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Cognitive abilities and performance in the temporal ordering tests for elderly people

Habilidades cognitivas e desempenho nos testes de ordenação temporal em idosos

Maysa Bastos Rabelo¹ , Marcia da Silva Lopes² , Ana Paula Corona² , Jozélio Freire de Carvalho¹ , Roberto Paulo Correia de Araújo³ 

ABSTRACT

Purpose: To investigate the influence of cognitive domains on the performance of the pitch pattern sequence and duration pattern sequence tests among elderly people. **Methods:** Cross-study realized among individuals aged between 60 to 79 years. We performed an interview, cognitive evaluation through Montreal Cognitive Assessment, peripheral audiologic evaluation (tonal and vocal audiometry) and central (pitch pattern sequence and duration pattern sequence). **Results:** The study involved 58 women with average age of 66.2, and 28 men at an age average of 68.3. On the one hand, we observed that the visual-spatial abilities, attention, concentration and working memory present correlation with temporal tests in females and that language ability correlates with the standard frequency test. Among men, there was a tendency to significance in terms of visual-spatial abilities. Furthermore, women had better performance in memory ability. **Conclusion:** Cognitive aspects may influence the temporal ordering tests among elderly individuals, especially females.

Keywords: Hearing; Auditory perception disorders; Aging; Elderly; Cognition

RESUMO

Objetivo: Investigar a influência dos domínios cognitivos no desempenho do teste padrão de frequência e teste padrão de duração em idosos. **Métodos:** estudo seccional, desenvolvido em indivíduos com idade entre 60 e 79 anos. Realizou-se entrevista, avaliação cognitiva por meio do *Montreal Cognitive Assessment*, avaliação audiológica periférica (audiometria tonal e vocal) e central (teste padrão de frequência e teste padrão de duração). **Resultados:** Participaram do estudo 58 mulheres com média de idade de 66 anos e 2 meses e 28 homens, com média de idade de 68 anos e 3 meses. Verificou-se que as habilidades visuoespaciais, de atenção, concentração e memória de trabalho apresentaram correlação com os testes temporais no sexo feminino e que a habilidade de linguagem apresentou correlação com o teste padrão de frequência. Já entre os homens, houve tendência à significância quanto à capacidade visuoespacial. Ademais, as mulheres apresentaram melhor desempenho na habilidade de memória. **Conclusão:** Os aspectos cognitivos podem influenciar nos testes de ordenação temporal em indivíduos idosos, sobretudo do sexo feminino.

Palavras-chave: Audição; Transtornos da percepção auditiva; Envelhecimento; Idoso; Cognição

Study carried out at Instituto de Ciências da Saúde, Universidade Federal da Bahia – UFBA – Salvador (BA), Brasil.

¹Programa de Pós-graduação Processos Interativos dos Órgãos e Sistemas, Instituto de Ciências da Saúde, Universidade Federal da Bahia – UFBA – Salvador (BA), Brasil.

²Departamento de Fonoaudiologia, Instituto de Ciências da Saúde, Universidade Federal da Bahia – UFBA – Salvador (BA), Brasil.

³Departamento de Bioquímica Oral, Instituto de Ciências da Saúde, Universidade Federal da Bahia – UFBA – Salvador (BA), Brasil.

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Corresponding author: Maysa Bastos Rabelo. E-mail: maysa_bastos@yahoo.com.br

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INTRODUCTION

The behavioral assessment of auditory temporal processing is based on tests that investigate the abilities of resolution, masking, integration and ordering. The latter can be analyzed using tests that assess the recognition of the pure tone temporal pattern, such as the pitch pattern sequence (PPS) and the duration pattern sequence (DPS) tests⁽¹⁾.

Temporal processing allows the individual to identify subtle variations that occur in the acoustic information, over time, that contribute to the analysis and decoding processes of the acoustic stimulus, presenting an impact on speech intelligibility⁽²⁾. Furthermore, due to aging, the difficulties related to speech perception imply a complaint of difficulty in understanding, especially in noisy environments, which is not related to peripheral hearing impairment⁽³⁾.

