Limiar de resolução temporal auditiva em idosos****

Auditory temporal resolution threshold in elderly individuals

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Abstract

Background: the Random Gap Detection Test (RGDT) evaluates temporal resolution threshold. There are doubts as to whether performance in this task remains unchanged with the aging process. At the same time, there is a concern about how much the difficulties of communication experienced by elderly individuals are related to the deterioration of temporal resolution. Aim: to determine auditory temporal resolution threshold in elderly individuals with normal peripheral hearing or symmetric mild sensorineural hearing loss, and to correlate findings with gender, age, audiometric findings and scores obtained in the Self - Assessment of Communication (SAC) questionnaire. Methods: 63 elderly individuals, aged between 60 and 80 years (53 women and 10 men), were submitted to the RGDT and the SAC. Results: statistical analysis of the relationship between gender and the RGDT indicated that the performance of elderly females was statistically poorer when compared to elderly males. Age and audiometric configuration did not correlate to performance in the RDGT and in the SAC. The results indicate that in the SAC both genders presented no significant complaints about communication difficulties regardless of the outcome obtained in the RGDT or audiometric configuration. Conclusion: the average temporal resolution threshold for women was 104.81ms. Considering gender, females did not present correlations between age and audiometric configuration, not only when considering the RGDT results but also when analyzing the SAC results.

Key Words: Aged; Hearing; Hearing Disorders; Hearing Tests.

Resumo

Tema: o Teste de Detecção de Intervalo Aleatório - Random Gap Detection Test (RGDT) avalia o limiar de resolução temporal. Existem dúvidas se à medida que o sujeito envelhece, seu desempenho nesta tarefa se mantém inalterada. Ao mesmo tempo, existe a preocupação do quanto as suas dificuldades de comunicação estariam relacionadas a uma degradação da resolução temporal. Objetivo: determinar o limiar de resolução temporal auditiva em idosos com audição periférica normal ou perda do tipo neurossensorial, simétrica de até grau leve, e sua correlação com: gênero, idade, achados audiométricos e pontuação no Questionário de Auto-Avaliação da Comunicação - *Self-Assessment of Communication* (SAC). Método: 63 idosos, com idades entre 60 e 80 anos (53 mulheres e 10 homens), foram submetidos ao RGDT e ao SAC. Resultados: a análise estatística da relação entre gênero e limiar do RGDT mostrou que o desempenho dos idosos do gênero feminino foi estatisticamente pior em relação ao masculino. Não houve correlação das variáveis idade e configuração audiométrica entre os sujeitos do gênero feminino e o desempenho do RGDT e no SAC. Os resultados do SAC mostraram que ambos os gêneros não apresentaram queixas significantes de dificuldade de comunicação independente do resultado do RGDT ou da configuração audiométrica. Conclusão: o limiar médio de resolução temporal para os idosos do gênero feminino foi de 104,81ms. Para o grupo do gênero feminino, não foram observadas correlação entre as variáveis idade e configuração audiométrica, tanto para os resultados do teste RGDT quanto para os resultados do questionário SAC.

Palavras-Chave: Idoso; Audição; Transtornos da Audição; Testes Auditivos.

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Introduction

The auditory temporal resolution is the ability to perceive or discriminate segments of sounds that are spatially close in time as separate events. It is responsible for the detection of changes in sound stimulus as a function of time and it is necessary for the individual to distinguish the occurrence of two stimuli instead of one (1). Temporal acuity is a prerequisite for the auditory system to determine duration, interval and temporal organization of sound stimuli, which are essential for the processing of speech and music (2).

The Random Gap Detection Test (RGDT) has been shown to be sensitive to dysfunctions of temporal resolution, which may be related to phonological processing deficits, auditory discrimination deficits, receptive language and reading (3). Study with this test showed that 20 among 24 elderly women evaluated were not able to detect silence intervals up to 40 milliseconds (ms) - ceiling of standard RGDT (4). Research has found increased temporal resolution thresholds in the elderly when compared to young adults with the same peripheral hearing conditions (5-8). This explains some speech comprehension complaints of this population. Thus, when an elderly individual refers hearing but not understanding, there is the possibility that the temporal resolution ability impaired by aging contributes to this difficulty, associated or not, to the damage of the peripheral hearing function.

The current study aimed to determine the threshold for auditory temporal resolution in elderly individuals with normal hearing or with symmetric up to mild sensorineural loss and its correlation with: gender, age, audiometric findings and communication difficulties complaints.

Method

Participants

This study was approved by the Ethics Committee of PUC-SP under protocol number 0047/2006. All participants signed a Consent Form.

