Original Article

Attention Level in Musicians that Study the Musical Score

Nível de Atenção em Músicos que Estudam Partitura

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ABSTRACT

The attention level was evaluated in musicians that study the musical score in the Music Conservatory of the Cabo de Santo Agostinho city/ PE, Brazil. Fifty three (53) musicians with more than 2 (two) years of experience in the 16-38 age group were evaluated. The subjects were divided into 4 (four) groups: a) Female non-musicians (CONTROL 1, n = 5) b) Male non-musicians, (CONTROL 2, n = 18), c) Female musicians that study the musical score, (FM, n = 5) b) Male musicians that study the musical score, (MM, n = 25). The evaluations were accomplished by the Trail Making A, d2 test, Digit Span Forward Test, Digit Span Inverse Test and paced auditory serial addition test (PASAT). Anova was used with $p<0.05$ and expresses data in mean ± SEM. The male musicians that study the musical score (MM) showed a reduction in time, which means a greater level of focus of attention (37.24 ± 3.14) compared to male non-musicians (CONTROL 2) (54.22 ± 4.77, $p<0.05$ *). However, for female non-musicians (CONTROL 1) (42.80 ± 5.05), there was not a significant statistical difference ($p>0.05$). The male musicians that study the musical score (MM) had greater ability to resist interference (9.68 ± 0.85), when compared to female musicians that study the musical score (FM) (4.60 ± 0.93, $p<0.05$ *), male non-musicians (CONTROL 2) (5.61 ± 0.97, $p <0.05$ *) and female non-musicians (CONTROL 1) (4.40 ± 2.42, $p<0.05$ *). This study found that the male musicians that the study musical score showed a high level of focused attention and the ability of resistance to interference when compared to non-musicians.

Key words: Musicians, focused, resistance to interference.

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RESUMO

Avaliou-se o nível de atenção em músicos que estudam partitura do Conservatório de Música do município do Cabo de Santo Agostinho/ PE, Brasil. Foram avaliados 53 indivíduos músicos com mais de 2 (dois) anos de experiência na faixa etária entre 16 e 38 anos. Os sujeitos foram divididos em 4 (quatro) grupos: a) Não-músicos do gênero feminino, (CONTROLE 1, n = 5); b) Não-músicos do gênero masculino, (CONTROLE 2, n = 18); c) Músicos do gênero feminino que estudam partitura, (FM, n = 5) d) Músicos do gênero masculino que estudam partitura, (MM, n = 25). As avaliações foram realizadas pelos testes das *trilhas A*, teste d2, *Span* de dígitos em ordem direta, *Span* de dígitos em ordem inversa e *paced auditory serial addition test (PASAT)*. Os dados foram analisados pelo teste de Análise de Variância (ANOVA) e expressos em média ± EP, com $p<0,05$. Os músicos do gênero masculino que estudam partitura (MM) apresentaram redução de tempo, significando maior nível de foco da atenção (37,24 ± 3,14), quando comparados a não-músicos do gênero masculino (CONTROLE 2) (54,22 ± 4,77, $p<0,05$*). Entretanto, em relação a não-músicos do gênero feminino (CONTROLE 1) (42,80 ± 5,05), não houve diferença estatística significativa ($p>0,05$). Os músicos do gênero masculino que estudam partitura (MM) apresentaram maior capacidade de resistência à interferência (9,68 ± 0,85), quando comparados a músicos do gênero feminino que estudam partitura (FM) (4,60 ± 0,93, $p<0,05$*), a não-músicos do gênero masculino (CONTROLE 2) (5,61 ± 0,97, $p<0,05$*) e a não-músicos do gênero feminino (CONTROLE 1) (4,40 ± 2,42, $p<0,05$*). Este trabalho constatou que os músicos que estudam partitura apresentaram um alto nível de foco de atenção e da capacidade da resistência à interferência quando comparados a não músicos.

