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Influence of the age, level of schooling and gender on the occurrence of the DSI test pauses

A influência da idade, escolaridade e gênero na ocorrência de pausas do teste DSI

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Keywords

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ABSTRACT

Purpose: To evaluate the influence of variables age, educational status and sex in the occurrence of pauses after the standard time in the dichotic sentence identification test. **Methods:** This investigation included 200 right-handed subjects divided into four groups according to age: group I - from 13 to 19 years old, group II - from 20 to 29 years old, group III - from 30 to 39 years old and group IV - from 40 to 49 years old. Each group contained 50 subjects (25 men and 25 women) matched by educational level. The following eligibility criteria was adopted: Brazilian Portuguese mother language, listeners, and fluent readers independent of the educational level. It was applied the dichotic sentence identification test in the steps of binaural integration, directed listening, and it was noted the need for pauses in the test after the standard time. The descriptive and inferential statistics were performed. **Results:** For the binaural integration stages there was a positive association between age and pause occurrence. The educational variable presented a negative association with the occurrence of pauses in all stages of the DSI test. The gender variable showed no association with the occurrence of pause in any of the test steps. **Conclusion:** With increasing age, there is an increase in the incidence of pauses in the binaural integration stages of the test. The more years of study the less chance that the individual will need breaks to perform the test at all stages of presentation. The variable gender did not influence the occurrence of pauses.

Descritores

Testes Auditivos
Córtex Auditivo
Testes de Discriminação de Fala
Escolaridade
Percepção Auditiva
Testes com Listas de Dissílabos

RESUMO

Objetivo: Avaliar a influência das variáveis idade, escolaridade e gênero na ocorrência de pausas após o tempo padrão no teste de identificação de sentenças dicóticas. **Método:** A amostra foi constituída por 200 indivíduos destros distribuídos em quatro grupos segundo a faixa etária: grupo I -13 a 19 anos de idade, grupo II - 20 a 29 anos de idade, grupo III - 30 a 39 anos de idade e o grupo IV - 40 a 49 anos de idade. Cada grupo continha 50 sujeitos (25 homens e 25 mulheres) pareados por escolaridade. Foram adotados os seguintes critérios de elegibilidade: língua materna português brasileiro, normouvinte, leitura fluente independentemente do grau de escolaridade. O teste de identificação de sentenças dicóticas foi aplicado nas etapas de integração binaural e escuta direcionada e a necessidade de pausas no teste após o tempo padrão foi anotada. Foram realizadas estatísticas descritivas e inferenciais. **Resultados**: Para as etapas de integração binaural, houve associação positiva entre idade e ocorrência de pausas. A variável escolaridade apresentou associação negativa com a ocorrência de pausas em todas as etapas do teste. A variável gênero não apresentou nenhuma associação com a ocorrência de pausa em nenhuma das etapas do teste. **Conclusão:** Com o aumento da idade, há um aumento na incidência de pausas na etapa de integração binaural do teste. Quanto mais anos de estudo menor a chance de o indivíduo necessitar de pausas para realizar o teste em todas as etapas de apresentação. A variável gênero não influenciou na ocorrência de pausas.

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INTRODUCTION

Central hearing processing is related to the ability that the individual presents in the detection, analysis and interpretation of sound patterns. These hearing skills in unfavorable listening situations can be analyzed through behavioral hearing tests.

Special hearing tests can be classified according to the mode of presentation of the stimuli in diotic, monotic and dichotic. Dichotic tests are carried out with headphones are based on the presentation of different stimuli in both ears simultaneously or sequentially. Among the dichotic tests available in Brazilian Portuguese, there is the *Dichotic Sentence Identificacion Test* – DSI[1,2].

Research with dichotic listening tests showed that the results are influenced by the variable age[3,4] and schooling[5-7], without differences of results for the analysis of the variable gender[3,6,8].

After analyzing these studies, a question arose: whether the time for conducting a test in dichotic task would also suffer influence of these variables. Faced with such questioning, the hypothesis is that the greater the age, the greater the time to carry out the task proposed. However, for schooling, it would be inversely proportionate, that is, the higher the degree of schooling, the less the time to answer the proposed activity, without significant differences between male and female genders.

Therefore, the objectives of this study are: to evaluate the influence of the variables age, schooling and gender in the occurrence of pauses, after the standard time, in the dichotic sentences identification test (DSI).

