ACUTE EFFECTS OF BRAIN STIMULATION IN SHORT-TERM MEMORY OF YOUNG PERSONS

CARIELO AA [1,2,3] ,CALOMENI MR [1], DIRÉ GF [2,4,5,], GOMES ML [4], FERNANDES JFO [4], FREIRE RB [6], BORBA HR [6], ALMEIDA MWS [1], BIANCHI CE [1], SILVA VF [1]

[1]Universidade Castelo Branco – LABNEU II, Rio de Janeiro/RJ – Brazil.

[2]Universidade Estácio de Sá – Centro de Ciências da saúde, Rio de Janeiro/RJ – Brazil.

[3]Projeto de pesquisa da escola de medicina da Unigranrio – Rio de Janeiro/ RJ – Brazil.

[4]Universidade Estadual da Zona Oeste, Colegiado de Ciências Biológicas e da Saúde, Campo Grande, Rio de Janeiro, Brazil.

[5]Instituto Federal de Educação, Ciência e Tecnologia do Rio de Janeiro, campus Maracanã, Rio de Janeiro, Brazil.

[6]Universidade Federal Rural do Rio de Janeiro, Departamento de Biologia Animal, Seropédica, Rio de Janeiro, Brazil.

Correspondence: e-mail: anatomy.carielo@gmail.com

ABSTRACT: The inherent goal here was to verify the effects of brain stimulation via an instrumentation frequency hearing and vision, aiming, immediate results (acute effect) on memory tasks associated with short-term. The random sample included 20 individuals of both genders, aged between 18 and 25 years (mean 21.8 years). The application for evaluation was to memorize in 10 seconds, a sequence of letters submitted and requiring the faithful reproduction of this sequence, after 20 seconds. Two days later, this providence, proceeded to brain stimulation by means of an electronic computer named Orion manufactured by Mindplace (brain machine), using the auditory modality of stimulation for only 10 individuals, and the visual, for others ten. Next, we carried out a reassessment in the same manner as the previous one. The pre-and post-stimulation were studied using three parametric Analysis of Variance (One-way ANOVA) independent, and the first occurred on the basis of global data, regardless of the rules and, second, by viewing the auditory modality, while the third, the visual. The results indicated a significant difference in performance from the whole group joining the two modalities (visual + auditory), compared to post-stimulation, F 7.467, df (1.38) = 0.009, p <0.05. Checking the effects isolated by method of stimulation, the analysis revealed to be F 6.68, df (1.18) = 0.019, p <0.05 and F = 1.699, df (1.18) = 0.209, p> 0.05 for the visual and auditory modalities, respectively. These results were interpreted as restricting or promoting support for the benefits of acute brain stimulation on the function of short-term memory, indicating further that the photic stimulation is more interactive than the auditory modality when dealing with this benefit. [Academia Arena, 2010;2(3):5-14] (ISSN 1553-992X).

Key words: Brain, Memory, Young persons, Acute effects, photic, sound

INTRODUCTION

Learning and memory processes are related and inseparable. Learning corresponds to the acquisition of new knowledge and consequent behavior modification, while the memory can be understood as the retention of this knowledge (Maxwell et al., 2003, quoted in Cardoso Machado, Silva, 2006). According to Sternberg (2000), quoted Linassi, Soares, Mota (2005), states that the basic operations of memory are encoding, storage and retrieval. The coding is the transformation of sensory input in a form of mental representation that can be stored. Storage is the storage of information encoded. According to Squire & Kandel (2003) recovery refers to access and use of information stored. All these processes interact and are interdependent. The working memory, according to Flavell et al., (1999), quoted Linassi, Soares, Mota (2005), is responsible for the temporary storing of information and has an active role in information processing. The duration of information in short-term memory is small and the decay usually happens within a period of approximately 15 to 25 seconds. The information may be copied or can be downloaded from this deposit to deposit, and long-term effectiveness of memory tends to always depend on the type of strategy used by the aide-memoire. Studies have long ago by George Miller, using a procedure like this determined that the deposit in the short term can "hold" 7 items of information, plus or minus 2. An item of information is "a piece" of information as a letter, number, formula, or sentence. In other words, anything that the brain stores as a unitary representation. In this case it may, the brain, register and hold more information in short-term memory, if organized in a few pieces of high-level information, such as group letters into words.

