

PROCESSING TIME IN THE ELDERLY: THE EFFECT OF THE ABILITY TO TEMPORAL RESOLUTION IN JOBS OF ORDERING A SERIES OF SOUNDS

Processamento temporal em idosos: o efeito da habilidade de resolução temporal em tarefas de ordenação de série de sons

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ABSTRACT

Purpose: to determine the effect on the ability of temporal resolution in the temporal ordering of a series of sounds with time of stimulation and varied interval inter-stimulus in an elderly population with or without hearing loss. **Method:** 10 (ten) elderly individuals with hearing loss from mild to moderate, who did or did not use hearing aids and 5 (five) subjects without hearing loss, aged from 60 to 80 years old, were tested for temporal ordering of series of sounds with pure tone, named standard pattern of Duration, and musical tone, named standard test for melodic duration and temporal resolution Gaps-in-Noise test or GIN test. **Results:** in the analysis of the test of temporal resolution as the percentage of correct identification, it was found that the group with no hearing loss has a higher percentage of identification of gaps than the group with hearing loss. Thus, individuals with hearing loss had worse threshold detection gaps (average of 1.4 milliseconds) than individuals without hearing loss (4.6 milliseconds). In the analysis of each test of ordering series of sounds, there were no statistically significant differences between groups. There was no significant correlation between the performance of the elderly with and without hearing loss among the temporal processing tests. **Conclusion:** the ability of temporal resolution does not affect the ability of temporal ordering of a series of sounds with duration of stimulation and varied inter-stimulus intervals in the elderly with or without hearing loss.

KEYWORDS: Auditory Perception; Elderly; Speech, Language and Hearing Sciences

■ INTRODUCTION

Hearing loss is one of the most chronic conditions in elderly ^{1,2}. Presbycusis is the progressive decline in hearing associated with age, its prevalence is estimated around 30% in this population³. Hearing loss associated to aging affects about 60% of people older than 65 years, and has multifactorial causes, as the physiological degeneration, ototoxic

agents and damage caused by organic dysfunction associated with aging. In addition of impairment in the peripheral auditory system, also occurs hearing central failures⁴.

Essential to the performance of human communication, listening is critical in speech perception and helps with the inclusion of the subject in society¹, therefore, is considered one of the most important sensory systems ².

Complaining about difficulty in understanding speech in noisy environments is common in the elderly. The difficulty seems to be higher than expected for the found degree of hearing loss. So, in addition to impairment in the peripheral auditory system, the elderly needs more time to process verbal information that they receive, ^{5,6} which suggests a functional impairment of the neurological processing via the sense of hearing ⁴.

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Assistance CNPq-PIBIC 2009/2010
Conflict of interests: non-existent

For acquisition and understanding of the symbolic components of language, dealing with the temporal processing skills, specifically ordering and temporal resolution, is a requirement^{7,8}. The perception of the order of occurrence of sounds that come in an acoustic event helps to understand the meaning of the message. Also, to notice the silence that occurs between linguistic segments (temporal resolution) helps to discriminate speech⁹. By using the set of hearing tests available to assess temporal processing, it becomes necessary to know how much a test of temporal resolution and a test of temporal ordering are correlated and thus better recognize the limits and benefits of the selection for such assessment.

Specifically, there is a need to know if the faults in temporal resolution in the noise segments measured by the hearing test Gaps-In-Noise will affect the temporal ordering ability measured by tests of auditory pattern recognition long tonal and melodic. This study aimed to investigate the effect of temporal resolution ability in the temporal ordering of a series of sounds with time of stimulation and inter-stimulus interval varied in an elderly population with or without hearing loss.

■ METHOD

15 elderly male and female, over 60 years old participated. They were divided into two groups: one with normal hearing sensitivity, abbreviated GISP, consists of five people and others with impaired hearing sensitivity, abbreviated GIP, consists of 10 seniors. Inclusion criteria for both groups of elderly have been no history of neurological disorders and / or psychiatric disorders observed through history.

For the group with normal hearing sensitivity criterion for inclusion was to show tone audiometry hearing thresholds up to 25dBNA at all frequencies evaluated. For the group with impaired hearing sensitivity, criterion for inclusion was hearing thresholds show larger than 25dBNA and smaller than 70dBNA, evaluated at all frequencies in audiometry. Thus, the exclusion criterion for the group with impaired hearing sensitivity was hearing loss, severe or profound.

