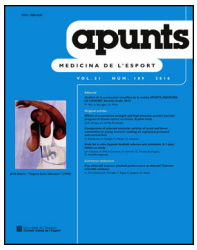
Apunts Med Esport. 2019;54(203):105–106

apunts
MEDICINA DE L'ESPORT
www.apunts/org



LETTER TO THE EDITOR

Non-invasive brain stimulation in athletic competition

Estimulación cerebral no invasiva en competencias atléticas

Dear Editor,

For professional athletes, three adjectives – faster, higher, stronger are corporate with the spirit of competitive sport. High demand applied by trainers on athletes to increase performance has raised the interest in enhancing performance using new approaches. Application of non-invasive brain stimulation (NIBS) techniques in sports has become a popular topic in sport science based on observations that are in favor of enhancing athletic performance.[1] NIBS techniques, such as transcranial magnetic stimulation (TMS), transcranial direct current stimulation (tDCS), are used in clinical and non-clinical setting. These techniques function through different mechanisms. While TMS is used to deliver a powerful but brief electrical current through an insulated wire coil placed on the skull that can depolarize neurons and thereby trigger action potentials,[2] tDCS modulates brain excitability through the application of direct current at low amplitudes delivered from electrodes that are placed on the scalp. Stimulation polarity in this technique leads to a different outcome, anodal stimulation increases excitability, while cathodal stimulation decreases it.[3] It has been proposed that athletic physical and mental performances can be enhanced by use of NIBS techniques.[4] Evidence presents that NIBS could decrease reaction time, and fatigue, and enhance cognitive function, complex motor skills, balance, and strength.[5]

Previous studies are mainly designed to test NIBS effects on enhancement of physical and mental performances under experimental setting. However, real world competition is normally performed under social stressors that are capable of provoking physiological and psychological responses that can be clustered into different coping patterns under competition. In real world competition, victory and defeat are often affected by anxiety, tension, stress, and pressure that can negatively influence technical and tactical skills. Therefore, simulation of competitions to test NIBS imposes limitations to identify effects of these aspects. Hence, it is important to consider these elements while designing studies to identify whether NIBS differentially modulates physical and mental function under experimental conditions. Alternatively, NIBS can be applied in real competitions. Currently, this is not a common practice and literature is still limited about enhancement effects of NIBS under real sport competitions. Future will reveal how NIBS might be applied in competitive sport. Future experimental studies must therefore be designed to include sham condition and control groups, while the study remains blinded. Moreover, to provide a better setting similar to actual load of official competitions, stressors mentioned above and appropriate ways to introduce those into an experimental setting must be considered. Combined assessments including physiological (e.g., neuroendocrine, immunological and cardiovascular responses) and psychological responses (e.g., perceived stress, competitive anxiety, and coping strategy) seem necessary in this context to allow multidimensional assessments that can lead to reliable and more accurate interpretation of results.

Another point that is largely neglected under experimental conditions is the effect of time and number of applications. Beneficial effects of NIBS might appear different when it is used as single or repetitive application. It is still not clear whether athletes might benefit from a single session effect or repetitive applications under non-experimental conditions and real world competition. Evidence shows that single session effect can be achieved.[6] Studies also show that repetitive application of NIBS can enhance the impact of stimulation and hence the overall outcome.[7] There is still a lack of information on safety aspects of long term or repetitive use of NIBS techniques,[8] and current literature does not provide a clear guide for application protocols to include electrode or coil placement, stimulation time and current. Previous studies have notified differences among responders while some are highly responsive, others do not respond well and this phenomenon seems to be influenced by athletes' sex.[9] In addition, synergistic effects of NIBS, along with other methods, can determine whether effectiveness of combined application would alter the overall outcome.

Taken together, current literature calls for further investigation to provide a clear context on technical, ethical, and regulatory aspects of NIBS for sport competition. Related to the ethics and regulations promoted by WADA, NIBS is not identified with a simple biological test at the present time[10] and hence other techniques might be required to determine

https://doi.org/10.1016/j.apunts.2019.07.002

if sport integrity is maintained in a sport competition where NIBS are applied.

Source of financing

Self-financed.

Conflicts of interest

None declared.

References

1. Davis NJ. Neurodoping: brain stimulation as a performance-enhancing measure. Sport Med. 2013;43:649–53, http://dx.doi.org/10.1007/s40279-013-0027-z.
2. Leite J, Simis M, Carvalho S, Fregni F, editors. Transcranial magnetic stimulation. Elsevier: 69LWWA Ltd.; 2018. p. 1577–87.
3. Fertonani A, Miniussi C. Transcranial electrical stimulation: what we know and do not know about mechanisms. Neuroscientist. 2017;23:109–23, http://dx.doi.org/10.1177/1073858416631966.
4. Colzato LS, Nitsche MA, Kibele A. Noninvasive brain stimulation and neural entrainment enhance athletic performance – a review. J Cogn Enhanc. 2017;1:73–9, http://dx.doi.org/10.1007/s41465-016-0003-2.
5. Reardon S. Brain doping' may improve athletes' performance. Nature. 2016;531:283, http://dx.doi.org/10.1038/nature.2016.19534.
6. Seidel O, Ragert P. Effects of transcranial direct current stimulation of primary motor cortex on reaction time and tapping performance: a comparison between athletes and non-athletes. Front Hum Neurosci. 2019;13:103–13, http://dx.doi.org/10.3389/fnhum.2019.00103.
7. Yosephi MH, Ehsani F, Zoghi M, Jaberzadeh S. Multi-session anodal tDCS enhances the effects of postural training on balance and postural stability in older adults with high fall risk: primary motor cortex versus cerebellar stimulation. Brain Stimul. 2018;11:1239–50, http://dx.doi.org/10.1016/j.brs.2018.07.044.
8. Imperatori LS, Milbourn L, Garasic MD. Would the use of safe, cost-effective tDCS tackle rather than cause unfairness in sports? J Cogn Enhanc. 2018;2:377–87, http://dx.doi.org/10.1007/s41465-018-0113-0.
9. Russell M, Goodman T, Wang Q, Groshong B, Lyeth BG. Gender differences in current received during transcranial electrical stimulation. Front Psychiatry. 2014;5:104–14, http://dx.doi.org/10.3389/fpsyt.2014.00104.
10. Gazerani P. Performance enhancement by brain stimulation. J Sports Sci Med. 2017;16:438.

Amir Hossien Mehrsafar[a,*], Parisa Gazerani[b]

[a] *Department of Sport Psychology, Faculty of Sports Sciences, University of Tehran, Tehran, Iran*
[b] *Department of Health Science and Technology, School of Medicine and Health, Aalborg University, Aalborg, Denmark*

[*] Corresponding author.
E-mail addresses: a.mehrsafar@ut.ac.ir, a.mehrsafar@gmail.com (A.H. Mehrsafar).
Available online 6 August 2019