Studies have shown a relationship between age-related working memory decline and difficulties in auditory processing, especially in temporal aspects⁽⁴⁾. Additionally, the verbal response modality in temporal tests involves refined cognitive processes, which depend on the integrity of both hemispheres and the corpus callosum⁽⁵⁾.

Thus, the interpretation of temporal tests findings, without considering the performance in tasks that require a contribution of cognitive skills, can culminate in the overestimation of the elderly's difficulties in relation to auditory processing.

Given the above, the present study aimed to investigate which cognitive domains can influence the performance of the pitch pattern sequence and duration pattern sequence tests in the elderly people.

METHODS

This sectional study was approved by the Research Ethics Committee of the Institute of Health Sciences of the Universidade Federal da Bahia (UFBA), protocol number 2,268,734, and all participants signed the Informed Consent Form.

A convenience sample was obtained from individuals who attended social and health centers of reference for the elderly, in the city of Salvador/BA. The selection criteria were age greater than or equal to 60 years, no report of traumatic brain injury, stroke and diagnosis of severe psychiatric disorder or neurodegenerative diseases. Individuals with conductive, mixed, or sensorineural hearing loss, with a degree from moderately severe in one ear and with altered cognitive status, were excluded from the Portuguese version of the questionnaire *Montreal Cognitive Assessment* (MoCA)⁽⁶⁾.

The evaluations were carried out at the Speech Therapy Teaching Center (CEDAF) of UFBA. Cognitive aspects were investigated using the MoCA, a cognitive screening tool in which eight domains are evaluated. The maximum test score is 30 and values below 26 indicate cognitive impairment⁽⁶⁾.

The peripheral auditory (pure tone and vocal audiometry) and central assessments (temporal ordering tests), were performed using the AC40 audiometer, supra-aural headphones TDH 39, and the individuals remained in an acoustic booth.

The central auditory processing (CAP) tests were performed in a binaural way, with a Samsung branded *tablet*, coupled to the audiometer, at 50 decibels sensation level, from the speech reception threshold. Three training sequences and 30 evaluation

sequences were used. Those who failed to discriminate the training sequences after three attempts returned the next day to retake the assessment.

In the PPS, pure tone sequences were presented, differing in frequency, being high (1122 Hz) or low (880 Hz). For the DPS, the sequences were three tones of 1000 Hz, which differed in duration, being short (250 ms), or long (500 ms)⁽¹⁾. In both tests, the nomination of the stimulus was requested.

A descriptive analysis of the variables sex, age and education, as well as the performance in the temporal tests and cognitive domains was performed. MoCA was analyzed considering the total score and the score obtained in the cognitive domains, namely: executive function; visuospatial capacity; memory, attention, concentration and working memory; language and orientation (temporal and spatial).

The association between the total score and each cognitive domain, according to gender, was investigated using the Mann-Whitney test. The performance in the temporal ordering tests was correlated to the cognitive domains, using Spearman's correlation coefficient. The level of significance established for this study was 5%.

RESULTS

We evaluated 131 individuals, however, 39 were excluded, the most frequent reason being a change in cognitive aspect ($n = 27$), followed by the diagnosis of conductive or mixed hearing loss ($n = 7$) and not understanding the temporal ordering tests, even with a score equal to or higher than 29 in MoCA ($n = 5$). For the analysis, 6 women were not considered because there were no men in the same age group included.

Thus, 86 individuals were included, most of them female (67.4%), with a mean age of 66 years and 2 months. In the male gender, mean age was 68 years and 3 months. Considering the heterogeneity of the sample in relation to gender, the analyzes were performed according to this variable. Regarding education, most women (39.7%) and men (42.9%) had incomplete or complete high school; 22.4% of women and 28.6% of men had incomplete or complete higher education and the others, up to first level of education.

When comparing performance in the different domains of MoCA, we observed that only memory showed a difference between genders, with women achieving better performance (Table 1).

The correlation between performance in temporal tests and the domains of MoCA demonstrated that, among women, visuospatial, attention, concentration and working memory skills showed a moderate and significant positive correlation in both temporal ordering tests. In addition, also among women, the language domain, and the total score in MoCA presented a moderate and significant positive correlation only with the PPS. Among men, a moderate positive correlation was identified, with a tendency to significance, for the visuospatial ability in both tests of temporal processing (Table 2).