The elderly volunteers with impaired hearing sensitivity who were invited to participate in the sample were part of the patients treated at the Center of Integrated Care, Research and Training in Hearing (NIAPEA) Department of Speech Pathology, School of Medicine, UNIFESP. These volunteers formed the sample of elderly people with impaired hearing sensitivity with or without the use of hearing aids (HA). In addition, other elderly volunteers were also invited to participate in this study. These volunteers formed the sample of elderly people with normal hearing sensitivity.

The interview and pure-tone audiometry were performed to select the elderly participants as to their clinical history and hearing sensitivity following the criteria of inclusion and exclusion. In all the selected subjects were administered tests to assess auditory temporal resolution, test GAPS IN-NOISE, abbreviated GIN test, and to assess the temporal ordering tests recognition STANDARD TIME, TPD, in two versions: one with pure tone (tonal TPD) as Musiek, 2004, and another with flute (TPD melodic) as Pereira and Schochat, 2011.

The study was approved by the Ethics Committee in Research of Universidade Federal de São Paulo, CEP / UNIFESP by the number 1018/09. The statistical method was done using descriptive statistics and ANOVA to compare the findings of the ages (in years) and hearing tests, selected according to the percentage of identification of gaps in noise test, thresholds of temporal resolution, tonal adjustments in TPD and melodic observed in the groups with and without hearing loss. We used the Pearson correlation to measure the degree of relationship between variables, but separately in each group. The significance level was 0.05.

■ RESULTS

Table 1 shows the percentage of identification of gaps in GIN test, thresholds of temporal resolution in milliseconds, the percentage of correct tonal and melodic TPD observed in the groups with (GIP) and without hearing loss (GISP). Local insertion of a table (authors: do not enter the tables here, is just a markup).

Table 1 – Descriptive statistics for age (in years), percentage of correct answers in the right ear by GIN (list 1) and left (list 2) and percentage of correct tonal and melodic TPD

Hearing Loss		Mean	Median	Standard Deviation	CV	Min	Max	N	IC	p-value
age (in years)	No Loss	63,0	64	2	3,2%	60	65	5	1,8	0,008*
	with Loss	70,0	69	4,7	6,8%	64	79	10	2,9	
GIN- % RE	No Loss	69,3%	70,0%	15,0%	21,7%	55,0%	93,3%	5	13,2%	<0,001*
	with Loss	39,1%	41,7%	10,1%	25,8%	25,0%	53,0%	10	6,3%	
GIN- % LE	No Loss	70,5%	63,3%	16,6%	23,6%	56,6%	97,5%	5	14,6%	<0,001*
	with Loss	36,8%	35,8%	9,2%	25,1%	23,3%	50,0%	10	5,7%	
GIN-L.GAP RE e LE	No Loss	4,6	5	1,1	24,8%	3	6	5	1,0	0,001*
	with Loss	11,4	10	3,2	28,1%	8	15	10	2,0	
TPD tonal	No Loss	84,6%	86,6%	13,0%	15,4%	63,3%	96,6%	5	11,4%	0,248
	with Loss	78,0%	76,6%	8,4%	10,7%	66,6%	93,3%	10	5,2%	
TPD melodic	No Loss	84,0%	90,0%	15,2%	18,1%	60,0%	100%	5	13,3%	0,514
	with Loss	89,0%	90,0%	12,9%	14,5%	60,0%	100%	10	8,0%	

Legend: CV = coefficient of variation, Min= minimum value Max = Maximum value N = number of sample CI = confidence interval RE = right ear LE = left ear, L= threshold TPD = Test Duration Pattern,% = percentage of correct

* Statistically significant

The age (in years) from the group without hearing loss, GISP is smaller than the group with loss, GIP, with statistically significant differences in age. Also, the GIN_% accuracy of GISP is greater than GIP and the threshold time accuracy, namely GIN_LI whose

differences were statistically significant. (Table 1). The results of tests of duration of tonal and melodic pattern showed no statistical significance between the groups. Data obtained by correlation test are shown in Table 2 to Table 3 for GISP and GIP.