Palavras-chave: Músicos, foco de atenção, resistência à interferência.

INTRODUCTION

For many years, according to Peretz (2001)[1], researchers have been studying the music, mainly, as a cultural product of great relevance for the cognitive development. Among these researchers, there are psychologists and musicologists that have demonstrated that the musical system, from the epistemological view, presents a high complexity that requires significant effort and an increase of the cognitive deve-lopment of a person that study it [2].

According to Gotgay *et al.* (2004) [3] the development of the human brain comes from a structural process and functionally non-linear. This affirmation stimulates the hypothesis that the musical practice may exert an increase of the cognitive development, such as: intelligence, concentration and attention.

It is important to know that the music classes may be considered as unique experiences, because involve particular combinations from several aspects, overall, the reading of musical scores at first sight, concentration, rhythm perception, auditory training, the presence of sound return on exposure to music, in short, it seems to stimulate a greater level of attention [4].

There are some observed aspects that, possibly, ratify these hypotheses, like the individuals that have music classes may develop different types of abilities, among them, quickly response to the auditory information related to different groups of musical tones, as bass or treble or still sounds of the different musical tones, improve the emotional sensitivity and develop fine motor skills and attention to several forms of signals [2].

From the foregoing assumptions, this present study has joined the research of the authors [5, 6, 7], related to investigations of attention level proposed by Mateer and Mapou (1996) [8] that is divided into two great factors: deployment and encoding. The interest for this subject appeared from the previous reading of all the mentioned articles that motivated

the hypothesis of musicians that study musical scores presenting an increase in the attention performance.

SUBJECTS and METHODS

Location

The experiment was carried out in the Conservatory of Music in Cabo de Santo Agostinho city/ PE, Brazil.

Subjects

Musicians with more than 2 (two) years of experience and non-musicians in the 16-38 age group, randomly chosen, forming a sample of 53 male and female individuals.

The subjects were divided into 4 (four) groups: a) Female non-musicians, (CONTROL 1, n = 5); b) Male non-musicians, (CONTROL 2, n = 18); c) Female musicians that study the musical score, (FM, n = 5) d) Male musicians that study the musical score, (MM, n = 25).

The subjects were subjected to neuropsychological evaluations in a room for to the psychological treatment of students, under pattern conditions, in a building, with air conditioning, at the temperature of 22° ± 2°C.

Attention evaluation

All the evaluations, correlations and interpretation of the Psychological Tests were conducted under the guidance and Constant presence of a Psychologist, Professor Dr. Valdenilson Ribeiro Ribas, registration CRP 11.797, according to the Federal Council of Psychology guidelines in Brazil. It is noteworthy that not only the statistical analysis were made by the psychologists but all the manipulations with the Psychological Tests, since in Brazil, only a psychologist can apply a Psychological Test, according to the resolution N° 25/2001 of the Federal Council of Psychology, besides the author of this work has the academic formation in Pedagogy.

Deployment factor – Verified by the *trail making* and d2 tests.

Deployment is divided in three aspects. The first one is the wakefulness level, which involves the phase that the individual is torpor, comatose, asleep or awake. The second aspect is the focus of attention, which is the capacity of the individual to select one stimulus among others, that is, choosing that stimulus that interests him most. The last aspect is the sustained attention that is related to the capacity of the individual to maintain or focus a selected stimulus during the time of interest.

Encoding factor – Verified by the *span* of digits in direct and inverse order tests.

The encoding factor, as mentioned above, is related to the capacity of the individual to select and store information for mental processing with resistance to environmental interferences [5].