The cognitive domains that correlated with the temporal ordering tests are shown in Figures 1 and 2.

Table 1. Median and association of cognitive domains assessed through Montreal Cognitive Assessment between genders

| Variable | Male | Female | P value |
|--|------|--------|---------|
| Executive function | 3.0 | 3.0 | 0.716 |
| Visuospatial capacity | 4.0 | 4.0 | 0.319 |
| Attention, concentration and working memory | 6.0 | 6.0 | 0.124 |
| Language | 6.0 | 6.0 | 0.073 |
| Memory | 3.0 | 4.0 | 0.019* |
| Guidance | - | - | - |
| Total score | 27.5 | 28.0 | 0.832 |

*p ≤ 0.05 Nonparametric test (Mann-Whitney U test of independent samples)

Table 2. Correlation between cognitive domains and temporal ordering tests

| Variable | Male | | Female | |
|--|-------|--------|--------|--------|
| | PPS | DPS | PPS | DPS |
| Executive function | | | | |
| Correlation coefficient | 0.08 | -0.13 | 0.072 | -0.065 |
| P value | 0.66 | 0.48 | 0.59 | 0.626 |
| Visuospatial capacity | | | | |
| Correlation coefficient | 0.349 | 0.369 | 0.322 | 0.328 |
| P value | 0.069 | 0.053 | 0.014* | 0.012* |
| Attention, concentration and working memory | | | | |
| Correlation coefficient | 0.062 | 0.168 | 0.428 | 0.449 |
| P value | 0.754 | 0.394 | 0.001* | 0.000* |
| Language | | | | |
| Correlation coefficient | 0.121 | 0.08 | 0.326 | 0.217 |
| P value | 0.538 | 0.684 | 0.013* | 0.102 |
| Memory | | | | |
| Correlation coefficient | 0.037 | -0.026 | 0.015 | -0.079 |
| P value | 0.851 | 0.896 | 0.908 | 0.556 |
| Guidance | | | | |
| Correlation coefficient | - | - | - | - |
| P value | - | - | - | - |
| Total score | | | | |
| Correlation coefficient | 0.098 | 0.086 | 0.393 | 0.251 |
| P value | 0.619 | 0.663 | 0.002* | 0.057 |

*p-value ≤ 0.05; Nonparametric correlations

Subtitle: PPS = Pitch pattern sequence; DPS = Duration pattern sequence

DISCUSSION

The results revealed that the performance of women in temporal ordering tests correlated with visuospatial, attention, concentration, working memory and language skills. For men, only the visuospatial capacity showed a correlation with the temporal tests. Furthermore, memory showed a difference between genders, with greater performance for women.

Cognitive changes are described in the literature as factors that influence poor performance in CAP tests^(3,5). Therefore, the variability in the performance of temporal ordering in the elderly can also be attributed to non-auditory aspects, related to aging, such as attention, memory, and linguistic competence⁽⁷⁾.

The difference found in the present study on cognitive behavior between genders can be attributed to anatomical and/or functional differences, especially in the temporal cortex, in the Broca's area and in the corpus callosum. The latter has a higher concentration of nerve fibers in women, providing a better inter-hemispheric connection⁽⁸⁾. However, authors reported that such differences are attributed to strategies for

using cognitive resources and not skills, therefore, they would have a greater relationship with brain functioning than with anatomy⁽⁹⁾. Thus, we believed that, due to the greater ease in integrating various skills, women use more cognitive resources to answer the tests, than men.

The visuospatial capacity involves the activation, retention, and manipulation of mental representations, therefore, it depends on the processing of information and working memory, considering the traces of storage, verbal or visual⁽¹⁰⁾. Since there is a relationship between visuospatial capacity and working memory, we believed that the interdependence of these domains contributes to better performance in temporal tests, among those with better development of this cognitive function.