The sample consisted of 63 subjects aged between 60 and 80 years (53 women, mean age of 69.87 years (SD: ± 6.48 years, median: 71 years; and 10 men, mean age 66.6 years (SD: ± 5.34 years, median: 65 years). Participants were selected according to the following criteria: no history of clinical otologic alterations in the central nervous system such as degenerative diseases, vascular events, aneurysm, among others; Brazilian Portuguese as first language; audiometric thresholds within normal limits or sensorineural audiometric curve, symmetric and up to mild degree; tympanometry type A or its variations (Ad or Ar).

Because of the differences in the audiometry results, the participants were divided into three groups according to audiometric configuration: Group 1 - composed of 21 participants (19 women and 2 men) with audiometric thresholds within normal limits and horizontal configuration; Group 2 - composed of 28 participants (22 women and 6 men) with pure tone average threshold of 500, 1000 and 2000 Hz within normal limits and descending configuration; and Group 3 - composed of 14 participants (12 women and 2 men) with mild degree pure tone average threshold of 500, 1000 and 2000 Hz and descending configuration.

Procedures

The RGDT is composed of paired sequences of pure tones at frequencies of 500, 1000, 2000 and 4000Hz. In the standard test (3), the intervals between the tones range from zero to 40 ms in a random order with increments ranging from two to 10ms. In the expanded test, the intervals between the tones range from 50 to 300ms presented in a random order with increments ranging from 10 to 50ms. The test was conducted at 40dBNS with binaural presentation. The participants were instructed to verbally respond or to inform by sign if they had heard one or two tones. The standard and expanded tracks were each applied once. The lowest range from which the individual has always identified two tones was verified. This analysis was performed on each frequency and the average among the frequencies of testing was calculated.

The Self-Assessment of Communication (SAC) questionnaire consists of 10 multiple choice questions. The alternative responses are numbered from 1 to 5 and are equivalent to scores between zero and four consecutively. Participants were instructed to choose only one alternative for each question. The score, in percentage, obeys the following scale: Degree 1 SAC (0 - 20%) - rarely (if ever) has communication difficulties; Degree 2 SAC (21 - 40%) - occasionally has difficulty in communicating (about ¼ of the time); Degree 3 SAC (41 - 60%) - sometimes have difficulty communicating (about half the time); Degree 4 SAC (61 - 80%) - often has difficulty in communicating (approximately ¾ of the time); and Degree 5 SAC (81 - 100%) - almost always (or ever) have difficulty communicating (9).

Statistical Analysis

Data analysis was divided into two stages.

At first, we compared the RGDT and SAC results between genders. Descriptive analyses were carried out through the calculations of mean, standard deviation, median, mode, minimum and maximum values. Statistical analyses were carried out using the Mann-Whitney test in order to verify possible differences between genders for the variables of interest.

In the second stage, only the group of women was considered - the group of men had low statistical power. Initially, the Spearman correlation analysis was calculated in order to verify the possible influence of age on the performance of RGDT and SAC.

Subsequently, the segregation of the sample according to age groups was ruled out and the groups were divided according to the audiometric configuration, as previously discussed. The results of the SAC and RGDT were compared among the three groups by means of descriptive analysis (mean, standard deviation, median, mode, minimum and maximum) and inferential statistical analysis using the Kruskal-Wallis test. This comparison had the aim to verify possible differences among the three groups of audiometric configuration for the variables of interest.

For all calculated significances (p), values below 5%, i. e., p ? 0.05 were adopted as significance level.

A confidence interval with the results of RGDT was calculated in order to provide reference values for the population studied.

Results

Between-genders Comparisons

Table 1 shows the descriptive and inferential statistical analyses for RGDT results according to gender. Statistically significant lower performances of females are observed for all RGDT variables.

Analyses of Results of Female Participants

No significant correlations were observed on the statistical analyses between age and RGDT and SAC (RGDT 500Hz: p = 0.394; RGDT 1kHz: p = 0.480, RGDT 2kHz: p = 0.883; RGDT 4kHz: p = 0.725; RGDT Average 500Hz -4kHz: p = 0.874; SAC%: p = 0.994; SAC Degree: p = 0.176). Therefore, the segregation of the sample into age groups was not considered.

Table 2 shows the descriptive and inferential statistical analysis of RGDT and SAC results of female participants according to audiometric configuration. Statistical analysis of the variable audiometric configuration versus the variables RGDT and SAC revealed no significant differences.

In the analysis of the SAC questionnaire according to its degree, the results showed that most of the studied population (52:53) had no complaints about difficulties in communication (SAC degrees 1 or 2) independently of peripheral hearing (p = 0.205).