Test application

Trail Making A: This test evaluates the focus of attention, it is formed by 25 random numbers in a organized way in a A4 paper sheet where the individual must link a sequence of spread and random numbers in ascending order (part A). The subject is instructed to perform the task in the shortest time possible and, at the end of the test, the total time achieved by the individual is recorded. This test will evaluate the capacity that the individual has to focus on a stimulus and maintain the search for it, the attention speed, sequencing and mental flexibility. As the evaluation of this test is simple and does not release more energy from the individual to maintain the focus, so it ends up, essentially, a test of focus evaluation.

d2: the *d2* test developed by Brinckenkamp in 1981 is a test of sustained/focused attention that was designed with the aim to measure the capacity to lead a test very used in the Traffic Department and in the psychotechnical test. The d2 test evaluates the focus maintenance of the subject. This test must be marked in a specific form containing 14 lines with 47 letters each, the objective is to maintain the focus on d*2*, according to the previous orientation/explanation, since the letter "d" may present two lines (") above or below it, as well as may present one line (') one above and another below it. The subject must mark each "d" followed

by two dashes and ignore all the other signals. The "p" must never be scratched or marked, if by chance the subject marks the letter "p" and automatically realize that, he may differentiate it with a circle. This will indicate that the individual is maintaining the focus.

The d2 test requires a capacity to maintain the focus of attention much more elaborated that in the *Trail Making* test, because during the execution of the d2 test there is the tiredness in focus and in the search for stimulus.

Digit Span Forward - *Span* of digits in direct order, a simple test for the evaluation of the attention extension, that is, it is an indirect form of measuring the storage capacity of information that the subject is able to apprehend in his attention. The *Digit Span Forward* is used for the evaluation in attention processes and temporary memory, that is, to measure the capacity that an individual has to store information for a short interval. The test begins with a sequence of three numbers and progressively increases, and then it is asked to the assessed subject to repeat the sequence. For example, the examiner says a sequence of numbers (5-2-9), but only he can see these numbers, then the subject must repeat the same sequence correctly.

Digit Span Inverse - *Span* of digits in inverse order is a test similar to the digits in direct order, in which the examiner says the sequence in the direct order and the subject repeats the sequence in the inverse order. For example, the examiner says 4-3-7; the individual must repeat 7-3-4. Thus, the subject memorizes the sequence, inverts the order and reproduces it in a loud voice in order to be observed by the examiner if he is doing correctly or not.

Through the *Span* of digits test in direct order it will be indirectly measured the amount of information that the subject is able to retain. In the *Span* of digits in inverse order, the subject will also store the information, but, besides the information storage in memory, he must manipulate mentally the information of the memory.

PASAT - Paced Auditory Serial Addition Test: It is a test of addition for the evaluation of the storage capacity of information, mental manipulation and resistance to interference, that is, sustained and focused attention. In this activity the subject will add a sequence of numbers said by the examiner. Then the examiner says the first number and the second, after that the subject adds both and answers. From the second number on, the individual must add this last number. For example, the examiner says 3, 4= 7, when he says the next number the subject must add it to the last number that was said by the examiner, which was 4 and not with the previous sum that was 7. So, the assessed subject must always maintain the last number and discard his own answer.

The *PASAT* requires the mental manipulation, information and resistance to interference from the subject.

DATA ANALYSIS

The data found in the individual application of the attention tests were analyzed by the Analysis of Variance (ANOVA) and expressed in mean ± SEM (mean ± SEM) , with the significance level of $p<0.05$.

RESULTS

Focus of attention evaluation - *Trail Making A*:

The male musicians that study the musical score (MM) presented time reduction, that means a greater level of focused attention (37.24 ± 3.14) when compared to male non-musicians (CONTROL 2) (54.22 ± 4.77, $p<0.05$*). However, in relation to female non-musicians (CONTROL 1) (42.80 ± 5.05) there was not a significant statistical difference ($p>0.05$).