Table 2 – Correlation between age, the gap thresholds and identification of gaps in noise test and the percentage of hits for the TPD in GISP group

No Loss		age	GIN-% RE	GIN-% LE	GIN-L.GAP RE e LE	TPD Tonal
GIN-% RE	Corr	-65,2%				
	p-valor	0,234				
GIN-% LE	Corr	-68,3%	96,2%			
	p-valor	0,204	0,009*			
GIN-L.GAP RE e LE	Corr	76,7%	-87,1%	-75,7%		
	p-valor	0,130	0,055	0,139		
TPD tonal	Corr	-41,5%	35,2%	18,8%	-51,6%	
	p-valor	0,487	0,561	0,762	0,374	
TPD melodic	Corr	-8,2%	-44,3%	-19,2%	54,9%	-49,8%
	p-valor	0,895	0,455	0,757	0,337	0,394

Legend: L = threshold; RE = right ear, left ear = LE; = TPD pattern of duration

* statistically significant

Table 3 – Values of the correlation between age, gap thresholds and identification of gaps in noise test and the percentage of hits in the TPD for GIP

With Loss		age	GIN-% RE	GIN-% LE	GIN-L. GAP RE e LE	TPD Tonal
GIN-% RE	Corr	33,8%				
	p-valor	0,339				
GIN- % LE	Corr	55,0%	79,3%			
	p-valor	0,099	0,006*			
GIN-L.GAP RE e LE	Corr	-5,9%	-92,8%	-72,2%		
	p-valor	0,872	<0,001*	0,018*		
TPD Tonal	Corr	-25,3%	56,3%	38,9%	-60,5%	
	p-valor	0,481	0,090	0,266	0,064	
TPD Melodic	Corr	12,8%	3,3%	17,3%	-9,7%	1,3%
	p-valor	0,725	0,929	0,633	0,790	0,971

Legend: L = threshold; RE = right ear, left ear = LE; = TPD pattern of duration

* statistically significant

In both groups there is significant correlation between the hits by ear as to the percentage of identification of gaps in noise test. A statistically significant negative correlation was found between the percentage of correct answers for the right ear and left threshold Gap in the GIN GIP. And negative values indicate that the higher the percentages of identifying gaps lower the threshold for GAP and vice versa.

The significance of these relations in GIP was seen due to the high sample size. GISP shows a high correlation value, but still not as significant, probably due to low sample sizes. There were no significant correlations between the hearing tests GIN and tonal and melodic TPD.

■ DISCUSSION

The aging is a natural consequence of the development process of society¹⁰. The percentage of people who have difficulties in communication increases progressively with age, associated with hearing impairment and the degeneration of cognitive factors, hearing impairment and sensory deprivation with the highest prevalence in this population⁴.

Auditory disorders in the elderly range from a decrease in hearing thresholds up to major difficulties in understanding speech. Regarding the degree of hearing loss based on the average of the frequencies 500, 1000 and 2000 Hz, a study¹¹ showed that among 211 elderly patients, aged between 60 and 99 years, 32.2% of subjects had normal hearing, 28% mild loss, 25.6% moderate

hearing loss, 6.2% moderately severe, 5.7% severe and 2.4% deep.

Thus, the occurrence of seniors with no hearing loss is small, and most elderly patients have hearing loss, usually mild to moderate. This may explain the difficulty that occurred in this study is selecting subjects without hearing loss. The criteria of normality for the GIN test in Brazilian adults with normal hearing were set at 2008¹². One study found that¹¹ women had thresholds better than expected and normal. In this study the gender variable was not studied due to the low number of causuistic.

In this study (Table 1) individuals in the group with loss, GIP, had older age groups and temporal acuity thresholds lower than the group without loss, GISP, which may have influenced the results observed in GIN. In each group performance per ear was similar, but was different between groups.

Hearing loss associated with age may have compromised the function of temporal resolution in this study. In a study¹³ on temporal resolution measured by the GIN test in healthy elderly and without hearing loss, showed gap detection threshold and percentage of recognition of the stimulus, average values, the right ear of 10.2 ms and 39.1% , and the left ear of 9.1 ms and 42.6% respectively.

There was no statistical significance between the mean thresholds in both ears, as well as the percentage of recognition of the stimulus. Some studies^{12, 14} have already demonstrated symmetry of responses between the ears on the GIN test. Thus, our findings regarding the performance per ear are consistent with those studies that found no right ear advantage on the left, and vice versa in the

GIN test tracks. Still, the gap thresholds for both the right ear and left ear for the group without loss were similar to literature for young normal individuals¹²⁻¹⁵.

An indication that the age factor affects the temporal resolution ability observed in this study was the review of the correlation (Table 2). There was a negative correlation that indicates that the older the worse the performance of individuals, although not statistically significant. GIP, those with hearing loss showed that the older the number of hits was also higher despite low compared to the hits of the GISP, namely, the group (Tables 1 and 3).