Table 3 displays the confidence intervals of RGDT results for the group of female participants which range from 91.36 ms to 118.26 ms for the average of frequencies from 500 to 4000Hz.

TABLE 1. Descriptive and inferential statistical analyses of RGDT(ms) and SAC(%) results according to gender (n= 63)

		Mean	Standard Deviation	Median	Mode	Minimum	Maximum	Significance (p)
RGDT 500Hz	Fem	86,17	45,74	70	60	2	150	<0,001
	Male	26	21,83	15	15	5	60	
RGDT 1kHz	Fem	111,26	55,61	150	150	2	200	<0,001
	Male	20,7	20,80	10	5	2	50	
RGDT 2kHz	Fem	99,57	50,1	100	150	2	200	<0,001
	Male	21,9	24,92	10	2	2	70	
RGDT 4kHz	Fem	122,25	70,47	150	150	2	300	<0,001
	Male	19,7	16,49	15	15	2	50	
RGDT Mean 500Hz-4kHz	Fem	104,81	48,8	102,5	150	8,75	187,5	<0,001
	Male	22,08	20,15	11,25	11,25	2,75	57,5	

TABLE 2. Descriptive and inferential statistical analyses of RGDT(ms) and SAC(%) results according audiometric configuration for the female participants(n= 53)

		Mean	Standard Deviation	Median	Mode	Minimum	Maximum	Significance (p)
RGDT 500Hz	Group 1	87,11	46,82	60	150	15	150	0,396
	Group 2	63,82	49,81	60	60	2	150	
	Group 3	90,36	45,76	90	150	15	150	
RGDT 1kHz	Group 1	112,11	50,06	100	150	10	200	0,483
	Group 2	82,04	61,3	65	150	2	200	
	Group 3	112,64	72,69	150	150	2	200	
RGDT 2kHz	Group 1	98,95	46,18	100	150	10	150	0,997
	Group 2	72,71	59,62	70	150	2	200	
	Group 3	90,29	59,80	95	150	2	150	
RGDT 4kHz	Group 1	127,21	65,3	150	150	2	250	0,257
	Group 2	83,64	61,41	75	150	2	200	
	Group 3	129,79	101,47	150	150	2	300	
RGDT Mean 500Hz-4kHz	Group 1	106,34	44,7	110	150	9,25	175	0,336
	Group 2	77,3	54,17	75	150	2,75	162,5	
	Group 3	105,77	64,78	130	162,5	9,25	187,5	
SAC	Group 1	7,5	9,89	5	0	0	40	0,309
	Group 2	8,45	11	5	0	0	37,5	
	Group 3	16,82	16,24	15	0	0	42,5	

Group 1: Audiometric thresholds within normal limits and horizontal configuration; Group 2: Mean pure tone within normal limits and descending configuration
Group 3: Mean pure tone of mild degree and descending configuration

TABLE 3. Confidence Interval of RGDT(ms) for the female gender (n= 53)

Variable	Confidence Interval	
	Lower Limit	Upper Limit
500Hz	73,56	98,78
1kHz	95,94	126,59
2kHz	85,76	113,38
4kHz	102,82	141,67
Mean 500Hz-4kHz	91,36	118,26

Discussion

Between-genders Comparisons

As in the current study, authors have found gender differences on tests of temporal resolution - with poorer results being reported for female participants. In a study with a different temporal resolution test, the authors found a statistical trend for better temporal resolution thresholds for men in one of the tracks of the test (10). In another study with a temporal organization test specifically designed for the research, authors found statistically significant differences between thresholds of temporal resolution when comparing results of women (average thresholds: 78ms) and men (average thresholds: 52ms) (11).

The RGDT evaluates a central auditory ability that is mediated by the left primary auditory cortex and uses non-verbal stimuli. The central auditory nervous system of men responds differently to non-verbal stimuli. Such difference is caused by intrauterine exposure to testosterone (12) and by the largest irrigation of these structures for nonverbal stimuli (13). Moreover, men have a higher proportion of white as compared to gray matter (more myelinated connective tissue than nerve cells), increased speed-dependent neurotransmission (best-dependent mechanisms of dopamine) and better use of more global strategies by the brain for temporal organization tasks (11). Thus, there are anatomical and functional differences that justify their better performance.

Analyses of results of Female Participants

Similar RDGT results were observed for the three groups, showing that, independently of the peripheral hearing, elderly female participants need large intervals of silence to identify the occurrence of two stimuli.