Evaluation of the focus of attention and/or psychomotor speed - *Trail Making*

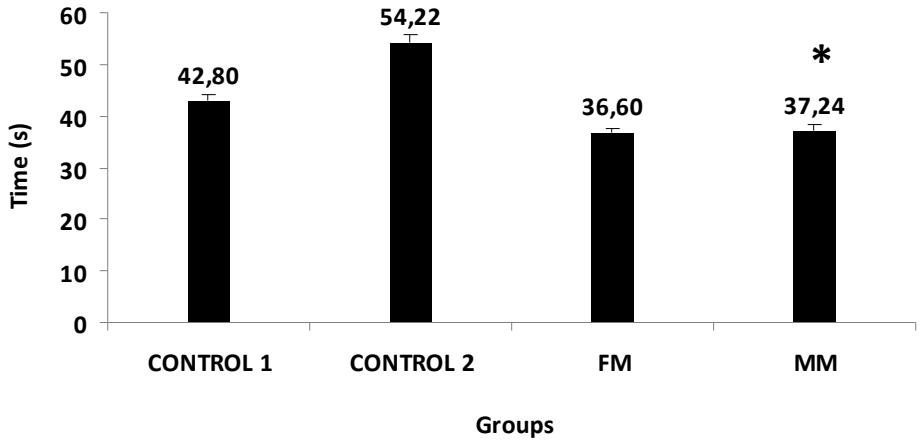

Figure 1. Measure of focus of attention, evaluated by the Trail Making A – in seconds in musicians of both genders that read the musical score, compared to non-musicians. Data represented in x ± SEM, com $p<0.05$*.

Evaluation of the Resistance to Interference Capacity - Paced Auditory Serial Addition Test (PASAT):

The male musicians that study the musical score (MM) presented a greater resistance to interference capacity (9.68 ± 0.85) when compared to female musicians that study the musical score (FM) (4.60 ± 0.93, $p<0.05$*) to male non-musicians (CONTROL 2) (5.61 ± 0.97, $p<0.05$*) and to female non-musicians CONTROL 1 (4.40 ± 2.42, $p<0.05$*).

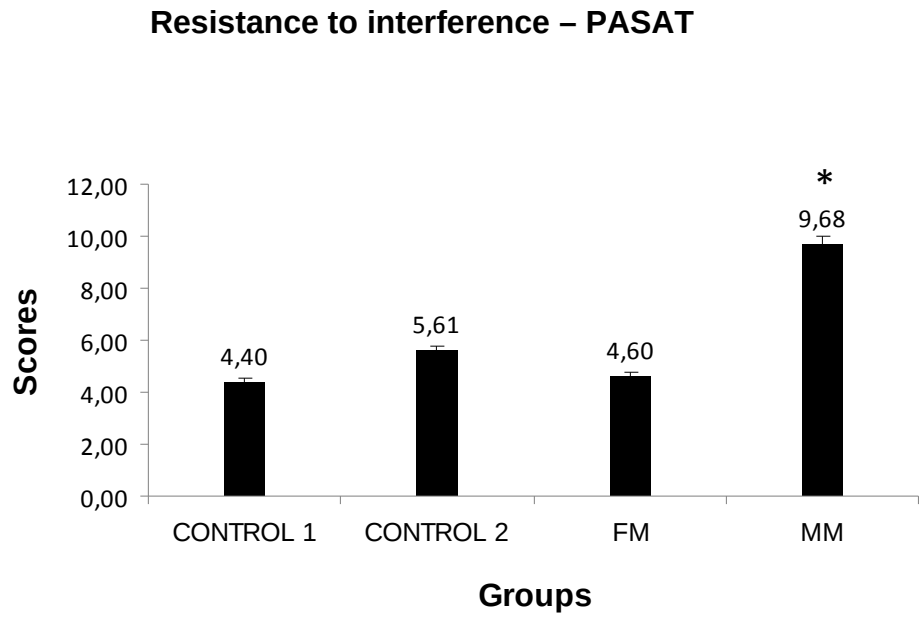

Figure 2. Measure of the resistance to interference capacity, evaluated by the *PASAT* test- Paced Auditory Serial Addition Test in musicians of both genders that read the musical score, compared to non-musicians. Data represented in x ± SEM, com $p<0.05$*.

