Fisioter Bras 2018;19(6):847-9
https://doi.org/10.33233/fb.v19i6.2501

SHORT COMMUNICATION

Movement automatization: motor interactions and electroencephalogram application

Automatização do movimento: interações motoras e aplicação do eletroencefalograma

João Marques Ferreira Neto*, Diandra Caroline Martins*, Anderson de Sousa Escórcio*, Gabriela Teles*, Monara Nunes*, Sávio Antoniel Almeida*, Maryanne Torres Rodrigues**, Marco Antonio Orsini Neves***, Janaina de Moraes Silva****, Silmar Silva Teixeira*****, Eduardo Trajano******, Denise Flávio de Carvalho*******, Patricia Dusek********, Victor Hugo do Vale Bastos*

**Brain Mapping and Functionality Laboratory (LAMCEF/UFPI), Federal University of Piauí, Brazil, **Undergraduated in Physiotherapy from the College of Sciences and Technology of Maranhão, Caxias, Brazil, ***Master Program in Applied Health Sciences, Vassouras University, Master Program in Local Development UNISUAM/RJ, Brazil, Centro de Atenção e Saúde Funcional Ramon Pereira Freitas, ****Assistant professor, State University of Piauí (UESPI), Health Sciences Center, Piauí, Brazil, *****Neuro-innovation Technology & Brain Mapping Laboratory, Federal University of Piauí, Parnaíba, Brazil, ******Master's Program in Applied Health Sciences, Vassouras University, Rio de Janeiro, Brazil, *******Centro de Atenção e Saúde Funcional Ramon Pereira Freitas, ********Master Program in Local Development UNISUAM/RJ*

Correspondence: Diandra Caroline Martins e Silva, Federal University of Piauí, Brazil. Email: diandra_martins@yahoo.com.br; João Marques Ferreira Neto: marques0809@gmail.com; Anderson de Sousa Escórcio: anderson.escorcio99@gmail.com; Gabriela Teles: gabitelesmonteiro@hotmail.com; Monara Nunes: monarakedma@hotmail.com; Sávio Antoniel Almeida: savioantoniel@outlook.com; Maryanne Torres Rodrigues: maryanne-torres@hotmail.com; Marco Antonio Orsini Neves: orsinimarco@hotmail.com; Janaina de Moraes Silva: fisiojanainams@gmail.com; Eduardo Trajano: eduardolimatrajano@hotmail.com; Denise Flávio de Carvalho: denise.flavio40@globo.com; Patricia Dusek: patricia.dusek@unisuam.edu.br; Silmar Silva Texeira: silmarteixeira@ufpi.edu.br; Victor Hugo do Vale Bastos: victorhugobastos@ufpi.edu.br

Abstract

The specificities of the motor system lead people to present skills to perform some movements in an automatic way after learning. Acquiring the automaticity of the movements is usually associated with reducing the demands of attention control. Thus, automatization represents a reduction in interference that undermines performance in dual task conditions. It was carried out a search on the databases of Pubmed, Scopus, SciELO e Lilacs, to understand the physiology of automaticity and analyze the use of electroencephalogram as a means of research in automatization. In this context, the study aims to verify the employment of the electroencephalogram as a resource in the analysis of the motor skills involved in the movement automatization.
Key-words: motion, attention, electroencephalogram.

Resumo

As especificidades do sistema motor levam às pessoas há apresentarem habilidades para realizar alguns movimentos de maneira automática depois de aprendidos. Adquirir a automaticidade dos movimentos geralmente está associada à redução das demandas de controle da atenção. Assim, a automatização representa uma redução da interferência que prejudica o desempenho em condições de tarefa dupla. Para este estudo foi realizado uma revisão integrativa de estudos indexados nas bases de dados Pubmed, Scopus, SciELO e Lilacs, para compreender a fisiologia da automaticidade e analisar a utilização do eletroencefalograma (EEG) como meio de investigação na automatização. Neste contexto, o

estudo tem por objetivo verificar o emprego do eletroencefalograma como recurso na análise das habilidades motoras envolvidas na automatização do movimento.
Palavras-chave: movimento, atenção, eletroencefalograma.

An indisputable feature of the motor system is that people have the ability to control some movements in an automatic way. In this way the movements are performed without the attention being directed properly to the details of the movement particularly for those requiring low precision or that are commonly made [1]. Humans generally do not think about how to move the lower extremities when they are walking, the viability of the attention resources throughout the practice is caused by the automatization process. Theories of automaticity postulate that the increase in the strength of a memory commonly benefits performance and leads to automatization, whatever the representative form of acquired memory [2,3].

In this way, automatization is a relevant aspect of motor learning, because the motor skills are controlled with a high degree of automatization as the experience increases. In contrast, beginners tend to involve a greater amount of attention to control their movements [4]. The motor automatization process involves the function of specific cortical areas: it is considered that the cerebellum, the motor area cingulate, the additional motor area and the putamen have more significant connectivity, and that the extent to which people they learn and become more skilled at performing specific tasks, they typically use less global brain resources. Once the automatization of the improved movement captures less working memory capacity [1,5,6].