METHODS

This study was analyzed and approved by the Research Ethics Committee under protocol nº 0322/07. The participants were invited by the researcher and third parties, through web advertisements, distribution of leaflets, exhibition of posters in public places with large numbers of people and verbal invitation by the researchers and third parties. All individuals were informed about the nature of the research and signed the term of free and informed consent, which was produced in accordance with resolution number 466/2012 of the National Health Council. For individuals under 18 years old, their parentes and/or responsible signed the consent form, and the participants signed a term accepting to be part of the research.

For the sample composition, the inclusion criteria listed were: age between thirteen and 49 years old (both genders); Brazilian Portuguese as a mother tongue; score of $\geq +50$ in the reduced version of the manual dominance test of Edinburgh[9,10], fluent reading, independent of their level of schooling; absence of complaint and/or obvious neurological alteration and/or evident psychic disorder; absence of audiological alteration (hearing thresholds less than 25 dB in between 250 Hz and 8000 Hz, tympanometric curves type A and presence of acoustic reflections with contralateral stimulation); symmetric audiometric configuration (difference between hearing thresholds of the right and left ear lower than 10 dB NA in all the frequencies researched); results according to normality standards in the special hearing tests of sound localization, memory test for verbal and non-verbal sounds in sequence and dichotic test of digits (binaural integration step)[11].

The sample was made up of 200 subjects, 100 female and 100 male. Their ages were between 13 and 49 years old, distributed in four groups according to the age range: Group I: 50 Individuals paired by gender (25 female and 25 males) from 13 to 19 years old; Group II: 50 Individuals paired by gender (25 female and 25 male) from 20 to 29 years old; Group III: 50 Individuals paired by gender (25 female and 25 male) from 30 to 39 years old; Group IV: 50 Individuals paired by gender (25 female and 25 male) from 40 and 49 years old.

The individuals informed their level of schooling in years completed during the anamnesis and were separated in groups according to their level of schooling. The division was carried out according to the criteria established by IBGE[12], namely: three to seven years of schooling (incomplete elementary education); Eight years of schooling (full elementary education); Nine to ten years of education (incomplete high school); 11 years of schooling (full secondary education); 12 to 15 years of schooling (incomplete higher education); 16 years of schooling (complete higher education, having as reference a five-years graduation-course); 17 years or more of schooling (post-graduation).

All individuals were evaluated, by means of the DSI test in Brazilian Portuguese presented to 50 dBNS in the stages of binaural integration and listening directed to the right and to the left. The stimuli were presented in Compact Disc and played in Discman with MP3 format, model Expanium of the Philips Company. For the evaluation, we used an acoustic hood, supra-aural headphones model TDH-39, coupled to the audiometer of two channels; model GSI-61, Grason-Stadler. During the application of the test, we noted the need for pauses, in addition to the standard time of the test, that is, predicted in the recording. We distributed the individuals according to the occurrence of pauses (yes or no) at each stage of the DSI test, taking into consideration the total sample and the variables age, schooling and gender.

It was carried out descriptive and inferential analyses. The inferential analysis was performed with software Minitab version 15 and SPSS version 11. The level of significance adopted was 0.05 and we used the T-Student statistical tests, Fisher's Exact test, Variance Analysis with repeated measurements, multiple logistic regression Models and Kappa statistics.

RESULTS

Two hundred subjects from 13 to 49 years old participated in the study, with an average age of 29.7 years, and between 3 and 24 years of schooling, an average schooling of 13.1 years.

The results were sorted according to the occurrences of pauses (yes or no) at all stages of the DSI test, considering the total sample (Table 1).

After the illustration of the results in the total sample, we analyzed the occurrence of pauses according to the age group and level of schooling (Table 2).

Considering the variable gender, 59% of men and 44% of women needed pauses for the training stage. For binaural integration step, 54% of men and 41% of women needed to

Table 1. Frequency and percentage of pause occurrence in each step of DSI test

Test	Pause		Total
	No	Yes	
Training	97	103	200
	48.50%	51.50%	100%
Integration	105	95	200
	52.50%	47.50%	100%
ROL	195	5	200
	97.50%	2.50%	100%
LOL	196	4	200
	98%	2%	100%

Caption: ROL = Right oriented listening; LOL = Left oriented listening

Table 2. Percentage of pause occurrence in the four test steps of DSI test according to age group and level of schooling

Group (n)	Training	Integration	ROL	LOL
13 to 19 years old (n=50)	36%	30%	2%	2%
20 to 29 years old (n=50)	38%	30%	0%	0%
30 to 39 years old (n=50)	52%	52%	4%	4%
40 to 49 years old (n=50)	80%	78%	4%	2%
3 to 7 school years (n=14)	100%	86%	14%	7%
8 school years (n=10)	100%	100%	10%	10%
9 a 10 school years (n=10)	80%	70%	0%	0%
11 school years (n=42)	60%	60%	5%	5%
12 a 15 school years (n=64)	33%	30%	0%	0%
16 school years (n=36)	53%	47%	0%	0%
17 or more school years (n=24)	25%	21%	0%	0%