Developmental searches have revealed a number of differences between young children and older in terms of operability. One of them, and of critical importance to ensuring a sufficiency in learning is referred to the time of durability of a temporary storage (Squire, Kandel, 2003).

If video games as an advisory stimulation may benefit the performance of some mechanisms of memory and the consequent and related performance, which could be the result of stimulation, the part on those same mechanisms? Brain stimulation is not a new event, since many years ago some researchers have managed to identify the effects of electromagnetic loads in individuals with diseases of various facets, in which they included some kind of depression and also neuroses (George et al., 2003).

Regarding the driving issues, Spiegel et al. (2003), found a significant improvement in ambulation of patients with parkinsonian brain stimulation through sound and photic stimulation, and these improvements were associated both amplitude and frequency gait. Another line of evidence, viewing the performance and not specifically, processes, points to the brain stimulation as a variant able to promote significant changes in motor performance (Carter et al., 2006, Marques et al., 2005, Lins, 2006, Silva et al., 2008), as well as for the development of cognitive skills of reference (Marques et al., 2005). This line, combined with stimulation through auditory and noise sources, as described by Marques et al. (2005), in order to produce changes in cortical patterns (rhythms of the brain), hoping for a improvement in its performance, tasks of contractual, or special of the day-to-day social human. Attempts changes are made by selecting a specific frequency to the nature of the individual involved in the research and referentially you want to achieve. The training is made operational by converging streams of light to the retina, then to the olivary nucleus and then to the thalamus, a structure that is responsible for receiving and filtering external stimuli (Machado, 2004). Through the activation of the reticular system, the frequency of operation is then sent to the cortex, occurring, then grip cortical frequency imposed (Brady, 2002).

Thus, considerations about the importance of a system of mental processing fast (fast and accurate) can have on all levels of human competence and the possibility that brain stimulation may have a potential effect on it, define need to conduct research that will strengthen knowledge on the possible relationship of interaction between mental processing and brain stimulation. This paper characterizes an effort toward this need.

MATERIALS AND METHODS

SAMPLE

The study sample was characterized on the agenda for the 20 individuals of both genders, 9 males and 11 females, all of school age (N = 20). As priority setting, they could not present any type of visual disturbance, hearing, physical or mental. Belonging to the same social class and the institution, aiming to keep this one more homogeneous as possible between them. These school children aged between 14 and 21 years were selected randomly, with no distinction made in practice or not physical activities because we believe that this type of control in this case would be irrelevant. This study met the standards for the conduct of human research, as directed by the National Health Council, Resolution 196/96 and approved by the Institutional Ethics Committee of the Universidade Castelo Branco - UCB / RJ. All participants were volunteers, having been requested in all cases, the agreement of parents or guardians for them.

PROCEDURES

The selection took place within a state institution in the city of Campos, RJ. The protocol for data collection was completed the following: young people were examined in a room inside the institution to which they belonged properly equipped with temperature controlled by external noise. Initially as a control for the research subjects were usually held in that room where he explained the type of work they would participate. Then, in order to assess the capacity of short-term memory of these were carried out individually, each of which tests should be evaluated memorize a sequence of letters from a common deck that was presented and, for this task of memorization, a total time of 10 seconds. Immediately after, the assessed should repeat the sequence was shown to them using this time a maximum of 20 seconds. We recorded the total time of execution and the maximum score of mistakes and successes of each individual. After a period of one day control experiment was performed, the process of stimulation, which is applied to groups composed of 4 individuals, and for two of each group used to photic stimulation and for the other two, the sound. Thus, all components of the group were stimulated. We used this stimulation to the electronic device (computer) named Orion (brain machine), manufactured by Mindplace, composed of dark glasses with 4 LEDs on the inner surface of each lens, a stereo headset and a PC where the sessions pre-programmed. These, picked up, according to the methodology, the appropriate section of paragraph 12, which is intended for the learning factor (stimulation to learning). The duration of the session lasted 10 minutes. After this stimulation the individuals were referred to another room, also in ideal conditions, where they repeated the first experimental procedure of memorization of playing cards. It should be noted that for this second data collection, the letters were presented in a different manner to control the collection. For the analysis of data obtained was used as a tool for statistical analysis using SPSS 10.0 for Windows, and the inferential statistics procedure was defined a parametric analysis (ANOVA), while the descriptive references for analysis were the mean and standard standard group, in comparison between pre and post-stimulation. We adopted the margin of error for the test of the principal value of alpha <or = 0.05. The results are listed below.