DISCUSSION

This work showed that musicians that study the musical score presented a greater level of focused attention and resistance to interference capacity when compared to non-musicians.

The results of this research corroborate to the ones found by Menezes *et al.* (2009), Ribas *et al.* (2010) and Rodrigues *et al.* (2010) [9], related to the increase in attention by the stimulation of the cognitive tool during the labor activities.

However, although the findings above mentioned are linked, it is necessary in this discussion to clarify their methodological differences and similarities. The difference is that Menezes *et al.* (2009), Ribas *et al.* (2010) and Rodrigues *et al.* (2010) have worked with the evaluation of the attention level in students that have parents who graduated college that presented reading habits, with air traffic controllers of Area Control Center of Recife and with students that participated in cultural movements, respectively.

The similarities in these studies are presented exactly in the theoretical methodological line used by the foregoing studies, which used the attention theory proposed by Mateer & Mapou (1996) and, possibly, in the pattern alteration of the brain perfusion with the increase in the blood flow, that is typically observed in structural neuroimaging examinations, after physical exercise [10] or in individuals that present persistent use of cognitive instrument, during the work activity, such as airline pilots and air traffic controllers or in day-to-day tasks, like reading, computer use, musicians and others [7].

This work, however, countered the findings of Guerra-Ribas *et al.* (2010)[11] who although has worked with the same theoretical fundamentation, based on the theory of Mateer & Mapou (1996), demonstrated the opposite effect, implying in his discussion that his results seem to influence the fact that the subjects do manual labor.

The methodological differences among the studies with conflicting results were that the study of Guerra-Ribas *et al.* (2010) [11] evaluated the stress effect in attention of the food handlers with more than five years in the profession that worked for outsourced companies of a public hospital in

Recife/PE that presented stress with a predominance of physical symptoms in the phase of resistance and also reduced the focused auditory attention and less resistance to the interference capacity. Thus, there it seems to be a plausible explanation of the differences and results between this work and the one previously mentioned, since Guerra-Ribas *et al.* (2010) did not work with subjects that make constant use of cognitive tools, but they only execute orders already planned by other subjects, such as chefs and/or nutritionists. These subjects, which were evaluated by Guerra-Ribas *et al.* (2010) seemed to have not developed other behavior that stimulate the neurocognitive structures, like the reading habit, the constant use of computers or games that involve a more complex strategy like chess [9].

The music, unlike the manual labor, seems to demonstrate higher forms that require a more complex brain functioning. It is known that the simple act of studying music and reading the musical score enables the blood displacement in determined regions of the brain [5].

The results of this work seem to demonstrate the interaction of the behavior developed by musicians with the displacement of glucose and the increase in the oxygenation in determined brain areas, making it possible a greater performance of glial cells, which are non-neuronal cells of the central nervous system that provide support and nutrition to neurons. Usually rounded, in the human brain the glial cells are around 10 times more numerous than neurons. Unlike the neuron, which is amitotic, in the glial cells occurs the mitosis[12].

For years, neuroscientists believed that neurons were the responsible for all the communication of the central and peripheral nervous system and that glial cells, although nine times more numerous than neurons, only feed them. New imaging techniques and ultrasound instruments show that glial cells communicate with neurons and with each other about the messages from nerve cells and that glial cells are capable to modify these signals in the synaptic between neurons and may even influence the location of the formation of new synapses [13].

Due to this feat, the glial cells may be essential, besides the importance in recovery from neurological injuries, for the construction of memories and for the learning that depends on the language, intelligence, perception, concentration and attention [14].

In this context, the results, showing a high level of focused attention and the resistance to interference capacity in this study seems to recommend, from the didactic point of view, the inclusion of the music discipline, as being a powerful tool facilitating the process of learning in all areas, since it increases the neurocognitive capacity of the subject that practices it.

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