One way to test movement automatization is by performing dual tasks, in which the participant performs two activities simultaneously. This type of method is an integral part of our daily operation. During the day, we often need to perform motor tasks with all kinds of cognitive abilities. For performance the dual task to be successful will depend on the working memory capacity of an individual [6]. Typically, it is assumed that during the dual task, each task consumes a portion of the capacity of the working memory. If the combined processing demands of two tasks exceed the capacity of the operating memory, interference will occur and performance on one or both of these tasks is going to deteriorate. Thus, one way to improve dual task performance is to reduce the demands placed on the working memory, then, by increasing the automaticity of the movement [6].

While performing two tasks simultaneously, most of the processing capacity is distributed to the main task. If the main task is relatively easy or the individual presents skill in its realization, more attention capacity can be directed to the secondary task, resulting in better performance in the latter. In this way the performance in the secondary task can be considered as an indirect reflection of the proficiency of the primary task [7]. A relevant methodological problem of testing the automatization of dual task tests derives from findings that are indicative of other explanations for the reduction of dual task costs, in addition to the expected automatization of the motor control [4]. Some studies show an effective integration of the two tasks (effective exchange of attention between tasks) that have been repeatedly performed together, rather than an automatization of the main task to reduce the costs of dual task [8].

Studies suggest analysis of automated motor skills with use of resources such as electromyography (EMG) and magnetic resonance imaging, but these two methods become difficult to access due to the high cost. In this way a way to understand the cognitive processes involved in acquiring a new skill is the electroencephalogram (EEG), which allows a record of electrical activities in the cerebral cortex corresponding to the flow of information processed by the cortex in activities during the execution of a motor task, be it complex, simple, or during an exercise, with a temporal resolution greater than other instruments [9]. The EEG is a method widely used in clinical and psychological laboratories to monitor in a non-invasive way the brain activity, based on the variations of voltages that are captured by different electrodes. The large pyramidal neurons vertically oriented and located in cortical layers are the main generators of the electrical fields of the EEG [10].

The incorporation of the motor gesture from the repetition of the motor activity produces neural alterations capable of being detected with the use of quantitative electroencephalogram (EEGq). The Alpha frequency band has been correlated to cognitive processes, particularly fast alpha (10 and 12 Hz), changes in the subject's exposure to cognitive tasks of the most different levels of complexity. Beta is considered a fast wave frequency (12 to 30 Hz) and appears to be the one that is most related to motor activities, both premotors and motor itself, having value for analyses related to normal and pathological movements. The theta frequency band is associated with automatism and attention processes, as well as being important for a variety of cognitive functions [11,12].

Although previous studies have already provided important aspects, the internal mechanisms in which automatic control can be achieved is still open to discussion, like in relevant studies that seek to verify the use of means of neuronal research, such as EEG as a resource in the analysis of the motor skills involved in the automatization of the movement.

References

1. Tao W, Piu C, Mark H. Modifications of the interactions in the motor networks when a movement becomes automatic. J Physiol 2008;586(17):4295-304. https://doi.org/10.1113/jphysiol.2008.153445
2. Manfred A, Krause D. Reduced dual task interference in multiple repeated dual-task tests: automatization or task integration? In: Juras G, Slomka K, eds. Current research in motor control IV - From Theory to Implementation. AWF Katowice; 2012. p.8-14
3. Daniel JS, Paul JR. Explicit pre-training instruction does not improve implicit perceptual-motor sequence learning. Cognition 2013;126(3):341-51. https://doi.org/10.1016/j.cognition.2012.11.006
4. Manfred A, Krause D. Effects of bandwidth feedback on the automatization of an arm movement sequence. Hum Mov Sci 2016;45:71-83. https://doi.org/10.1016/j.humov.2015.11.005
5. Chein JM, Schneider W. The brain's learning and control architecture. Curr Dir Psychol Sci 2012;21(2):78-84. https://doi.org/10.1177/0963721411434977
6. Kal EC, Kamp JV, Houdijk H, Groet E, Bennekom CAM, Scherder EJA. Stay focused! the effects of internal and external focus of attention on movement automaticity in patients with stroke. Plos One 2015;10(8): e0136917.https://doi.org/ 10.1371/journal.pone.0136917
7. Chen CY, Dai J, Chen IF, Chou KM, Chang CK. Reliability and validity of a dual-task test for skill proficiency in roundhouse kicks in elite taekwondo athletes. Open Access J Sports Med 2015;19(6):181-9. https://doi.org/ 10.2147/OAJSM.S84671.
8. Agethen M, Krause D, Jasarovski N. The validity of multiple-repeated dual-task tests to estimate the level of motor skill automaticity. J Sport Exerc Psychol 2012;34(Suppl):98-99
9. Luft CDB. A pesquisa com EEG aplicada à área de aprendizagem motora. Rev Port Cien Desp 2006;6(1)106-15. https://doi.org/10.5628/rpcd.06.01.106
10. Gomes MM. Bases fisiológicas do eletroencefalograma. Rev Bras Neurol 2015;51(1):12-7.
11. Machado D, Bastos VH, Cunha M, Silva VF, Cagy M, Piedade R, Ribeiro P. Efeitos do bromazepam observados pela Eletroencefalografia quantitativa (eegq) durante a prática de datilografia. Arq Neuropsiquiatr 2005;63(2b). https://doi.org/10.1590/S0004-282X2005000300016
12. Paul Sauseng P, Wolfgang Klimesch W. What does phase information of oscillatory brain activity tell us about cognitive processes? Neurosci Biobehav Rev 2008;32(5):1001-13. https://doi.org/10.1016/j.neubiorev.2008.03.014