RESULTS

Table 1 presents both the number (N) of the subjects of the group, as the values for the mean, standard deviation, maximum and minimum scores of correct memory test performed by the group in control and experimental situations without taking into account the type of stimulation performed. It is also described the level of significance found when comparing the two moments, demonstrating that the existence of a statistically significant difference between tasks performed (time of testing).

According to Table 1, by considering the control task (memory test before stimulation) compared to the post-stimulation (experimental task) for the group as a whole, the difference was statistically significant, showing that stimulation influenced, positively, the functions of memory, the group, resulting in greater power to the task of memorization. Stand out that this test has a reference to the short-term memory. In this case, the ANOVA performed resulted in F = 7.467, df 1.38 p 0.009 <0.05.

These data can be more easily interpreted in the plot made in Figure 1 (below).

Figure 1. Plot of mean scores and standard deviations of the group, the control and experimental tasks, identifying a significant increase in the number of correct answers in the memory task compared to the experimental task control.

By comparing the standard deviations before and after stimulation, would be observed that it had a differential effect "within the group," indicating that some individuals were more susceptible to stimulation than others. These differences, however, were not sufficient to cause a heterogeneity that could compromise the test inferential.

Table 2 shows the total N of individuals in the group, at one time task, and the results of the mean, standard deviations, minimum scores, maximum and level of significance between control and experimental time. Note that this table only describes the data of individuals who received photic stimulation (light). The significance of the comparison result shows that there is a significant difference between the time before and after stimulation on photic mode, and the ANOVA performed resulted in F = 6.68, df 1,18, p 0.019, <0 , 05.

Just as occurred with the standard deviation of the group, considering the photic stimulation (light) and noise (sound), together, photic stimulation differently influenced the performance of individuals in the group, increasing the heterogeneity of those at the time of memorization task post-stimulation. However, the group was moderately more effective at this time, making a differentiation result statistically significant, as shown above. Probably this heterogeneity possibly justify the absence of significant interaction observed in the comparison made in the form of sound stimulation (sound). That is, since this did not influence considerably the comparison between pre and post-photic stimulation in the modality, should influence the comparison of data before and after pacing mode noise.

This possibility is addressed in the presentation of relevant data, shown in Table 3 and Figure 3, below.

Figure 2. Difference between the mean scores of hits from the group in relation to pre and post-photic stimulation. Note that this figure also depicts the standard deviation for each time.

According to table 3, in which the scores before and after stimulation performed in the auditory modality trial, stimulation was passed resulting in better performance of individuals who received this type of stimulation, evidenced by higher

scores on the task of memorization, after sound stimulation. It should be noted, the same trend observed in previous periods, in which the heterogeneity of the group increases when the experimental task (the post-stimulation). Since this time, the standard deviation shown greater good. In fact, nearly doubling compared to the time of task control.

As predicted this heterogeneity is reflected in the inferential analysis, resulting in a not statistically significant when comparing pre and post-stimulation, and F = 1.699, df 1.18, p 0.209> 0.05.

Table 1. Average of correct answers, SD - standard deviation scores of correct minimum and maximum memory in the sequence of letters submitted to the group, task control and experimental.