The correlation between attention skills, concentration and working memory with the temporal tests, observed in the current study, is confirmed by other authors, since the temporal tests are not exclusive to the auditory modality, since the stimulus must be temporarily stored before to be verbalized, which involves such skills, in addition to linguistic competence⁽¹¹⁾.

Verbal response requires the integrity of the cerebral hemispheres and the corpus callosum for perception and

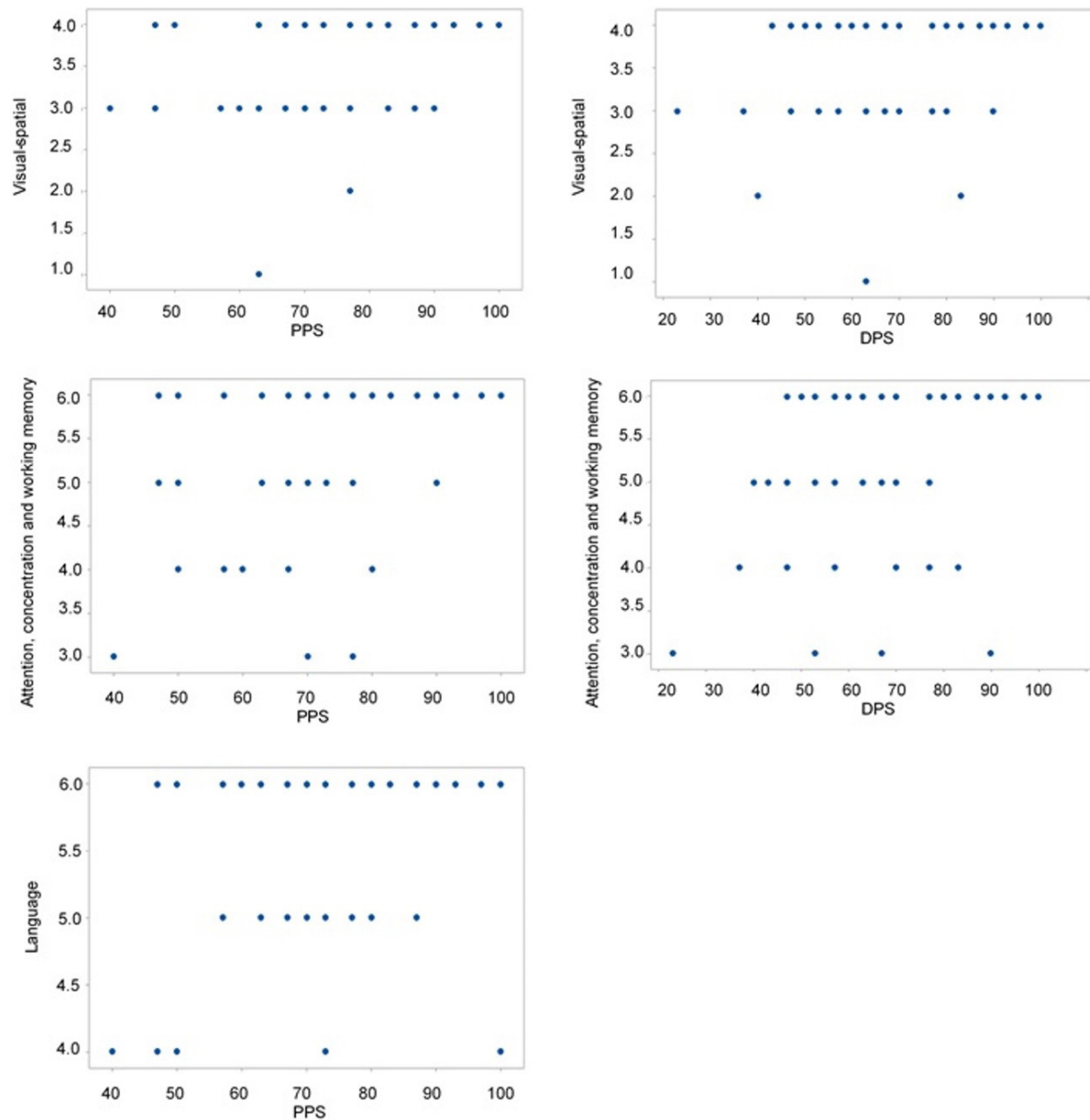


Figure 1. Dispersion diagram for correlation between cognitive domains and performance in temporal ordering tests in females