Caption: ROL = Right oriented listening; LOL = Left oriented listening

Table 3. P-values obtained comparing the average of Age and Schooling in the Pause categories and the Pause and Gender association test

Test Steps	Age[1]	Schooling[1]	Gender[2]
Training	0.000*	0.000*	0.047*
Integration	0.000*	0.000*	0.089
Right oriented listening	0.294	0.001*	0.369
Left oriented listening	0.680	0.007*	0.621

[1]Student's T Test; [2]Fischer Exact Test; *statistically significant p-value

pause the test to identify the response correctly. During oriented listening steps, only 1% of men needed pauses in the test. In relation to women, 4% of the sample required pauses in the oriented report on the right ear step and 3% for oriented report on the left ear step.

After the initial descriptive analysis, we compared the age and schooling averages in the groups defined by the pause occurrence (yes or no) at each stage of the test, and we carried out the association test between gender and pause occurrence (Table 3).

The results presented in Table 3 refer to the study of each variable association: age, schooling and gender alone with the occurrence of pause. Variables that, in isolation, presented p-value less than 0.25 were selected to adjust the logistic regression models. After this analysis, we found that, during training, there was an association between pauses and age (p=0.000) and schooling (p=0.000). The odds ratio for age was 1.10 (confidence interval of 95%: [1.06; 1.13]) and for schooling was of 0.79 (CI 95%: [0.71; 0.88]). It was not detect association with gender (p=0.123).

For binaural integration, there is also association between pause occurrence and age (p=0.000) and schooling (p=0.000). The odds ratio for age was 1.11 (confidence interval of 95%: [1.07; 1.15]) and for the schooling the odds ratio was 0.78 (CI 95%: [0.70; 0.87]). There was no association with gender (p=0.174).

For the oriented listening steps, we adjusted logistic regression models including only schooling level. In the oriented report on the right ear step, schooling level showed association with the pause occurrence (p=0.002). The odds ratio was 0.57 (CI 95%: [0.40; 0.82]). For the oriented report on the left ear step, schooling level showed association with the pause occurrence (p=0.009). The odds ratio was 0.62 (CI 95%: [0.43; 0.89]).

Observing the results, we notice similar behaviors for the occurrence of pauses in the oriented listening steps. It was verified a results concordance between both stages of the test. The results showed that 195 individuals (97.5% of the sample) did not need pauses in the two stages of oriented listening and four individuals (2% of the sample) needed pauses in the two stages of oriented listening. The value of Kappa statistic (concordance measure) was 0.89 (p=0.11), which indicates a strong concordance between the listening steps directed and the pause occurrence.

The Variance Analysis technique with repeated measurements for ordinal data showed that the differences between the percentages of pause occurrences in the tests depend on the age group (p=0.000) and the level of schooling (p=0.000). In the multi-logistic regression model for the steps of binaural training and integration, it was not detect association with gender. As the pause occurrence presented association with age and level of schooling, we compared the percentages of pause's occurrence in the tests according to the age range and level of schooling variables in the stages of training, integration and directed report on the right ear (Tables 4 and 5). We did not consider the directed report on the left ear step due to the strong agreement between the results of the oriented listening steps.

Table 4. P-values obtained on comparing the percentage of pause occurrence in training, integration and oriented listening steps according to the variable age group

Age group	Comparison	p-value
13 to 19 years old	Training × Integration	0.000*
	Training × Right Oriented Listening	0.000*
	Integration × Right Oriented Listening	0.000*
20 to 29 years old	Training × Integration	0.039*
	Training × Right Oriented Listening	0.000*
	Integration × Right Oriented Listening	0.000*
30 to 39 years old	Training × Integração	1.000
	Training × Right Oriented Listening	0.004*
	Integration × Right Oriented Listening	0.000*
40 to 49 years old	Training × Integração	0.317
	Training × Right Oriented Listening	0.000*
	Integration × Right Oriented Listening	0.000*

*statistically significant p-value
Analysis of variance with repeated measures for ordinal data

Table 5. P-values obtained on comparing the percentage of pause occurrence in training, integration and oriented listening steps according to the variable level of schooling