Task	Subjects	Mean	SD	Minimum	Maximum	Significance
Control	20	3.1	1.02	1	5	
						0.009
Experimental	20	4.4	1.96	0	8	

Table 2. Averages of correct answers, SD - standard deviation, scores of correct minimum and maximum storage in the sequence of letters submitted to the group in control and experimental moments, with hit rates far higher in the experimental time.

Task	Subjects	Mean	SD	Minimum	Maximum	Significance
Control	10	3.2	1.03	2	5	
						0.019
Experimental	10	5.0	1.94	2	8	

Table 3. Average of correct answers, SD - standard deviations and scores of correct maximum and minimum on memorization of the sequence of letters presented in the experimental and control groups.

Task	Subjects	Mean	SD	Minimum	Maximum	Significance
Control	10	3.0	1.05	1	5	
						0.209
Experimental	10	3.9	1.91	0	7	

Figure 3 represents the statistical equality of the scores of hits in the memory test compared to control tasks, referring to the auditory stimulation, with their respective standard deviations.

Figure 3. Representation of the negligible difference between the scores of hits from the control group and the group received only auditory stimuli.

Studying Table 3 and Figure 3, respectively, we see, in a first instance, the big difference in the standard deviation of the group, when comparing the data for the task to control the experimental task. In a second instance, we notice that although this is so, the group performance when the experimental task was remarkably better, because it identifies a trend effect also of sound stimulation on individuals stimulated in this mode.

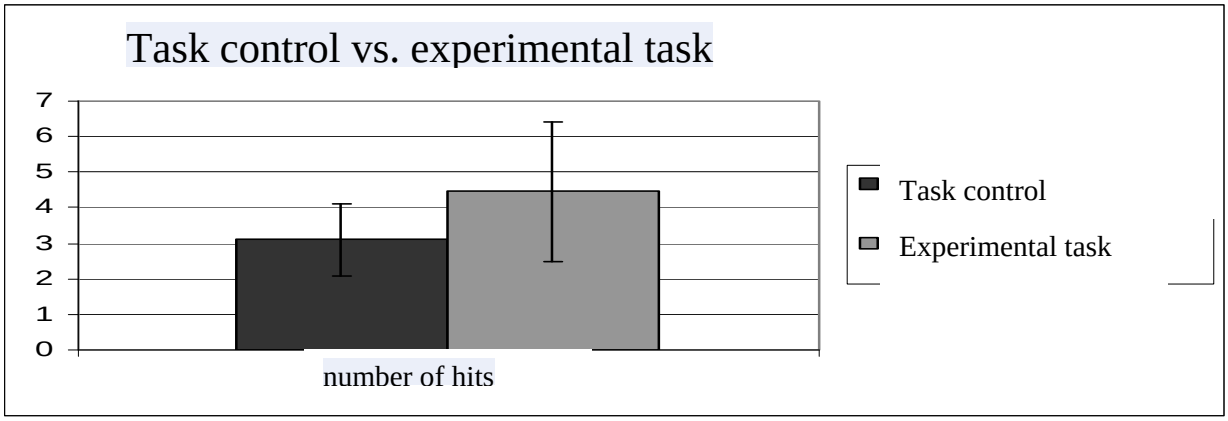

Figure 1. Plot of mean scores and standard deviations of the group, the control and experimental tasks, identifying a significant increase in the number of correct answers in the memory task compared to the experimental task control.