Subtitle: PPS = Pitch pattern sequence; DPS = Duration pattern sequence

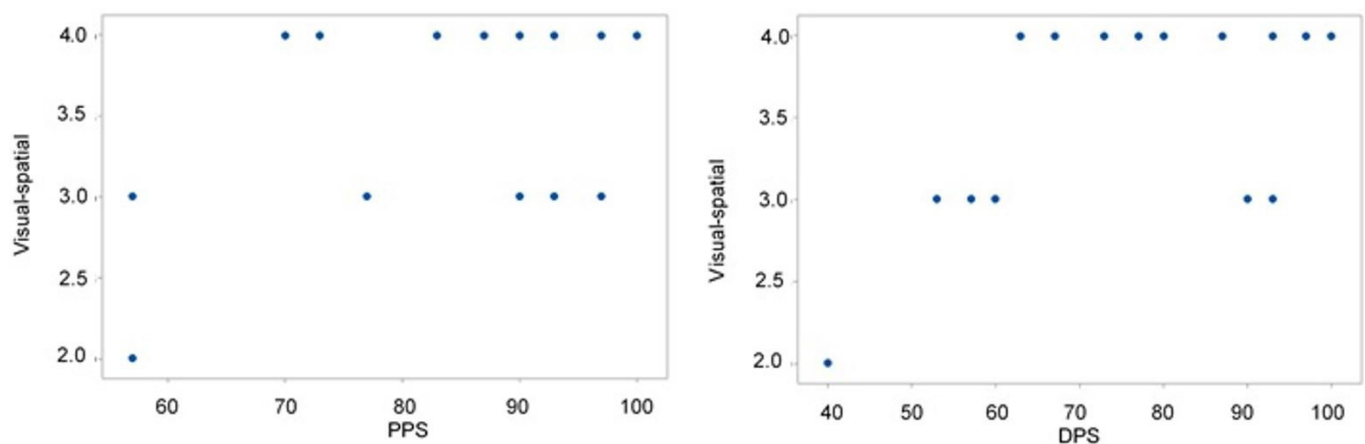


Figure 2. Dispersion diagram for correlation between visuospatial cognitive domain and performance in temporal ordering tests in males

Subtitle: PPS = Pitch pattern sequence; DPS = Duration pattern sequence

naming⁽⁴⁾. Thus, language is fundamental in temporal tests, as identified in the current study and, the better this skill, the better the performance in tests.

It is suggested that daily stimulation of cortical functions favors synchrony between brain hemispheres and integration with auditory skills⁽¹²⁾. In addition, the greater the brain organization process, the greater the cognitive reserve, providing increased activity and synaptic density, implying an improvement in perception, memory and reasoning and a consequent delay in the appearance of cognitive decline⁽¹³⁾.

In the present study, there was a difference between genders for memory ability, with better performance among women, in agreement with previous investigation⁽¹⁴⁾. However, this investigation deserves caution, since the memory required to perform temporal tests is working memory, related to information processing, which refers to recent acquisition and storage, different from long-term memory⁽¹⁵⁾.

The main limitation of this study was related to the reduced number of male individuals, which may have contributed to the fact that the analyzed variables were not statistically significant in this group. However, it is noteworthy that this is an expected phenomenon in the elderly population, due to the greater care with health issues among women and, consequently, increased life expectancy. Thus, further investigations must be carried out with a larger group of men.

From this study, we found that cognition is fundamental for the performance of auditory skills, therefore, it must be evaluated prior to the application of CAP tests, aiming to guide the diagnostic investigation of elderly people susceptible to cognitive decline, due to age.

CONCLUSION

The findings of the present study revealed that, in the elderly, the performance in temporal ordering tests is influenced by visuospatial skills. They also indicated that, in women, this performance is also associated with attention, concentration, working memory and language. Thus, the results showed that to perform the tasks required by the tests of temporal ordering, men and women use different cognitive skills.

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