Level of Schooling	Comparison	p-value
3 to 7 years of schooling	Training × Integration	0.154
	Training × Right Oriented Listening	0.000
	Integração × Right Oriented Listening	0.000
8 years of schooling	Training × Integration	1.000
	Training × Right Oriented Listening	0.000
	Integração × Right Oriented Listening	0.000
9 to 10 years of schooling	Training × Integration	0.317
	Training × Right Oriented Listening	0.000
	Integração × Right Oriented Listening	0.000
11 years of schooling	Training × Integration	0.141
	Training × Right Oriented Listening	0.000
	Integração × Right Oriented Listening	0.000
12 to 15 years of schooling	Training × Integration	1.000
	Training × Right Oriented Listening	0.000
	Integração × Right Oriented Listening	0.000
16 years of schooling	Training × Integration	0.153
	Training × Right Oriented Listening	0.000
	Integração × Right Oriented Listening	0.000
17 or more years of schooling	Training × Integration	0.317
	Training × Right Oriented Listening	0.006
	Integration × Right Oriented Listening	0.014

Analysis of variance with repeated measures for ordinal data

DISCUSSION

In the present study, we analyze the influence of age, level of schooling and gender variables on the pause occurrences of the DSI test.

The DSI test has a training stage, performed with binaural integration, in which the individual hears two sentences simultaneously, one in each ear and must point the two sentences heard in a picture with answers. The training was the step that presented more pauses, 51.5% of the sample needed a pause to answer appropriately to the requested task. Due to the complexity of the binaural integration task, 47.5% of the sample also needed a pause to answer. For the oriented listening steps, only 2.5% and 2% of the sample required pauses beyond the standard time (Table 1). When a new activity starts, it takes time to understand the task and present the answer adequately. This time, in the hearing tests, would be the training stage, in which the individual learns the activity that will be requested and programs a response, which justifies the highest percentage of pauses in the training step and the statistically significant differences when compared to the other steps of the DSI Test (Table 4).

In the dichotic listening tests, the stimuli presented in one ear go to the contralateral hemisphere and the inputs of ipsilateral information are automatically inhibited[13]. The success for performing a dichotic listening task lies on the attention and inhibition carried out by the individual to keep their attention on the target sound[14]. Studies conducted with hearing skills training in the process of sustained attention reflect better performance in dichotic listening tests on selective attention tasks[13]. Since it is not possible to carry out training activities to maintain the focus attentional during the evaluation, training is necessary in the most difficult listening situation of the test, as in the DSI test, in which training is presented in binaural integration task.

Learning is extremely important for neural plasticity. The stimuli received from the outside environment excite the organs of the senses and produce sensations. After the repetition of these stimuli, there is a change in the pattern of interpretation of the sensations due to a more elaborate and reflexive perception, which will culminate in the analysis and interpretation of the sensation, recruiting a large number of neurons to perform this task when there is a pattern modification; then there's plasticity[15]. As the DSI test is performed, the occurrence of pauses decreased, which demonstrates the learning effect. The plasticity of the nervous system can be caused by the maintenance of the morphological and functional dynamism of the neurons that are used in a particular task, the modification in the production of neurotransmitters and/or the formation of new synapses[15].

Performing a training stage is important because of the hearing plasticity that occurs with the repetition of stimulation and learning a hearing process[16]. Plasticity decreases with the age, because it also depends on the interaction with the brain stem, and can be measured by means of physiological tests[16] and verified with the improvement of the results after its realization. Therefore, the training stage is of utmost importance and should not be omitted, as it provides the individual with the opportunity to understand and practice the test before starting the evaluation itself. Thus, the results obtained are more reliable and it is possible to find a real difficulty in evaluating the hearing skills.

After analyzing the variable age, we observed that the occurrence of pauses increases in more advanced age groups. Only 36% of individuals from 13 to 19 years old, needed pauses in the training and 30% in the binaural integration steps of the test. As the age progressed, the need for pauses also increased. The participants from 40 to 49 years old presented 80% of pauses during training and 78% during the binaural integration step (Table 2). There was an association between the occurrence of pauses and the age (Table 3) and, with every one year of age increased, the chance of pause increased 10% in the training step and 11% in the binaural integration step.

As we grow up, we also get older. Aging is an ongoing process of transformations that affect the physical, cognitive structures and the subjective perception of the individual on this phenomenon[17]. This transformation starts early, from birth and becomes more evident to middle-aged individuals[18]. The effects of aging on hearing skills[19] and in other dimensions occurs in an individualized way and is influenced by the lifestyle, by genetic and environmental factors.