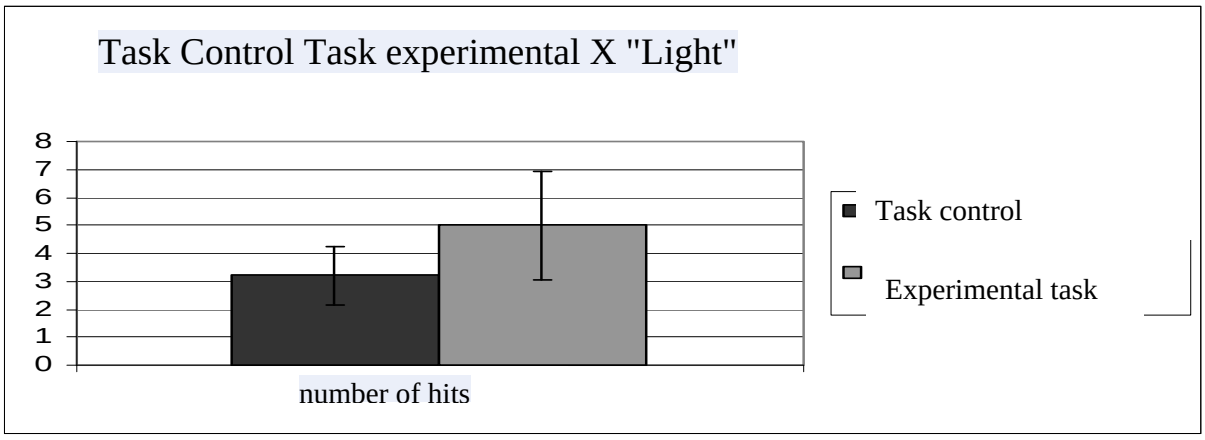

Figure 2. Difference between the mean scores of hits from the group in relation to pre and post-photic stimulation. Note that this figure also depicts the standard deviation for each time.

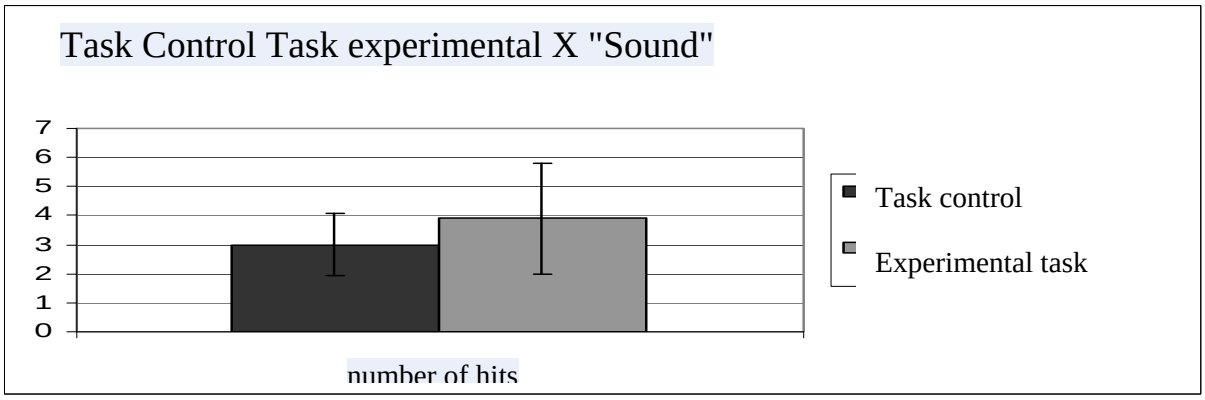

Figure 3. Representation of the negligible difference between the scores of hits from the control group and the group received only auditory stimuli.

DISCUSSION

After the presentation of the results it is, from this point is to highlight the relationship between cause and effect that may have generated the differences that were observed in the test scores of memory, in a comparative way between the time of testing before and after the stimulation effected manipulated.

The first comparison made between the time the control test (control) and experimental (test after stimulation), in which it was not considered separately the effects of sound stimulation or photic, the group of 20 subjects showed an average success rate measured in 3.2 ± 1.03, with the minimum score 1, maximum 5. As for the

time trial, when the memory task was performed after stimulation, the average was 4.4 ± 1.94 items with the same minimum score 0 and maximum of 8, noting that there is overall brain stimulation caused a beneficial effect on the ability of short-term memory. That is, the time control to the experimental, there was an improvement of 43.5% average score on the memory test. Viewing of this result from the perspective of an inferential analysis, the result was significant within the definition of alpha <0.05. Another approach of this study was about the pacing would be more effective the results of this sample for this group was divided into two subgroups of 10 subjects (N = 10) receiving a single photic stimuli and another that received only auditory stimuli. Of interest was the statistical comparison for each type of stimulation in pre and post-stimulation.