These results are consistent with the literature. Authors showed that age and hearing loss each independently contribute to temporal processing disorders. They identified that increasing age may lead to decreased efficiency of the central mechanisms of timing and that deterioration in the ability of temporal resolution is interfered by age independently of hearing loss. The authors believe that the effects of age may justify the limitation on the ability to rapidly process the segments of speech. Furthermore, they suggest that regardless of the individual being young or old, the hearing loss does not affect performance on tests because the cochlear mechanisms do not subsume age-related differences in temporal sensitivity (14-17). Alterations associated with aging in auditory processing occur throughout elderhood and specifically age-related alterations in temporal acuity may begin before the changes in hearing thresholds or word recognition (8).

The advancing age is an important factor in the deficits of temporal resolution. Otherwise, elderly individuals with normal hearing would present performance similar to young adults.

The increased thresholds observed for female participants agree with the literature. Other studies have also found increased thresholds of temporal resolution when compared to young adults with the same peripheral hearing conditions (5-8, 18-20).

The RGDT was standardized on American children between five and 11 years and the normal limit established for this population was up to 20ms for the average of the results between 500 and 4kHz (3). Study with this test showed that 20 of the 24 elderly women evaluated were not able to detect silence intervals up to 40ms (4). Using the AFT-R test - a precursor of RGDT - authors found that for ten in 21 seniors who were unable to identify a silence interval of up to 60ms, the average thresholds were 87.1 ms (21). In another study with RGDT, authors found statistically significant differences between two age groups: 500Hz 8.23ms, 1kHz 8.62ms, 2kHz 8.15ms, 4kHz 6.85ms and Clicks 9.23ms for the age range between 18 and 30 years; and 500Hz 18.95ms, 1kHz 14.45ms, 2kHz 13.45ms, 4kHz 10.95ms and Clicks 12.15ms for the age range between 50 and 67 years(22).

The standard deviation of the groups also shows the variability of the sample, which is also in agreement with the literature (5). Using the AFT-R test, authors found standard deviations of up to 27.9 ms (21).

In contrast, the SAC results are not in agreement with the literature. According to some authors, the integrity of temporal aspects of hearing is a prerequisite for the auditory system to properly execute phonological processing and auditory discrimination of temporal cues of speech (2, 23). Individuals with thresholds of temporal resolution higher than the duration of phonemes composing the word heard, that is, more than 20ms (3), may have difficulty in auditorily discriminate similar words even knowing the language and making use of its extrinsic redundancy (24). Authors also claim that the difficulties in speech recognition of the elderly may be a consequence of the decline in temporal sensitivity. Moreover, elderly individuals that relate hearing but not understanding may present this ability deteriorated by aging. This would explain some complaints in comprehending speech and communication difficulties even without the presence of peripheral hearing loss (15-17, 19).

However, this study, as well as another study (25), showed that one cannot infer that the elderly has difficulty comprehending speech and in communication on behalf of the increased threshold of temporal resolution. One hypothesis is that even with the temporal resolution deteriorated by aging the elderly individual is able to use extrinsic redundancy of speech to comprehend the message heard.

Another hypothesis for the low scores on the SAC is the non-awareness of the difficulty of communication as this complication has a slow and insidious installation process. Moreover, the plasticity of the nervous system, present even in elderhood, could cause the central auditory system to adapt to understand the message heard, even when requiring larger intervals of silence.

The confidence interval in Table 3 allows estimating the reference values of RGDT for women between 60 and 80 years of age. It should be noted that such values are higher than the normal reference values of the test obtained for children and young adults. A study of on and off cells (26) may help understanding this difference. If the detection of silent interval only occurs when the off cells fire, revealing that there was lack of energy, the hypothesis for the findings of this research is that the central auditory nervous system of elderly women need a longer interval of silence to enable the functioning of off cells. That is, when the silent intervals are very short, there is a perceptual persistence of the first marker along the interval of silence. Other study also attributes the increase in thresholds of temporal resolution in elderly to effects of central auditory nervous system adaptation to stimuli of short duration. The authors state that the temporal acuity for short duration is reduced in the elderly because the recovery of adaptation in this population is not as rapid as in younger individuals. That is, the elderly individual requires a longer interval of silence to realize the absence of stimulation (6). Studies have found changes in psycho-acoustic measures that have been proven by electrophysiological alterations of the central auditory nervous system of elderly individuals. Such studies demonstrates that the decrease in the number of cells in the central nervous system due to the aging process causes slowness in nerve conduction and modifies the effectiveness of tasks as the detection of silent intervals (27-29). This has been already outlined in the 70s (30).

Conclusion

The average threshold of temporal resolution for elderly females was 104.81 ms. For the group of females, no significant correlation between age and audiometric configuration were verified for both the RGDT test and the SAC questionnaire results.

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