One of the limitations of this study was not studying the elderly according to the degree of hearing loss and rehabilitation time with the use of hearing aids, two important factors that could explain the findings. Thus, it is interesting that other studies to research the temporal acuity threshold for hearing loss and experiencing hearing offered by the use of hearing aids or auditory deprivation in those elderly with hearing loss and who do not use hearing aids.

The ability to sort the TPD melodic involves discrimination and ordering a series of four sounds that are distinguished by being short with duration of 500ms or 2000ms long lasting, with inter-stimulus interval of 500ms. These lengths are more easily perceived than those of the tonal TPD¹⁶. For the tonal and melodic Duration Pattern tests there was no interference from the presence of hearing loss in the response of the two tests, and the two groups had equivalent performance (Table 3).

The age of participants of the study did not influence the performance in each of the different hearing tests, tonal and melodic TPD. The comparison of performance for the group without hearing loss (Table 2) showed better performance in the tonal TPD than in the melodic TPD, these findings were not statistically significant correlation and these results can be explained by the possible lack of attention from individuals during the test. In a study¹⁷ the factor attention was also found to be a possible cause for prejudice in response on tonal TPD because its psychoacoustics task requires a behavioral response of the conscious individual,

who may be affected by many factors, such as attention.

In the group of elderly people with hearing loss there was no difference between the two tests, although the task of melodic TPD has shown it is easier, with better performance than the tonal TPD (Table 3). The findings of this study for TPD agree with the findings of a study of literature¹⁷ in which older people with hearing loss up to moderate showed similar performance in the TPD of elderly people with normal hearing.

Thus the TPD test responses were unchanged in the presence of cochlear hearing losses from mild to moderate. There was no statistically significant correlation between the results of each test (Tables 2 and 3), namely, the temporal resolution ability as measured by GIN hearing test did not correlate with the temporal ordering ability as measured by standard tests of tonal and melodic pattern.

It is noteworthy that in this comparison of the GIN test with the two TPD tests was observed that the greater the number of hits per ear in the GIN test and the lower the threshold of hearing acuity as measured by the same test, the better the results found in two tests of TPD in both groups, although not statistically significant, showing that the small sample size has limited the study. It was not possible to consult studies similar to this in literature, until the end of this study.

■ CONCLUSION

Comparing the GIN test with the two TPD tests was observed that the greater the number of hits per ear in the GIN test and the lower the threshold of hearing acuity as measured by the same test, the better the results found in two tests of TPD in both groups of elderly patients with and without hearing loss, without statistical-significance. Thus, we can conclude that the ability of temporal resolution does not affect the ability of temporal ordering of a series of sounds with duration times of stimuli and inter-stimulus intervals varied as those observed in standard tests of tonal and melodic duration studied.

RESUMO

Objetivo: verificar o efeito da habilidade de resolução temporal na ordenação temporal de uma série de sons com tempo de estímulo e de intervalo inter-estímulo variado em uma população de idosos com ou sem perda auditiva. **Método:** 10 (dez) indivíduos idosos com perda auditiva de grau leve a moderado que faziam ou não uso de AASI e cinco idosos sem perda auditiva, com idade entre 60 e 80 anos foram submetidos aos testes de ordenação temporal de série de sons com tom puro, denominado Teste padrão de Duração, e com tom musical, denominado teste de padrão de duração melódico, e o teste de resolução temporal Gaps-in-Noise ou teste GIN. **Resultados:** a análise do teste de resolução temporal quanto à porcentagem de identificação correta mostra que o grupo sem perda possui maior porcentagem de identificação de gaps do que o grupo com perda. Assim, os indivíduos com perda auditiva tiveram piores limiares de detecção de Gaps (médias de 11,4 milissegundos) do que os indivíduos sem perda auditiva (4,6 milissegundos). Na análise de cada um dos testes de ordenação de série de sons não ocorreram diferenças estatisticamente significantes entre os grupos. Não houve correlação significativa entre o desempenho dos idosos sem e com perda auditiva entre os testes de processamento temporal. **Conclusão:** a habilidade de resolução temporal não interfere na habilidade de ordenação temporal de uma série de sons com tempos de duração de estímulos e intervalos inter-estímulos variados em idosos com ou sem perda auditiva.

DESCRITORES: Percepção Auditiva; Idosos; Fonoaudiologia

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Received on: December 08, 2011

Accepted on: June 12, 2012

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