In the group that was stimulated only by photic stimuli (light, N = 10) was found as an average score on the test, when the experimental task, the value 5.0 ± 1.94 compared to the average for the same individuals at the time control that was 3.2 ± 1.03. The difference represents an improvement of about 56.6%.

It was observed that in the control task items ranged between 2 and 5 items, whereas in the experimental, these items ranged between 2 and 8 items, setting the percentage improvement already reported. In the case of inferential analysis, this difference was significant, with an alpha value <0.05. This result, therefore, is defined as supportive of the significant effects of brain stimulation in the modality photic (light) on memory function studied. For individuals who received only auditory stimuli was found as the average balance of the group, the experimental task, a value of 3.9 ± 1.91, whereas the control task, the average scores of these individuals was 3 , 0 ± 1.05. The statistical inference concerning the these data revealed a non-significant result, p = 0.209,> 0.05.

Interestingly, despite the lack of statistical significance observed for the type of sound stimulation, the Crescencia on items, checked the task to control the experimental task, ie an increase of 1 to 5, for 0 to 7 items, representing an improvement of 75% in the number of items stored, a fact that is associated with the data obtained by Cardoso Machado, Silva (2006), who found significant results in motor learning using only auditory stimuli and proving the efficiency of stimulation for this purpose.

According to Brady (2002) Apud Marques Ribeiro, Borges, Guagliardi Jr (2005) it is possible to select a particular frequency range in the protocols already established for photic stimulation and noise when you want to train an individual in terms of performance, in this case, from memory. Neurologically As theorized, the stimulation is given by the bombing in the retina with strobe light, which does effect the perception of the frequency of that light, the olivary nucleus and hence its receipt by the thalamus and the reticular system in conjunction diffuse this frequency is sent to the cortex in a few minutes, by imposition of these agents is to accompany it. This induction is benign, matching the hemispheres in the task of processing stimuli.

The data from this study, confirms the author quoted above, but the effects seemed to be not only these, as we shall see below. Due to the fact that the short-term memory, to be effective in tasks of memory you need, also, the effectiveness of a "temporary storage" effective. That is, so we can remember a series of items, it is necessary that we keep these are, for a period until the recall is charged. When temporary storage is not effective, some items may be lost (fragility of perceptual trace), resulting in an impaired ability to remember (Hasse, Lacerda, 2004).

Taking as reference the pre-and post-stimulation recorded from tests in this study, the improvement

in scores in the post-stimulation, may well be directly related to the mechanisms of memory associated with this temporary custody. This deduction, however is only an assumption, considering that the experimental manipulation, here committed, was not addressed in this type of test.

The fact of photic stimulation to show in this research, more efficient in relation to auditory stimulation should be considered for future analysis. Accepting that the cognitive tasks are performed in a subsystem of the short-term memory (or working memory), the speed with which these can be run as the deciding factor in performance (Vernon, 1983a, 1983b, apud Ribeiro, Almeida, 2005). It is expected that the more quickly they recovered and processed the relevant information to solve a problem, the greater the probability threshold of system capacity is not exceeded. Similarly, in the absence of test information in working memory is subject to a rapid decline or disappearance. Hence, a situation of slow processing, the previously encoded information can be recovered or lost, or the maintenance can be done at the expense of overloading the system, so it is unable to perform the processes needed to solve a problem (Ribeiro, Almeida, 2005).

CONCLUSION

According to the results discussed above, we can speculate that the brain stimulation as a whole was effective in improving short-term memory of individuals studied here.

The examination in this study on the processing speed, in reference to short-term memory, showed a beneficial effect of brain stimulation, via light and sound. This knowledge can be used to improve the functions decaying by aging and to improve the functions of the body or specific common tasks of life, since, Andrade, Belmonte, Viana (2007) reports that it is genetically predisposed, but it is possible to improve it (memory) through training, and this improvement can reach 15%.