The effect of aging on dichotic listening tests has already been reported by several authors[3,4,20], even when there is no great variation in an age group or when in young population, it is possible to observe differences between the performance of younger and older individuals, where young people obtained better results[3,4,20]. This fact stems from the structural and morphological changes arising from the aging process[19] and the reduction of other capacities related to superior mental functions such as memory, language, planning and sequence capacity[21,22].

Cognitive processes of attention, memory[23,24], emotion and motivation directly influence the results obtained in the behavioral hearing tests[24]. Among the environmental influences, we have education as an important factor[6,7,18,20,25]. Descriptive analysis of the variable level of schooling showed that there was a decrease in the occurrence of pauses at all stages of the test as the level of schooling increased. All individuals with up to eight years of schooling needed a pause during training and more than 80% in the binaural integration stage. When analyzed individuals with a high level of literacy, i.e. 17 years or more of schooling, it was found that only 25% of the sample needed a pause in training step and no one needed pauses in the binaural integration step (Table 2).

There was association between the occurrence of pauses and the level of schooling (Table 3) and for every one year of level of schooling increased the chance of pause occurrence decreased 21% in the training stage, 22% in the binaural integration step, 43% in the directed report on the right ear step and 38% for the oriented report on the left ear step.

When comparing the occurrence of pauses in the three stages of the DSI test (training, binaural integration and oriented listening) according to age and level of schooling Tables 4 and 5), we observed that from 13 to 19 years old and from 20 to 29 years old, there was a difference between the occurrence of pauses in the three stages of the DSI test. For the other age groups and all levels of education, statistically significant differences between the occurrence of pauses in training and integration steps,

but we observed differences between the binaural integration oriented-listening steps and; more pauses occurred during binaural integration step (Table 5).

We already expected the influence of schooling on the time to carry out the requested activity, because hearing and linguistic skills are associated with neural processing and common underlying cognitive resources[14] Studies with dichotic listening tests reported better performance for individuals with higher education when compared to subjects of the same age and level of schooling[6,7,14,18,20,25]. The highest incidence of pauses in the population with low level of schooling comes from the direct association between level of schooling and linguistic-cognitive skills[26].

Individuals with low level of schooling have a marked difficulty in inhibiting verbal information that reaches the left hemisphere by the dominant way, which impaires them to direct attention to the ear that links the information to the lingüistic hemisphere. This no longer happens individuals with a higher level of education, who have better control orienting their attention and have better ability to follow instructions to suit both ears[25].

We can raise other explanations from a cognitive point of view. High schooling favors the more efficient use of their cognitive skills that permeate the hearing processes. Among these skills we can mention the active participation of cognitive networks processing a sound stimulus, the accuracy of the interaction between cognitive abilities, such as attention and working memory, for the automatic processing of a sound and modification of the sound aspects selectivity that are relevant to a particular behavior[24].

In this study, men and women presented similar behaviors in relation to the need for pauses in the DSI test and there was no statistically significant association between the variable gender and the occurrence of pauses for any of the DSI test steps. Several studies tried to correlate the anatomical and functional differences between male and female brains to the performance obtained in dichotic listening tests, but most of the findings did not show strong differences between the gender in the dichotic listening tasks[6,8,27] (Table 3).

Over time, the cognitive differences between genders changed, some differences remained stable and others increased with the evolution of society. In general, the greatest cognitive differences between genders appear in childhood, but these differences depend on the characteristics of the requested task[28].

The main differences found in the comparison between genders, using behavioral hearing evaluation, are related to the greater advantage of the right ear[3,18,29]. This advantage is stronger in older ages, independent of manual preference, and it's more precocious in women[3]. When comparing young people from 16 to 49 years old, men presented greater perceptual asymmetry, with better results for the right ear when compared to women[3].

These results emphasized the importance of a training stage before the application of any behavioral hearing test and the need to hold pauses, when necessary, for older individuals and low level of schooling, to minimize the influence of non-hearing factors on the results of the behavioral hearing tests. It is important to develop other similar studies, considering these factors both to elaborate and evaluate instruments and for the analysis of results obtained.

CONCLUSION

The variables age and level of schooling influence the occurrence of pauses in the DSI test. With the increase in age, there is an increase in the incidence of pauses in training and binaural integration steps of the DSI test. The more years of study, the less chance the individual needs to pause at all steps of the DSI test. The variable gender does not influence the pause occurrence.

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Author contributions

ANA was responsible for designing and outlining the study, collection, analysis and interpretation of the data and preparation of the manuscript; JGMR was responsible for the interpretation of the data and manuscript preparation; MCMI and DG were responsible for designing and outlining the study, interpretation of the data and manuscript review.