed. Although the incidence of children with changes was observed in both groups, the incidence was higher in G2.

It was still verified that both groups had a higher percentage of correct answers in the CR condition (G1: 74.7% and G2: 66.7%) in relation to CE (G1: 73.4% and G2: 64.7%). This finding corroborates with the findings in the literature (7, 26), which demonstrated the superiority of the right ear in children at the SSW test.

In the second analysis, concerning the qualitative aspects, there was a tendency to test responses (OE, AE, inversions and Type A), depending on the number of children with typical results and changes (Table 3). The analysis found statistically significant only for OE.

However, as in the quantitative analysis, it was possible to observe that in the four conditions analyzed, the number of children with a change was higher in G2 in comparison with G1, as it can be seen in Table 3.

A descriptive analysis of the qualitative variant was also performed (response tendency) and then the classification was performed as proposed by Katz and Ivey (1994) (20), according to Table 4.

The change in the category of *phonemic decoding reveals* processing problems in a phonemic level. These children usually have poor phonological ability and difficulty in reading and spelling. There may also be a history of speech problems in the first school years (27, 28). In G1, 5 (21.7%) children showed a change in this category, while

in G2, the number of children with a change increased to 10 (35.8%).

The classification of *gradual loss of memory* refers to two important features: difficulty in ignoring background noise, and immediate memory. Educational performance is not as outdated as in individuals with problems of decoding (27, 28). In this study, 8 (34.8%) children of G1 against 16 (57.2%) children of G2 were classified in this category.

Those children falling into the category of *organization* have a great difficulty in organizing the information sequentially. Thus, the spelling may be affected especially by reversing the order of letters (27, 28). In G1, 7 (30.5%) children were classified in this category and in G2, 11 (39.3%).

When the problem lies in the category of *integration*, the individual may be classified into two subtypes of problems. One is related to the difficulties of visual auditory integration and severe reading and spelling disorders, with a great phonetic deficit. The other subtype is less severe and its performance is similar to individuals showing a gradual loss of memory (27, 28). Here, only 3 (13%) children of G1 and 9 (32.2%) of G2 were detected with a change in this category.

This way, according to the classification of children in G1 and G2 verified in this study, it can be affirmed that there is a greater number of children of medium-low socioeconomic and cultural level showing problems in the categories presented. Generally speaking, these results suggest, as a result, a higher educational deficit in this group.

The kind of dysfunction that mostly occurred, contrary to the reviewed literature that observed a higher incidence of the category of the decoding category (7, 9, 19, 29), was the gradual loss of memory in both G1 and G2. That is to say, the greatest difficulty lies in these children's auditory skills and figure-ground memory. The difficulties related to the ability to extract acoustic tips in the auditory information, recognition of auditory patterns and/or short-term memory influence the child's ability to focus attention on certain tasks (30).

It is still important to mention that the categories are not mutually exclusive. The same individual may be classified in more than one category.

In G1, out of the 23 children studied, nine (39.1%) were not classified in any category, 11 (47.8%) were classified in one, two (8.7%) children in two categories and only one child (4.5%) was classified into three categories.

While in G2, out of the 28 children, only three (10.7%) had no classification as to the categorization, 13 (46.4%) children were classified into one; 6 (21.4%) in two categories and two (21 4%) children in 3 categories.

Thus, in G1, 13.2% of the children showed changes in more than one category, while in G2, 42.8% of the children had this condition.

Therefore, the results show that in both groups there were children with changes in quantitative and qualitative aspects of the SSW test. The fact that G1 children presented a change ratio higher than expected, considering the advantage of a rich environment to develop auditory stimuli, can be explained by the interference of other factors influencing the results of this test, such as attention, the intellectual level and linguistic load.

In addition, when evaluating skills associated with cognitive functions, such as auditory skills, several factors can affect the results, turning the diversity of their responses into something expected (31). The literature highlights that, despite some results on tests of auditory processing in children appear to be expressive, there is often a wide range between the tests and individuals, which makes its interpretation difficult (32).

Specific studies that could compare the test results of the SSW test in children of different socioeconomic levels were not found in the literature. However, by using different methodologies and tests, researchers found few differences in auditory skills, including skills of recognition, location, discrimination and sequential memory for verbal and non-verbal sounds (33), selective attention (34, 35), speech recognition in noise (36) and temporal resolution (5). All showed the worst performance in children of lower middle-low level, concluding that the socioeconomic and cultural development negatively interferes with the development of the auditory processing.

It is known that the auditory processing has a key role in the development of speech and language. Despite being separate clinical entities, they can co-exist (37). The damage of auditory skills is related to changes in speech, reading and writing, poor school and social performance (38).

Under all the analysis conditions of the SSW test: CR and CL conditions and qualitative variants in accordance with the trend of answers- OE, AE, inversions and type A-, better answers and a higher in G1 were verified; however, there was no statistically significant difference for the total of right answers and OE only.

Conclusion

Based on the analysis and discussion of the achieved results, it was verified that the hearing abilities evaluated by the SSW test in schoolchildren aged between 7 and 10 showed lower scores in children with a medium-low socioeconomic level in comparison with those with a medium-high level.

Thus, the results suggest that the children with a medium-low socioeconomic level have a higher discrepancy of the evaluated hearing skills, mainly of the gradual loss of memory, and hence they are more susceptible to changes in speech and difficulties in learning.

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