Correspondence to:

Prof. Alessandro Carielo de Albuquerque

Universidade Estácio de Sá – Centro de Ciências da saúde, (Bangu) Rio de Janeiro/RJ – Brazil.

Rua Arlete C. Ayres Wanderley, 336, CEP 21745-650

Sulacap, Rio de Janeiro - RJ – Brazil.

Telephone: ++ (55) (21) 35552134

Cellular phone: ++ (55) (21) 95291430

e-mail: anatomy.carielo@gmail.com

REFERENCES

Andrade A, Belmonte AP, Viana MS. Tempo de reação, flexibilidade e velocidade acíclica de membros inferiores de atletas de tae kwon do. Lecturas Educación Física y Deportes. 2006;11(96).

Silva VF, Poly MWO, Junior SMR, Calomeni MR, Pinto MMV, Silva SAL. Efeito agudo da estimulação cerebral atraves de luz e som no tempo de reação motora de jovens atletas. Lecturas Educación Física y Deportes. 2008;13(120).

Lins FRW. A incidência padrão de atividade cortical e a influência da potencialização cerebral sobre os efeitos da ansiedade na execução do pênalti, em atletas de futebol de campo. 2006. Dissertação de mestrado. Universidade Castelo Branco-RJ.

Machado SEC, Cardoso FB, Silva VF. Estimulação Cerebral e Aprendizagem Motora: Efeitos no Aprendizado do Jogo de Boliche. III Congresso Científico Latino-Americano da FIEP, Foz do Iguaçu – PR/2006.
http://penta.ufrgs.br/edu/telelab/1/types.htm#primary

Linassi LZ, Keske S, Marcia MHB. Habilidades de memória de trabalho e o grau de severidade do desvio fonológico. Pró-Fono R. Atual. Cient. 2005;17(3):383-92.

Brady DB. Binaural-Beat Induced Theta EEG Activity and Hypnotic Susceptibility. Northern Arizona University. 1997. http://www.portalmonroebrasil.com/.

Cardoso FB, Machado SEC, Silva VF. Estimulação Cerebral e Aprendizagem Motora: Efeitos no Aprendizado do Jogo de Boliche. Apresentado no III Congresso Científico Latino-Americano da FIEP, Foz do Iguaçu - PR/2006.

Ribeiro IS, Almeida LS. Velocidade de Processamento da Informação na Definição e Avaliação da Inteligência. Psicologia: Teoria e Pesquisa. 2005;21(1):1-5.

Spiegel S, Fuss G, Backens M, Reith W, Magnus T, Becker G, Moringlane JRD. Journal of Neurosurgery. 2003;99:772-74.

George M, Nahas Z, Lisanby S, Schlaepfer T, Kozel F, Greenberg B. Transcranial Magnetic Stimulation. Neurosurgery Clinics of North America. 2003;2(14):283-301.

Marques LJ, Ribeiro LHB, Borges D, Guagliardi JR, Mário R. Método M.R. de Potencialização Cerebral e Controle da Mente © 2004 em Atleta de Triatlon. 2005. Apresentado no Congresso FIEP Cabo Frio.

Marques LJ, Ribeiro LHB, Rocha D, Barros G, Borges D, Dias F, Delanei L, Araujo CEV, Guagliard JR, Mário R, Godoy ES, Silva RPA. Comparação dos efeitos da Potencialização Cerebral sobre a atividade cortical em grupos de diferentes preferências de processamento hemisférico. 2005. Artigo apresentado no congresso FIEP/Foz do Iguaçu.

Squire LR, Kandel ER. Memória: da mente as moléculas. Artmed. Porto Alegre, Brasil. 2003.

Machado ABM. Neuronanatomia funcional. Atheneu. São Paulo, Brasil. 2004.

Hasse VG, Lacerda SS. Neuroplasticidade, Variação interindividual e recuperação funcional em neuropsicologia. Temas em psicologia da SBP. 2004;12(1):28-42.

Submission date: 19/01/2010